UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF MICHIGAN
SOUTHERN DIVISION

BEI TECHNOLOGIES, INC., a Delaware corporation, and BEI SENSORS & SYSTEMS COMPANY, INC., a Delaware corporation,

Plaintiffs/Counter-Defendants,

Case No. 01-73758

v.

HON. AVERN COHN

MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD., a corporation of Japan, MATSUSHITA ELECTRONIC COMPONENTS CO., LTD., a corporation of Japan, and MATSUSHITA ELECTRIC CORPORATION OF AMERICA, a Delaware corporation,

Defendants/Counter-Plaintiffs.

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AMENDED DECISION ON CROSS-MOTIONS

FOR SUMMARY JUDGMENT

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AMENDED DECISION ON CROSS-MOTIONS FOR SUMMARY JUDGMENT[*]

I. Introduction

This is a patent case. Plaintiffs BEI Technologies, Inc. and BEI Sensors & Systems Company, Inc. (collectively, BEI),[1] exclusive licensee of U.S. Patent No. 4,654,663 ('663), entitled Angular Rate Sensor Systems, are suing defendants Matsushita Electric Industrial Co., Ltd., Matsushita Electronic Components Co., Ltd.,

[*]This amended decision is issued to correct typographical errors in the decision filed June 12, 2003. The parties were advised of the conclusion of this decision by letter dated May 7, 2003.

[1]The role of BEI Sensors & Systems Company, Inc. is not clear.

and Matsushita Electric Corporation of America (collectively, Matsushita),[2] for infringement in the making, etc., of quartz rate sensor products and components, and related products and services which fall within the scope of one or more of the claims of the '663 patent. At this time the sole claim in issue is claim 1; the other asserted claims have been bifurcated.

Now before the Court are cross-motions for summary judgment. In particular, what is at issue is one of the elements of claim 1. That is, whether the tuning forks for Matsushita's angular rate sensors are formed from "a single crystal of piezoelectric material" as that phase has been interpreted by the Court.[3]

For the reasons which follow, BEI's motion is DENIED and Matsushita's motion is GRANTED IN PART and DENIED IN PART. Matsushita's product line of angular rate sensors do not literally infringe claim 1; there is a genuine issue of material fact over whether they infringe claim 1 under the doctrine of equivalents.[4]

The decision here has not been easy to reach but not because of the subject matter. Rather, the case has been marked by an excessiveness that has resulted in the Court being inundated with papers in the form of briefs, exhibits (sometimes filed three

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[2]The separate roles of defendants is not clear.

[3]The parties also disputed whether Matsushita's angular rate sensors met another element of claim 1: that is, a "tuning fork providing a balanced resonant sensor responsive solely to a component of angular motion about the longitudinal axis of the output shaft." The court-appointed expert found that this element was literally satisfied. Neither party took exception to the expert's report on this ground; thus, the Court will not consider this element.

[4]Excluded from this decision is the model S7 sensor. The claim of infringement against the S7 sensor was bifurcated on March 7, 2003 on the record; it will be considered separately.

or four times), overblown and argumentative statements of material facts and responses, copies of cited cases in triplicate on occasion, repetitious analysis and argument, and sometimes dissembling and tendentious argument as well as inconsistent styling of papers.

II. The '663 Patent

An Angular Rate Sensor System is described in the ABSTRACT of the '663 patent as follows:

> An angular rate sensor system is disclosed, consisting of a balanced resonant sensor. The sensor consists of a tuning fork of a piezoelectric material, preferably of quartz. The tines of the tuning fork are caused to vibrate electromechanically, for example, by impressing an alternating voltage on a pair of electrodes on each tine. This will cause the tines to vibrate. Any component of angular motion around the axis of the sensor causes a cyclic deflection of the tines at right angles to the normal driven vibration of the tines. If the rotational input to the handle of the sensor is applied through a torsion element, the resulting tine deflection is directed to cyclically rotate the entire sensor along the input/output axis. This deflection can be used for changing the capacitance of a capacitance bridge, or for generating an electric signal, due to the piezoelectric effect resulting from the deflection. Finally, the output signal may consist of a frequency-modulated signal or an optical pick-up may be used. The system may take various forms, including one, two, four, or eight tuning forks forming a unitary system.

The '663 patent discloses in the words of the DETAILED DESCRIPTION (Col. 6, ll. 7-28):

> . . . an angular rate sensor comprising basically a tuning fork energized by a drive oscillator. Angular motion of the system will cause a deflection of the output shaft at right angles to the direction of vibration. This deflection can be measured either by a capacitance effect, by a resistive effect, or by an electric voltage generated by the piezoelectric effect. Also, a frequency-modulated output

> signal may be obtained, or an optical pick-up may be used. Various configurations have been shown providing a multiplicity of tuning forks. The preferred arrangement permits control of the frequency of the output signal with respect to the vibration of the sensor. Such an angular rate sensor can be manufactured by semiconductor techniques much more inexpensively than a conventional gyroscope. In addition to being less expensive to manufacture, its accuracy should be sufficient for most practical applications, as directional and attitude references with magnetically or gravitationally corrected applications and even for inertial quality references used as a self-contained inertial guidance system.

Angular rate sensors are useful in determining the angular rate of motion in aircraft, spacecraft, ships, missiles, and motor vehicles, and are a significant improvement over gyroscopes, particularly when miniature size is useful.

Claim 1 of the '663 patent reads:

> An angular rate sensor system comprising:
>
> (a) a tuning fork formed from a single crystal of piezoelectric material, said tuning fork having two tines and a common shaft disposed in a plane, said common shaft serving as an output shaft, said tuning fork providing a balanced resonant sensor responsive solely to a component of angular motion about the longitudinal axis of the output shaft, causing a torsional deflection of said output shaft
>
> (b) driving means coupled to said tines for causing them to vibrate at a drive frequency
>
> (c) electrode means, responsive to piezoelectric signals, positioned on said tuning fork for sensing said piezoelectric signals representative of the angular rate of motion about said axis to which said system is subjected and
>
> (d) output means including a phase detector for said piezoelectric signals and means for generating an output signal indicative of the angular rate of motion.

The phrase a single crystal of piezoelectric material was the principle subject of

the Markman hearing and after a good deal of argument was interpreted by the Court as follows:

> A single piece of natural or synthetic piezoelectric or semiconductor material whose atoms are arranged with some degree of geometric regularity and which produces a relatively stable output signal when mechanical force is applied.[5]

In its interpretation the Court said:

> This construction is consistent with [the] scientific dictionary definition of crystal and distinguishes the material from which the tuning fork is made from the material called for in the relevant prior art, particularly U.S. Patent Nos. 3,141,100; 3,206,986; and 3,258,617.[6]

The Court also said:

> The parties and the Court have been engaged in a Markman proceeding. Considerable lawyer effort has been expended in the proceeding and an enormous amount of paper has been generated. The parties know more about and are better aware of the consequences of claim construction than is the Court. What follows are the Court's determinations - determinations that are tentative and subject to revision should there be cause to reconsider.[7]
>
> . . . .
>
> The Court has fully considered Matsushita's arguments in opposition to BEI's proffered constructions and has, to the extent not reflected in this order, rejected them. However, nothing in this order precludes Matsushita in arguing against infringement to assert, once the infringing device is in issue and the Court made aware of the material from which it is constructed, that BEI's efforts to read claim 1

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[5]See Order On Claim Construction filed October 24, 2002, at p. 6.

[6]Id. at 6-7.

[7]Id. at 4 (footnote omitted).

> on the infringing device are limited under the doctrine of argument-based estoppel. See Elkay Mfg. Co. v. Ebco Mfg. Co., 192 F.3d 973, 979 (Fed. Cir. 1999).[8]

Unfortunately, what followed in the cross-motions for summary judgment on infringement was a dispute over the Court's interpretation. As will be seen, the parties assiduously failed to come to grips at the Markman hearing with the characteristics of a bonded wafer.

III. Preliminary Matters

A. The Motions For Summary Judgment

BEI moves for summary judgment on the ground:

> Based on its own scientific publications, patents, patent applications, marketing materials and the admission of its witnesses, the accused products satisfy the claim element of a single crystal of piezoelectric material as that claim element has been construed by the Court.

Matsushita moves for summary judgment on the ground that

> [t]he tuning forks of the MACO ARS are not formed from "A single crystal of piezoelectric material."

What is involved in these differing positions is whether a tuning fork manufactured from two crystal wafers bonded by fusion into a single wafer in a process known as direct bonding in which each of the unbonded wafers maintain their separate identities, particularly because of reverse polarity of the separate wafers, constitutes "a single crystal of piezoelectric material," as that phrase has been interpreted by the Court.

Both literal infringement and infringement by equivalents are asserted by BEI.

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[8] Id. at 9.

B. Other Motions

Because of the short remaining life of the '663 patent, BEI, at the Markman hearing, urged the Court to set an early trial date. The Court obliged. The Markman hearing took place on August 26, 2002. The Order On Claim Construction was entered on October 24, 2002. On October 23, 2002, the Court entered a detailed Amended Pretrial and Scheduling Order setting February 3, 2003 as the trial date. In order to simplify the trial, the Court, on December 2, 2002, entered an order bifurcating damages and willfulness and staying the issue of inequitable conduct.

Inexplicably on December 6, 2002, BEI filed the following motions:

– motion for summary judgment of infringement

– motion for summary judgment of validity

– motion for summary judgment that claim 1 of the '663 patent does not violate the best mode obligation of 35 U.S.C. § 112.

On December 6, 2002, Matsushita also filed a motion for summary judgment of non-infringement and a motion in limine to exclude the testimony of BEI's expert Dr. Errol P. EerNisse concerning infringement.

These motions put the February 3, 2003 trial date in jeopardy. In an effort to maintain the date, the Court obtained the agreement of the parties to the appointment of a court-appointed expert under Fed. R. Evid. 706 to report to the Court by January 20, 2003 on the pending motions, stating:

> Because of the immediacy of the trial and the likelihood that decision on one or more of the pending motions may materially affect the trial of the case, an early appraisal of the merits of each of the motions is in the best interest of the parties. It will materially assist the Court in appraising the

> merits of each of the motions if it has the opinion of an expert as to whether or not there are genuine issues of material fact involved in each of the motions, and, if so, what these facts are.[9]

C. The Court Appointed Expert

The Court, because of the pressure of time, directed the expert orally to first report on the infringement/non-infringement motions.

On January 23, 2003, the expert filed his report recommending that the Court deny BEI's motion for summary judgment and grant Matsushita's motion for summary judgment.[10] Relevant portions (edited) of the expert's report follow:

> [1.]
>
> [Literal Infringement]
>
> The [accused devices] are all angular rate sensors having a bimorph tuning fork. . . . That the tuning forks of these devices are manufactured from two separate wafers of crystalline quartz which are directly bonded together with their electric axes reversed does not appear to be in dispute.
>
> What appears also not to be in dispute is that the direct bonding process creates a small boundary layer or interface of disrupted, possibly amorphous material having a thickness on the order of 20 nanometers.
>
> The first limitation interpreted by the Court and relevant to an infringement analysis relates to the claim limitation "a single crystal of piezoelectric material" which the Court has construed as meaning:
>
> A single piece of natural or synthetic

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[9]See Amended Order Appointing Expert Under Fed. R. Evid. 706 filed December 17, 2002, at p. 2.

[10]See Report By Court Appointed Expert David D. Murray filed January 23, 2003, attached as Exhibit A.

> piezoelectric or semi-conductor material whose atoms are arranged with some degree of geometric regularity and which produces a relatively stable output signal when mechanical force is applied.

Judge Cohn's construction both remains true to the "single crystal" language of the claim and acknowledges the possibility of dislocations or other minor irregularities in the crystal (lattice) structure. It does not, however, encompass a structure having two distinct arrangements of atoms each independently having some degree of geometric regularity and certainly does not encompass a boundary layer or interface between the two crystal layers.

. . . .

BEI's argument and the opinion of its expert, Dr. Errol P. EerNisse regarding the direct bonding or boundary layer and its minuscule thickness are misplaced. Regardless of the thickness or even the existence of such a layer, the tuning forks of these angular rate sensors are bimorphs – made up of two crystals with their electrical axes reversed. These are not single crystals as the Court has construed this language. Hence, these accused devices do not respond to this claim limitation as construed by Judge Cohn.

[2.]

[Infringement By Equivalents]

Consideration of this limitation under the doctrine of equivalents necessitates application of the precepts of Warner-Jenkinson Co. v. Hilton Davis Chemical Co., 520 U.S. 17, 41 U.S.P.Q.2d 1865 (1997) and Festo Corporation v. Shoketsu Kinzoku Kogyo Kabushiki Co., Ltd., 535 U.S. 722 (2002).

In Warner-Jenkinson, the Court recognized that prosecution history estoppel does not arise in every instance of claim amendment. In Festo, the court sought to correct an overzealous Federal Circuit Court that had sought to eliminate any flexible estoppel application. Here, the very limitation at issue is the same limitation, that when added to the claims, conferred patentability thereupon. Since the

> amendment was clearly undertaken to overcome prior art, it had a substantial reason related to patentability and under both Warner-Jenkinson and Festo, prosecution history estoppel applies. The doctrine of equivalents is therefore not available to BEI with regard to the single crystal claim limitation.[11]

D. The Parties' Response to the Expert's Report

As to be expected, Matsushita embraced the expert's report; BEI vigorously disputed the expert's report.

1.

Particularly as to literal infringement BEI says that the expert's statement that

> the [Matsushita] tuning fork[] . . . [is] manufactured from two separate wafers of crystalline quartz which are directly bonded with their electric axes reversed

is inaccurate. To be accurate, BEI says the statement should read:

> [The Matsushita tuning fork is] manufactured from a single wafer of crystalline quartz which is the product of two separate wafers of crystalline quartz directly bonded by fusion at their atomic level with their electric axes reversed.

However, as will be described below, in the bonded wafer the separate identity of the two wafers which are directly bonded is not lost because the electrical axis of each continues to be reversed on the opposite sides of the bonded wafer and because the separate identity of each is identifiable in the bonded wafer. The bonded wafer is not a

[11]The expert also observed that the lack of specificity in the specification with regard to the phrase "single crystal" raised a question of invalidity under 35 U.S.C. § 112 or § 132. Matsushita then sought to supplement its interrogatory answers to include this particular invalidity defense. The Court denied Matsushita's request. See Order Denying Matsushita's Motion for Leave to Serve Supplemental Interrogatory Responses filed March 27, 2003. Thus, this particular invalidity defense is not an issue in this case.

monolithic piece of crystalline quartz. As will be explained, the bonded wafer does not meet the literal call of claim 1 as interpreted by the Court.

2.

As to infringement by equivalents, BEI says the expert got it wrong because:

> . . . it was not foreseeable to claim direct bonded tuning forks as an equivalent of non-direct bonded tuning forks thus precluding application of prosecution history estoppel

and

> Matsushita's tuning forks formed from direct bonded quartz wafers are equivalent to tuning forks formed from non-direct bonded quartz wafers in the context of the '638 patent.

Matsushita denies equivalence.

E. Overview of Discussion

BEI is correct in its assertion that prosecution history estoppel does not apply. As to infringement by equivalence, on the record as it stands this issue requires resolution by the finder of fact. There is a legitimate dispute over whether the Matsushita angular rate sensor performs substantially the same function in substantially the same way to obtain substantially the same result as the angular rate sensor defined in claim 1 of the '663 patent. The key word is "substantially."

After stating the law applicable, the Court will first discuss whether, because of BEI's insistence, the bonded wafer is "a single crystal of piezoelectric material" as that phrase has been interpreted by the Court. Important to this discussion is:

– the file history of the '663 patent with particular attention to the evolution of the phrase "single crystal of piezoelectric material;"

– the prior art which the inventors distinguished before the Patent Office and

the materials involved; and

– BEI's position at the Markman hearing;

The Court will then go on to discuss:

– the nature of the bonding process; and

– the conflicting views in the record regarding the characteristics of a bonded versus a non-bonded wafer.

– The Court will then discuss literal infringement. After that, the Court will discuss prosecution history estoppel and infringement by equivalents.

IV. The Law

A. Summary Judgment

Summary judgment will be granted when the moving party demonstrates that there is "no genuine issue as to any material fact and that the moving party is entitled to a judgment as a matter of law." Fed. R. Civ. P. 56(c). There is no genuine issue of material fact when "the record taken as a whole could not lead a rational trier of fact to find for the non-moving party." Matsushita Elec. Indus. Co. v. Zenith Radio Corp., 475 U.S. 574, 587 (1986). See also Kemco Sales, Inc. v. Control Papers Co., 208 F.3d 1352, 1359 (Fed. Cir. 2000).

The Court must decide "whether the evidence presents a sufficient disagreement to require submission to a trial of fact[12] or whether it is so one-sided that one party must prevail as a matter of law." In re Dollar Corp., 25 F.3d 1320, 1323 (6th Cir. 1994) (quoting Anderson v. Liberty Lobby, Inc., 477U.S. 242, 251-52 (1986)). The Court "must view the

[12]In this case, BEI has demanded a trial by jury.

evidence in the light most favorable to the non-moving party." Employers Ins. of Wausau v. Petroleum Specialties, Inc., 69 F.3d 98, 101 (6th Cir. 1995).

B. Infringement Generally

The infringement inquiry requires a comparison of the asserted claim with the allegedly infringing device. Kemco Sales, 208 F.3d at 1359. To prove infringement, the patentee must establish that the accused device contains each limitation of the asserted claim, Mas-Hamilton Group v. LaGard, Inc., 156 F.3d 1206, 1211 (Fed. Cir. 1998), or an equivalent of each limitation, Warner-Jenkinson Co. v., Hilton Davis Chemical Co., 520 U.S. 17, 40 (1997). The determination of infringement, both literal and under the doctrine of equivalents, is a question of fact. Teleflex, Inc. v. Ficosa North America Corp, 299 F.3d 1313, 1323 (Fed. Cir. 2002).

C. Literal Infringement

Literal infringement requires that the accused device embody exactly each limitation of the asserted claim. Laitrim Corp. v. Rexnord, Inc., 939 F.2d 1533, 1535 (Fed. Cir. 1991).

D. Prosecution History Estoppel

Prosecution history estoppel can prevent a patentee from asserting as an equivalent subject matter surrendered during prosecution of the patent application. See generally Allen Eng'g. Corp. v. Bartell Indus. Inc., 299 F.3d 1336, 1349-50 (Fed. Cir. 2002). "Estoppel arises when an amendment is made to secure allowance of the patent and the amendment narrows the patent's scope." Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 530 U.S. 722, 736 (2002). In Festo, the Supreme Court explained the relationship between the doctrine of equivalents and prosecution history estoppel,

making clear that application of the latter does not operate as a complete bar to application of the former:

> A patentee's decision to narrow his claims through amendment may be presumed to be a general disclaimer of the territory between the original claim and the amended claim. Exhibit Supply, 315 U.S., at 136-137, ("By the amendment [the patentee] recognized and emphasized the difference between the two phrases and proclaimed his abandonment of all that is embraced in that difference"). There are some cases, however, where the amendment cannot reasonably be viewed as surrendering a particular equivalent. The equivalent may have been unforeseeable at the time of the application; the rationale underlying the amendment may bear no more than a tangential relation to the equivalent in question; or there may be some other reason suggesting that the patentee could not reasonably be expected to have described the insubstantial substitute in question. In those cases the patentee can overcome the presumption that prosecution history estoppel bars a finding of equivalence.
>
> This presumption is not, then, just the complete bar by another name. Rather, it reflects the fact that the interpretation of the patent must begin with its literal claims, and the prosecution history is relevant to construing those claims. When the patentee has chosen to narrow a claim, courts may presume the amended text was composed with awareness of this rule and that the territory surrendered is not an equivalent of the territory claimed. In those instances, however, the patentee still might rebut the presumption that estoppel bars a claim of equivalence. The patentee must show that at the time of the amendment one skilled in the art could not reasonably be expected to have drafted a claim that would have literally encompassed the alleged equivalent.

Festo, 530 U.S. at 740-41.

"Whether or not prosecution history estoppel precludes a particular action for infringement by equivalents is a question of law." CAE Screenplates Inc. v. Heinrich Feidler GmbH & Co. KG, 224 F.3d 1308, 1319 (Fed. Cir. 2000).

Additionally, as one district court has said:

> The patentee bears the burden of overcoming a presumption that narrowing amendments are made for reasons of patentability. If the Court finds that [the applicant] filed the requisite amendment, then the Court proceeds to the second step: determining whether the amendment "surrender[ed] the particular equivalent in question." "A patentee's decision to narrow his claims through amendment may be presumed to be a general disclaimer of the territory between the original claim and the amended claim." The patentee must overcome the presumption that "the patentee surrendered all subject matter between the broader and narrower language."
>
> . . . .
>
> The heartland issue is whether [the amendments to the] patent application surrendered the alleged equivalent . . . . ("[T]he patentee should bear the burden of showing that the amendment d[id] not surrender the particular equivalent in question."). [The applicant] can overcome this presumption by showing [the infringing device] was "unforeseeable at the time of the application," or that "the rationale underlying the amendment . . . bear[s] no more than a tangential relation to the equivalent in question," or "some other reason suggesting that the patentee could not reasonably be expected to have described the insubstantial substitute in question."

Soundtube Entertainment, Inc. v. Brown Innovations, Inc., 233 F. Supp. 2d 188, 195-96 (D. Mass. 2002)(internal citations omitted).

E. Infringement by Equivalents

Infringement under the doctrine of equivalents requires that the accused device contain each limitation of the asserted claim or its equivalent. See Warner-Jenkinson, 52 U.S. at 40 (1997) (noting that because each limitation contained in a claim is material to defining the scope of the patented invention, the doctrine of equivalents analysis must be applied to individual claim limitations, not to the invention as a whole). An element in the accused device is equivalent to a claim limitation if the differences between the two are

"insubstantial" to one of the ordinary skill in the art. See id. Relevant to an insubstantial difference inquiry is whether the missing element in the accused device "performs substantially the same function in substantially the same way to obtain the same result" as the asserted claim limitation. Graver Tank & Mfg. Co. v. Linde Air Prods. Co., 339 U.S. 605, 608 (1950); see also Warner-Jenkinson, 520 U.S. at 39-40.

V. "A Single Crystal of Piezoelectric Material:" A Reprise

What follows is an elaboration of what the Court said in the Order On Claim Construction which has been made necessary by the tendentiousness of BEI's interpretation of the Claim Construction Order.

A. File History

The application for the '663 patent was filed November 16, 1981. In claim 1, the material and structure of the invention was described as "a tuning fork of piezoelectric material."

The original application was rejected as obvious under 35 U.S.C. § 103. There was no reference in the rejection to the material.

On December 13, 1983, an Amendment was filed which amended claim 1 to read:

> "a tuning fork of [a] quartz exhibiting piezoelectric properties."

In the Remarks accompanying the Amendment, the applicants stated:

> It should be noted that the use of quartz; that is, crystalline quartz, allows to compensate for various errors without the threat of aging of the material.

This claim language was rejected July 18, 1984, with the examiner stating as to the material of the tuning fork:

> . . . [it] is typical of a large body of art teaching a tuning fork

> can be quartz. Obviously the material used would be mere design choice.

On October 1, 1984, an Amendment was filed which amended claim 1 to read:

> "a tuning fork [of] having [quartz exhibiting] piezoelectric properties."

This claim language was rejected on February 22, 1985 as unpatentable over U.S. Patent No. 3, 258,617 issued to T. G. Hart (the Hart '617 Patent). The Hart '617 states in part:

> It will now be clear that multiple-member piezoelectric structures may have certain advantages over monolithic piezoelectric structures for purpose of rotation sensing. The techniques for precisely fabricating and furnishing with electrodes such multiple-member rectangular-prismatic structures are the same conventional and well-known techniques as for precisely fabricating and furnishing with electrodes monolithic blocks, but with the additional technique required for bonding individual members together into a single structure.
>
> A successfully used method of bonding individual members together into a single structure is an extension of the technique for furnishing firmly bonded electrodes on surfaces and comprises vacuum evaporating consecutive layers of suitable different metals, one on top of the other, onto the surfaces to be abutted; clamping the metallized surfaces firmly together and then applying heat sufficient to fuse the metal layers into a single alloy metal bond. For example, consecutive layers of chromium, gold, and indium, each of thickness between one- and two-millionths of an inch, form, when heated to about 500° C., a high-strength alloy firmly bonded to the surfaces. In order that the extremely thin metal bond may be disposed uniformly without voids between the abutting surfaces, the surfaces must be flat within a few millionths of an inch. Such precisely flat surfaces are also desirable on monolithic rotation-sensing structures, as is also precise parallelism of opposing surfaces; the techniques for producing such precise flatness and parallelism are widely practiced and well known in the art, relying mainly upon abrasive lapping methods.

On March 18, 1985, Amendment F was filed with amended claim 1 to read:

> "a tuning fork [having] formed from a single crystal of piezoelectric [properties] material"

In the Remarks accompanying the Amendment the applicants stated:

> None of the references teaches or suggests the use of a unitary body of piezoelectric material . . . . As set forth in previous amendments, the unique configuration of a unitary body of piezoelectric material allows the apparatus of Applicants' invention to be constructed using semiconductor techniques
>
> . . . .
>
> . . . . The construction of Applicants' invention is in direct contrast with devices such as the Watson device (U.S. Pat. No. 4,479,098, Figure 1), the Christensen device (U.S. Pat. No. 3,206,986), and other devices which require two or more individual elements to be attached to form the vibrating and sensing elements of the sensors. . . . The provision of an angular sensor system having a balanced resonant sensor consisting of a single, tuning fork-shaped piezoelectric crystal is novel and is not suggested by the prior art. . . . Referring specifically to the claims, it will be appreciated that each of the claims develop the distinguishing features that characterize the present invention as patentable over the cited art. For example, independent Claim 1 recites 'a tuning fork formed from a single crystal of piezoelectric material... [13]

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[13]The parties disagree on the significance of Amendment F, particularly with regard to the doctrine of equivalents issue and prosecution history estoppel. Matsushita says the amendment "emphasized the difference between angular rate sensors including tuning forks of multiple individual elements and the tuning fork of claim 1." BEI says:

> BEI notes that the specification states "Such an angular rate sensor can be manufactured by semiconductor techniques much more inexpensively than a conventional gyroscope." '663 Patent, Col. 6:19-22. One of skill in the art would understand that the use of semiconductor techniques necessarily shows that the original intention was that the tuning fork be formed from one piece of material, where such techniques operate by etching away excess material. Further, such techniques could not be used to make a composite structure with separate bits glued together; this is

On June 24, 1985, the new claim language was rejected under 35 U.S.C. § 103 as unpatentable over U.S. Patent No. 3,206,986 issued to F.W. Christensen (the Christensen '986 patent) in view of the Hart '6l7 patent. The Christensen '986 patent states in part:

> The side members 15, the other elements of the generally H-shaped unit 13, may be constructed from layers 24 that are cemented together to form bimorphic elements 26. The layers 24 may be fabricated from piezoelectric crystals of the piezo-ceramic type, such as barium titanate.

On November 1, 1985, Amendment G was filed with no change made in the language of Claim 1. In order to highlight the "single crystal of piezoelectric material" element and to contrast the disclosures of the Hart '617 patent and the Christensen '986 patent, in the Remarks accompanying the Amendment to highlight, the applicants stated:

> Applicants have disclosed and claimed an angular sensor system having a balanced resonant sensor consisting of a single, tuning fork-shaped piezoelectric crystal. The important structural elements of Applicants' invention are clearly set forth in all pending claims, such as, for example Claim 1, with the structural limitation of (1) a single crystal piezoelectric material, (2) shaped in the form of a tuning fork with two tines and a common shaft being of paramount importance in distinguishing the present invention from the combination of Christensen. . . .

> simply oppositional to the use of semiconductor manufacturing techniques. BEI therefore respectfully submits that Amendment F in no way narrowed the claims from the original intention of the invention. Rather, it simply clarified that intent. Amendment F was not a narrowing amendment, and Matsushita has not shown to the contrary.

BEI's Response to Matsushita's Statement of Facts, etc., filed April 7, 2003, at p. 12.

> Applicants' structure is not to be found in either of the cited prior patent publications. For example, in the primary reference, Christensen discloses an assembled tuning fork structure made of a polycrystalline piezoelectric ceramic material, barium titanate. Such a structure immediately presents two problems not found in Applicants' structure: (1) the use of a polycrystalline material; and (2) the use of a composite structure, both of which factors have a significant adverse effect on the stability and reproducibility of the output signals from the angular rate sensor system constructed in accordance therewith. . . .
>
> . . . .
>
> Applicants have taught the necessity for both a single-crystal structure and a balanced tuning fork design in order to obtain an operational oscillatory gyroscope. All of the cited prior patent publications, including both Christensen and Hart ['617 Patent] are missing one or the other of these concepts, and as a result, the output signals generated by the vibrating member are not sufficiently stable to be useful in measuring the rate of angular rotation.

On November 1, 1985, one of the applicants filed a Declaration under 37 C.F.R. § 1.132[14] in which he stated:

> 10. That based upon my understanding of the Christensen . . . [it has] the following physical . . . characteristic[]:
>
> . . . .
>
> 2. Drive and pick up elements that are "bimorphs," i.e., slabs of piezoelectric material that are laminated together with adhesive, such as an epoxy.

On December 3, 1985, the applicants' representatives had an interview with the examiner. The Examiner Interview Summary Record (emphasis added) states:

> Applicant noted that the improvements **achieved by the invention were made possible by the use of a unitary quartz crystal and the balanced tuning fork design.**

[14]This rule governs the manner in which evidence to traverse a rejection or objection by the examiner must be stated.

> Applicant will request reconsideration and the rejected claims will be reviewed.

On June 17, 1986, a Supplemental Information Disclosure Statement was filed which stated:

> [An identifiable reference] discloses nothing of relevance with respect to the utilization of a single crystal of piezoelectric material, a limitation found in each of the allowable claims.

The '663 patent issued on March 31, 1987.

2.

The impact of this extended discussion of the file history and evolution of the language of claim 1 to "a single crystal of piezoelectric material" emphasizes that the composition of the material, as well as its characteristics, was important to distinguishing the invention of the '663 patent from the prior art. The nature of the bonding of prior art material, two pieces, whether by gluing or some other form of adhesion was not distinguishing. What was distinguishing and what was involved, in the words of the examiner, was "a unitary quartz crystal." This point is emphasized by the nature of the prior art as described above.

B. Definition of "A Single Crystal"

Also of significance is the manner in which "a single crystal" was defined in the prosecution history. The claim term "a single crystal" was defined, not as a special term of art but synonymous with such terms as a "unitary mass of piezoelectric material," "a unitary body of piezoelectric material," a "single, unitary crystal of piezoelectric material," and "a single, tuning fork-shaped piezoelectric crystal." This is what is important to an understanding of the nature of material called for in claim 1. The emphasis in the

definitions is to distinguish the two piece characteristic of the prior art from the single piece of the '663 patent.

1. "A Unitary Mass of Piezoelectric Material"

In a Supplemental Information Disclosure Statement Under 37 C.F.R. § 1.99[15] filed February 6, 1985, the applicants stated in distinguishing the Hart '100 patent:

> [the Hart] device is constructed from a plurality of separate quartz members rather than *a unitary mass of piezoelectric material* as claimed . . . .

2. "A Unitary Body of Piezoelectric Material"

In Amendment F, filed March 18, 1985, the applicants stated:

> None of the references teaches or suggests the use of *a unitary body of piezoelectric material* . . . .

and

> . . . .
> The construction of Applicants' invention is in direct contrast with devices such as . . . the Christensen device . . . which require two or more individual elements to be attached . . . .

In the Supplemental Information Disclosure Statement under 37 C.F.R. § 1.99, filed simultaneously with Amendment F, the applicants stated:

> The Christensen application does not disclose *a unitary body* . . . . Unlike Applicants' invention, the bimorphic construction of the Christensen apparatus does not lend itself to being manufactured by semi-conductor techniques.

3. "A Single, Tuning Fork-Shaped Piezoelectric Crystal and "A Single, Unitary Crystal of Piezoelectric Material" and

[15]This Statement is not referenced in the chronology set forth in Subpart A above.

"A Unitary Crystal of Piezoelectric Material"

In Amendment G, filed November 1, 1985, the applicants stated:

> Applicants have disclosed and claimed an angular sensor system having a balanced resonant sensor consisting of *a single, tuning fork-shaped piezoelectric crystal*. . . . [I]t is the provision of *a single, unitary crystal of piezoelectric material* . . . . Just as important, it is this structure . . . manufactured from *a unitary crystal of piezoelectric material*
>
> . . . .

4. "A Single Crystal of Piezoelectric Material"

In Amendment H And Request For Reconsideration Under Rules 112 and 116,[16] filed December 5, 1985, the applicants stated:

> Applicants' have stated the their present, inventive angular sensor embodies two essential characteristics that result in meaningful output signals: (1) its fabrication out of *a single crystal of piezoelectric material* . . . .

C. The Dialogue at the Markman Hearing

1.

The dialogue at the Markman hearing on August 26, 2002 further illuminates the nature of the material called for by the phrase "a single crystal of piezoelectric material" and makes clear that BEI was emphasizing the nature of the material described in claim 1, its characteristics and its crystalline orientation.

> MR. RITCHEY:[17] It is the position of BEI that the language of these elements is generally plain and readily interpretable by a trier of fact, there are not any

[16]This Amendment is also not referenced in the chronology set forth in Subpart A above.

[17]Mr. Ritchey is BEI's counsel.

ambiguities that require construction. . . .[18]

We have two disputes with Matsushita's construction. First of all, they consider single crystal to have been used as a special term of art.

THE COURT: I have already told you it is not a special term of art.

MR. RITCHEY: We agree, your honor.

MR. RITCHEY: . . . repeatedly throughout the file history we see single and crystal not[19] appearing together . . . we see a synonymous term used, unitary crystal or single unitary crystal . . . .[20]

MR. RITCHEY: . . . in particular Hart '100, and they distinguished Hart by saying that the Hart device was "constructed from a plurality of separate crystal quartz members rather than a unitary mass of piezoelectric material." So they are basically contrasting the composite structure of Hart with a unitary mass of piezoelectric material.[21]

MR. RITCHEY: It is our intention not to form a composite . . . with several pieces glued together.

. . . .

MR. RITCHEY: It is a unitary crystalline solid.[22]

MR. RITCHEY: we intended is that by single, we simply mean it is one piece of material as opposed to multiple.

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[18]Transcript at p. 5.

[19]This is obviously a transcription error.

[20]Transcript at p. 6.

[21]Id. at p. 8.

[22]Id. at p. 9-10.

. . . .

Could we just say . . . one piece of crystal or one piece of crystalline solid?

. . . .

And if we look at Hart '100 again, we see it's composed of a plurality of separate quartz members, multiple pieces that are joined together.[23]

. . . .

MR. RITCHEY: The problem with the language that they were using previously when they were referring to a unitary mass instead . . . you'll see that there's a claim where mass was used in reference to the tines as well as in reference to the tuning fork as a whole, and that appears to have been somewhat confusing so they stopped using the word unitary mass and substituted in formed from a single crystal.

In the same Amendment F . . . changed the claim to recite a single crystal they are still speaking of a unitary body of piezoelectric material. So in that same amendment when they discussed what they did they are not again using single crystal as term of art having special meaning other than trying to convey that it's not a composite structure, not little pieces glued together. It's an unitary body.

And again in Amendment F . . . . They say, "None of the references teaches or suggests the use of a unitary body of piezoelectric material."

They say later on in the summary where they refer to, "The provision of an angular sensor system having a balanced resonant sensor consisting of a single, tuning fork-shaped piezoelectric crystal." . . . again, not using single crystal as a term of art, and obviously using it synonymously with unitary body.

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[23] Id. at p. 11 (emphasis added).

> In subsequent amendments we still have the claim language single crystal . . . the applicant continues to refer to it as . . . a single unitary crystal, and we see later on in the same section they say "structure of balanced tines manufactured from a unitary crystal of piezoelectric material." . . . again, unitary crystal or a single unitary crystal all being used basically after the word single crystal was added to the patent.
>
> . . . in Amendment H we see that they mention Christensen, and they say, "Christensen provides no teaching with respect to fabrication out of a single, unitary crystal." . . .
>
> . . . .
>
> That's a nice lead in . . . to why Christensen was not covered by the claims.[24]
>
> . . . .

THE COURT: . . . we know from this morning that there's piezoelectric material and there's piezoelectric material. . . . This piezoelectric material produces a stable output signal when mechanical force is applied, right?

MR. RITCHEY: Yes.

THE COURT: . . . I'm thinking that what we have here is a single piece of a natural or synthetic piezoelectric or semiconductor material whose atoms are arranged with some degree of geometric regularity which produces a stable . . . .

THE COURT: I would add a qualifier in a relatively stable signal . . . .

. . . .

MR. RITCHEY: I think relatively stable captures the essence of the invention . . . [a]nd distinguishes Christensen. . . . because there were stability problems whenever you had bimorphic structure,

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[24] Id. at p. 12-14, 15.

glued together structure, composite structure.[25]

THE COURT: . . . inherent in a piezoelectric piece of -- piezoelectric semiconductor material is crystallographic orientation.

MR. RITCHEY: Some degree of regularity . . . .

THE COURT: [T]here has to be some degree of regularity or it won't perform.

MR. RITCHEY: Correct. . . . Even the best you can do will not be perfectly homogeneous or have imperfection, and obviously the inventors here weren't trying to narrow their invention down to an ideal material. . . .[26]

D. Summary

In sum, it is clear from all that has been said above that the applicants were attempting to convince the examiner of two separate and distinguishing features of their invention in contrast to the prior art. First, the material that claim 1 called for was a single piece of crystalline material. It was not two pieces joined together in any manner whether by glue or a similar substance such as cement or otherwise.[27] Significantly at one point in BEI's discussion with the Court, its counsel used the word "joined" rather than "bonded."

What was conspicuously missing in retrospect in the Markman hearing, and which displays a considerable lack of candor on the part of both BEI and Matsushita, was any discussion of the joining together of two pieces of crystalline material by direct bonding.

BEI also argued that an important characteristic of the material from which the

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[25]Id. at p. 15.

[26]Id. at p. 19-20.

[27]One dictionary defines "bonding" in part as "the binding or connecting together of any substance esp. by adhesion." Oxford English Dictionary (2d ed. 1989).

tuning fork is manufactured is that it have a stable output. BEI says in this regard:

> The prior art references discussed in the prosecution of the '663 Patent relevant to the claim limitation "a tuning fork formed from a single crystal of piezoelectric material" were distinguished by the Court on the basis of their failure to produce a relatively stable output signal when mechanical force is applied.

BEI's Amended Opposition To Matsushita's Patent, etc. filed Feb. 12, 2003, at ¶ 8.

This is an overstatement. What it should say is "were one of the ways distinguished by the Court . . . . " This, however, is a separate and distinct characteristic of the "single piece" and does not trump it.[28]

Lastly, see Application of Hotte, 475 F.2d 644, 647 (Fed. Cir. 1973)(noting that two pieces joined together so that the resulting piece can be characterized as "integral" still is two pieces) and Advanced Cardiovascular Sys., Inc. v. Scimed Life Sys., Inc., 887 F/2d 1070, 1074 (Fed. Cir. 1989) (noting that dictionary definition of "integral" does not conclusively limit it to one piece).

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[28]BEI also suggests that the single crystal requirement of claim 1 is satisfied by what is known as a twin crystal. There is no merit in this position. The Concise Encyclopedia Chemistry under "crystal" states:

> A *single crystal* is a body consisting of a single, uniform C. [crystal] in which all parts are in a definite orientation with respect to the others. In many cases, e.g., in metals and ceramics, however, there are numerous small C. (*crystallites*) with different orientations within the solid (see Polycrystalline material), which is thus *polycrystalline*. Two single C. which have fused through regular growth are called *twins* (there are also triplets, and in general multiplets), and can be described by certain "twin rules."

Concise Encyclopedia Chemistry 279 (Walter De Gruyter & Co. 1993)(emphasis in original).

VI. The Nature of the Direct Bonding Process

A. Matsushita's Bonded Wafer

The tuning fork of the accused sensor is manufactured from a bonded piece of piezoelectric material in the form of quartz. The manufacturing process begins with two quartz wafers, circular in shape, with a large flat edge and a small flat edge. These flat edges identify the electrical axis orientation of each wafer.

The orientation of a quartz crystal is characterized by its orthogonal axes known as the X - (or electric axis) the Y - (or mechanical axis) and Z- (or optical axis).

Two quality wafers are selected for bonding after inspection and polishing. One wafer is rotated about its Y-axis relative to the other wafer so that the large flat ends are aligned. This results in the X- and Z-axis of the two wafers being inverted.

Bonding takes place in two steps. First, the wafers are preliminarily annealed at 350°C. Then the two wafers are treated in a sintering furnace at 538°C. Both of these heating processes are carried out below 573°C., the temperatures at which the crystal structure of quartz may change phase. The resulting bonded wafer retains the polarity of the original two wafers.[29]

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[29]The record includes a number of papers describing direct bonding of piezoelectric materials. The most enlightening papers are: Kazuo Eda, et. al, Direct Bonding Of Piezoelectric Materials Onto Si (Exhibit L to BEI's Motion For Summary Judgment) and Kazuo Eda, et. al, Direct Bonding of Piezoelectric Materials and Its Applications (Exhibit I to BEI's Motion For Summary Judgment).

Of particular interest in this regard (and not cited by the parties) is a book by Q.Y. Tong and U. Gösele entitled Semi Conductor Wafer Bonding: Science And Technology (John Wiley & Sons, Inc. 1999). At page one of the Introduction the authors state:

> "Wafer bonding" generally refers to a process by which two mirror-polished wafers adhere to each other at room

The tuning forks of the accused device is then formed from the bonded wafer. More than one fork is formed at a time.

B. The Interface of the Bonded Wafer

A good deal of effort has been spent by the parties in disagreeing over the characteristics of the interface of a bonded wafer.

Matsushita says that there is an amorphous layer existent between the two wafers and that the interface is unstable. This, Matsushita says, establishes that the tuning fork

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> temperature without the application of any macroscopic gluing layer or outside force. Wafer bonding is alternatively known as "direct bonding" and "fusion bonding" or more colloquially as "gluing without glue.". . .
>
> . . . .

At page three they state:

> Widespread interest in modern wafer bonding techniques was generated by reports on silicon-silicon wafer bonding by two groups (6-8) in 1985-1986 in which the initial bonding of the two wafers at room temperature was followed by a high-temperature bond-strengthening heat treatment. . .
>
> . . . .

At page six they state:

> Although the work of Shimbo et al. (6) and Lasky (7, 8) generated a lot of interest and follow-up research, it did not immediately lead to viable products in the area of microelectronics, because the difficulties associated with wafer bonding were also noticed quickly. . . .

In Chapter 7, entitled Electrical Properties of Bonding Interface they state on page 175:

> Typically, the bonding interface of wafer pairs is commonly not included in active regions of the devices fabricated in the bonded materials, and it functions usually only as part of a mechanical support.

in the accused device is comprised of the "two pieces of crystalline quartz bonded together with their electrical axis inverted, with a distinct unstable, highly disturbed layer of material in-between centered on the bonded interfacing which is likely to contain amorphous material." BEI disputes this; it says the record does not support a finding that there is an amorphous layer between the two wafers.

Whether or not there is an amorphous layer is of no significance. What is undisputed is that there is a detectable difference between the two layers under high magnification and that the two wafers maintain their different crystallographic orientation after bonding. See Reply Memorandum Of Law In Further Support of Matsushita's Motion For Summary Judgment Of Non-Infringement filed January 6, 2003, at p. 2. Matsushita points out that Dr. EerNisse says in his report that there is an interface between the two quartz pieces; BEI recognizes the existence of "an etching effect where the two wafers were joined." Thus, the direct bonding of two wafer results in an interface. It is the fact that there is an interface which is significant; the exact nature of the interface (whether it can be called etched or amorphous) is not significant.

VII. Literal Infringement

Again, the element of claim 1 "a single crystal of piezoelectric material" as interpreted by the Court is:

> A single piece of natural or synthetic piezoelectric or semi-conductor material whose atoms are arranged with some degree of geometric regularity . . . .

This element does not read on Matsushita's bonded wafer.

The bonded wafer is not a single piece; it is two pieces joined together. In terms of the language of the file history it is a bimorph. That the result of the joining together of

two wafers by fusion which produces a relatively stable output signal is of no moment. Fusion is simply another way of joining two wafers together. Additionally, as explained above, the atoms of bonded wafer atoms are not arranged with some degree of geometric regularity. That each of the two wafers, which when joined together, compose the bonded wafer may have an atomic structure of some degree of regularity is, again, of no moment. This is a stand alone phenomenon characteristic of each of the separate wafers. When the bonded wafer is considered as a whole the reversal of axis results in an overall irregular atomic arrangement.

The statement of the expert, when all is said and done that

> [the construction of claim 1] does not encompass a structure having two distinct arrangements of atoms each independently having some degree of geometric regularity and certainly does not encompass . . . [an] inter-face between the two crystal layers

is correct. Matsushita is entitled to summary judgment on BEI's claim of literal infringement.

VIII. Infringement by Equivalents

A. Prosecution History Estoppel

1.

BEI has the burden of showing that the limitation of claim 1 to a tuning fork formed from a single crystal did not surrender the equivalent of a tuning fork formed from a direct bonded crystal wafer as found in the accused device. In other words, BEI must show that forming the tuning fork from a direct bonded wafer was unforeseeable at the time of the application, i.e. there is a reason why a person skilled in the art would not reasonably have been expected to draft a claim to literally cover the accused equivalent at that time.

It should be noted that there is no estoppel merely because an accused infringer improves on the claimed invention. See Boehringer Ingelheim Vetmedica, Inc. v. Schering-Plough Corp., 320 F. 3d 1339, 1352 (Fed. Cir. 2003).

Here, claim 1 as initially drafted called for:

> A tuning fork of piezoelectric material.

Claim 1 now reads:

> A tuning fork formed from a single crystal of piezoelectric material.

BEI asserts that it was not foreseeable during the prosecution of the '663 patent which extended from November 16, 1981 to March 31, 1987 for the applicant to have drafted a claim covering a direct bonded tuning fork.

2.

a.

As summarized by the Court, BEI says:

1. None of the prior art references raised during the course of prosecution of the '663 patent suggested or disclosed forming a tuning fork from a direct-bonded quartz crystal wafer. They all described tuning fork structures made from a plurality of individual, physically-separate components that were glued together.
2. None of the inventors were personally aware of the possibility of forming the tuning fork from a direct-bonded crystal wafer.
3. Matsushita did not think to use a direct-bonded crystal quartz wafer in a tuning fork until 1999.
4. In 1999, an article appeared in the Journal of the Electrochemical Society which

stated “to our knowledge, direct bonding of quartz to quartz has not been achieved before.” P. Rangsten, et. al, Quartz-to-Quartz Direct Bonding, J. Electrochemical Soc. 146(3), 1104 (1999).

b.

Matsushita says:

1. A number of prior art references describe various methods of bonding piezoelectric material in general and specifically quartz. In each reference, however, a glue-like material was used as a bonding agent. None of them called for direct bonding.
2. Semi-conductor manufacturing techniques to create tuning forks were well known.
3. Silicon-silicon bonding in which the initial bonding of the two wafers at room temperature without a gluing layer was followed by a high temperature bond-strengthening heat treatment was known in 1985-1986.
4. As early as 1966, direct bonding was known using a form of growing process or a catalytic agent.
5. In the 1980's direct bonding was described in various scientific papers.

c.

A careful review of the materials cited by the parties makes it clear that, while the direct bonding two quartz wafers by fusion to form a piece of quartz from which a tuning fork is fabricated was an outgrowth of the development of direct bonding, it was not clearly foreseeable at the time that the critical prior art was considered in the course of prosecution of the ‘667 patent; direct-bonding of piezoelectric material by fusion in the making of a tuning fork for an angular rate sensor was something the inventors should have considered. In the narrowing of the language of claim 1, however, BEI did not

create a prosecution history estoppel to eliminate consideration of infringement by equivalents in this case.

The expert, in his analysis of the prosecution history, did not dig deep enough; he erred in his conclusion that

> [s]ince the amendment was clearly undertaken to overcome prior art, it had a substantive reason related to patentability.

This is not so. Direct bonding by fusion as a step in the manufacture of the tuning fork of an angular rate sensor was qualitatively different than what went before. As described by Tong and Gösele, footnote 27, supra, modern wafer bonding was generated by 1986-1986 reports, it "did not immediately lead to viable products in the area of microelectronics." What is really at work here is the development of after-arising technology (direct bonding of quartz wafers) and infringement under the doctrine of equivalents. Because direct bonding of quartz wafers was not foreseeable at the relevant time, BEI is not estopped from arguing infringement by the doctrine of equivalents to Matsushita's after-arising technology.

The interplay between Festo and after-arising technology was the subject of a recent article where the author, in critically analyzing the Federal Circuit's decision in Festo, urged the Supreme Court to overrule the decision because it "runs contrary to the major function of the doctrine of equivalents – protecting patent holders from after-arising technology" and urging the Supreme Court to "allow the flexible approach to prosecution history estoppel in all cases of infringement by after-arising technology." Anthony H. Azure, Notes & Comments, Festo's Effect on After-Arising Technology and the Doctrine of Equivalents, 76 Wash. L. Rev. 1153, 1183 (Oct. 2001). While the author of this article

may have been prescient as to the Supreme Court's decision, there is nothing in the law of prosecution history estoppel requiring an inventor to be prescient.

B. The Need for a Trial

1.

Following oral argument on the response of the parties to the expert's report, the Court asked Matsushita to file a statement of facts establishing its right to summary judgment. See Matsushita's Statement of Facts filed March 26, 2003 at ¶ 21-28. Based on a side-by-side comparison of Matsushita's assertions of the material facts not in dispute and BEI's response, filed April 7, 2003, (in which BEI appears to say either that the fact is disputed or that the difference between the fact asserted and the manner in which claim 1 operates is irrelevant) it simply cannot be said without a doubt that the differences between the Matsushita tuning fork and the tuning fork of claim 1 are substantial in either their function, the way in which they operation, or the result of their operation.

Indeed, the parties' positions regarding infringement under the doctrine of equivalents can be summarized as follows:

1. As to the tines, BEI says the tines of the tuning fork move out of place. The stresses occasioned by the movement induce electric fields. The field in the front portion has a direct opposite movement to that in the rear portion.

   Matsushita responds by saying that while the tines of the tuning fork move out of place, the fields move in the same direction.

2. As to voltages, BEI says that the voltage in the front half of the tine has a polarity opposite to the voltage in the other half of the tine. The voltages may be added or used individually.

Matsushita responds by saying that the voltages in the tine of the tuning fork are in the same direction.

3. As to sense electrode, BEI says that in order to sense voltage in the tuning fork a split pair of sense electrodes are placed in the front side surface of a tine and a separate split pair are placed on the rear side surface of each tine. Each split pair is separated by a gap.

Matsushita responds by saying that in its sensor there is a single continuous sense electrode on each tine. There are no gaps. Additionally, the single continuous sense electrodes produces a greater output signal than the split sense electrodes and that a simple continuous electrodes cannot be used on a tuning fork made of a single quartz wafer.

4. Lastly, Matsushita argues that fabricating a single continuous electrode is much easier.

Additionally, the expert opinions proffered by BEI and Matsushita display contrasting views on whether these differences are substantial.

Suffice it to say that no useful purpose would be served by a detailed discussion of

these differences in terms of the function, way, and result to decide if there is infringement by equivalents. Such an analysis requires a considerable intellectual effort to decide which expert has it right and whether the differences are substantial. The result of such an intellectual effort would, whatever its outcome, be reviewed by the Court of Appeals for the Federal Circuit. Such a review is inevitably of an uncertain outcome. See, e.g., Caterpillar, Inc. v. Deere & Company, 224 F.3d 1374 (Fed. Cir. 2000).

2.

The better course is to put the issue to the finder of fact. While that also involves a considerable effort, it is effort of a different order and has the certainty of finality in most cases because the competing positions are played out at trial, can be reviewed on appeal, and there is little danger of the case coming back for a second consideration. Once author compared the costs and benefits of proceeding to trial or proceeding via summary judgment (tribulation) and noted that "[a]lthough the summary judgment motion always creates the certainty of a later trial if summary judgment is not granted for any reason, no corresponding risk is implicated in the alterative decision to go to trial - for a trial will necessarily produce a judgment." The author concluded that "trials are indeed often better than tribulations." Milton I. Shadur, From the Bench: Trials or Tribulations (Rule 56 Style)? 29 Litigation No. 2, 5 (Winter 2003).

In sum, a trial is required to determine whether the differences between the MACO ARS and claim 1 of the '663 patent are "substantial" differences as required for

infringement by the doctrine of equivalents.[30]

SO ORDERED.

/s/
AVERN COHN
UNITED STATES DISTRICT JUDGE

DATED: June 20, 2003
Detroit, Michigan

[30]While this decision focuses on whether the tuning forks of the MACO ARS are made of an equivalent structure to "a single piece of piezoelectric material," there are still other open issues before the Court. Indeed, BEI has filed five motions in limine; Matsushita has filed seven. These motions are pending.

Exhibit A

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF MICHIGAN
SOUTHERN DIVISION

BEI TECHNOLOGIES, INC.
a Delaware Corporation, et al.

Plaintiffs/Counter-defendants.

v.

Case No. 01-73758

HON. AVERN COHN

MATSUSHITA ELECTRIC
INDUSTRIAL CO., LTD.,
a Corporation of Japan, et al.

Defendants/Counter-plaintiffs.

REPORT BY COURT APPOINTED EXPERT
DAVID D. MURRAY

I have been retained by the Court to study and make recommendations to the Court regarding four currently pending Motions for Summary Judgment: cross Motions for Infringement and Non-Infringement and BEI's Motions that the '663 patent is not invalid and that the '663 patent does not violate the best mode requirement of 35 U.S.C. 112, first paragraph.

I. Introduction

BEI and Matsushita have moved this Court under the provisions of Fed. R. Civ. P. 56 for a ruling finding infringement or non-infringement, respectively, by Matsushita of U.S. Patent No. 4,654,663.

Upon a careful and comprehensive review of the legal memoranda, case law and exhibits proffered by the parties and for the reasons set forth below, I recommend that the Court deny BEI's Motion and grant Matsushita's Motion.

II. Legal Standard for Summary Judgment

Pursuant to Fed. R. Civ. P. 56(c) summary judgment "shall be rendered forthwith if the pleadings, depositions, answers to interrogatories, and admissions on file, together with the affidavits, if any, show that there is no genuine issue as to any material fact and that the moving party is entitled to judgment as a matter of law". A dispute as to a material fact is genuine only if there is sufficient evidence for the fact finder to find for the non-moving party. Anderson v. Liberty Lobby Inc., 477 U.S. 242 (1986). Moreover, there is no question that summary judgment is as appropriate in a case involving a patent as any other where there are no genuine issues of material fact and the moving party is entitled to judgment as a matter of law. C.R. Bard, Inc. v. Advanced Cardiovascular Systems, Inc.., 911 F.2d 670, 15 U.S.P.Q.2d 1540 (Fed. Cir. 1990).

Furthermore, while the Federal Circuit has cautioned courts that a motion for summary judgment of infringement must be assessed with great care, Cole v. Kimberly-Clark Corp., 102 F.3d 524, 41 U.S.P.Q.2d 1001, (Fed. Cir. 1996), it has acknowledged that comparison of a properly interpreted claim with an uncontested description of the accused devices reflects such an absence of material fact issues warranting summary judgment of infringement or non-infringement, D.M.I., Inc. v. Deere & Co., 755 F.2d 1570, 225 U.S.P.Q. 236 (Fed. Cir. 1985).

III. Claim Interpretation

A paradigm claim, independent claim 1, has been adopted for purposes of interpretation and infringement.

Through a Markman proceeding including both briefing and a hearing before this Court, it became apparent that five limitations of claim 1 were in dispute and necessitated the Court's interpretation. The five disputed limitations and the Court's tentative determinations appear below.

1. A single crystal of piezoelectric material

THE COURT: A single piece of natural or synthetic piezoelectric or semiconductor material whose atoms are arranged with some degree of geometric regularity and which produces a relatively stable output signal when mechanical force is applied.

2. [A] common shaft serving as an output shaft

THE COURT: This is the common shaft or handle of the tuning fork, from which the output signal may be derived.

3. [A] tuning fork providing a balanced resonant sensor responsive solely to a component of angular motion about the longitudinal axis of the output shaft,

THE COURT: Not ambiguous

4. Driving means coupled to said tines for causing them to vibrate at a drive frequency

THE COURT: A means-plus-function limitation. A drive oscillator, illustrated in Figures 8 and 9, and described at Col. 5, lines 40-41 and Col. 6, lines 7-9 performs this function.

5. Electrode means ... positioned on said tuning fork for sensing said piezoelectric signals representative of the angular rate of motion.

THE COURT: While found not to be ambiguous, a jury instruction defining the language was entered in the Order.

IV. Prosecution History of U.S. Patent No. 4,654,663

While it is true that issues relating to prosecution of U.S. Patent No. 4,654,663 have, to a great extent, been subsumed by the Court in its claim interpretation, I feel it is necessary to briefly review the prosecution history, certain prior art, and the claim amendment sequence which culminated in the '663 patent. Since claim 1 has been adopted as the paradigm claim, I will so limit my review and analysis.

In the application filed November 16, 1981, claim 1 appeared as follows:

1. An angular rate sensor system comprising:

(a) a tuning fork of a piezoelectric material being substantially mechanically temperature stable, having low internal friction and following Hook's law, said tuning fork having two substantially parallel tines and a common shaft, said tuning fork providing a balanced resonant sensor;

(b) electromagnetic means coupled to said tines for causing them to vibrate at a drive frequency; and

(c) output means coupled to said shaft for deriving an electric signal representative of the angular rate of motion to which said system is subjected, said output means including a phase detector for the

electric signal and means for generating an output signal indicative of the angular rate of motion.

This claim and others were rejected as obvious under 35 U.S.C. 103 over Riordan et al. (U.S. Pat. No. 3,465,597) or Southworth et al. (U.S. Pat. No. 3,269,192) in view of Morris (U.S. Pat. No. 4,263,546).

In a responsive Amendment filed December 13, 1983, claim 1 was amended, with deletions bracketed and additions underlined, as follows:

1. (Amended) An angular rate sensor system comprising:

(a) a tuning fork of [a] quartz exhibiting piezoelectric properties [material being substantially mechanically temperature stable, having low internal friction and following Hook's law], said tuning fork having two substantially parallel tines and a common shaft disposed in a plane, said common shaft serving as an output shaft, said tuning fork providing a balanced resonant sensor responsive solely to angular motion within said plane, causing a deflection of said output shaft;

(b) electromagnetic means coupled to said tines for causing them to vibrate at a drive frequency; and

(c) output means coupled to said shaft for deriving an electric signal representative of the angular rate of motion within said plane to which said system is subjected, said output means including a phase detector for the electric signal and means for generating an output signal indicative of the angular rate of motion.

A Supplemental Amendment was filed January 9, 1984 and further amended claim 1 as follows:

1. (Twice Amended) An angular rate sensor system comprising:

(a) a tuning fork of quartz exhibiting piezoelectric properties, said tuning fork having two substantially parallel tines and a common shaft disposed in a plane, said common shaft serving as an output shaft, said tuning fork providing a balanced resonant sensor responsive solely to angular motion [within said plane] about an axis parallel to said output shaft, causing a torsional deflection of said output shaft;

(b) electromagnetic means coupled to said tines for causing them to vibrate at a drive frequency; and

(c) output means coupled to said shaft for deriving an electric signal representative of the angular rate of motion [within said plane] about said axis to which said system is subjected, said output means including a phase detector for the electric signal and means for generating an output signal indicative of the angular rate of motion.

A restriction requirement was mailed by the Patent Office April 3, 1984 and applicants responded in an Amendment and election filed April 23, 1984. No amendment or relevant activity regarding claim 1 occurred in this exchange of papers.

A third Office action on the merits issued July 18, 1984 and rejected, inter alia, claim 1 under 35 U.S.C. 103 as unpatentable over Barnaby, Morrow or Lyman, either in view of Chuang (U.S. Pat. No. 4,429,248).

Claim 1 was again amended in a responsive Amendment filed October 1, 1984:

1. (Thrice Amended) An angular rate sensor system comprising:

(a) a tuning fork [of] having [quartz exhibiting] piezoelectric properties, said tuning fork having two [substantially parallel] tines and a common shaft disposed in a plane, said common shaft serving as an output shaft, said tuning fork providing a balanced resonant sensor responsive solely to angular motion about the longitudinal axis of the [about an axis parallel to said] output shaft, causing a torsional deflection of said output shaft;

(b) driving [electromagnetic] means coupled to said tines for causing them to vibrate at a drive frequency; and

(c) output means responsive to said piezoelectrical properties positioned on [coupled to] said [shaft] tuning fork for deriving a[n electric] signal representative of the angular rate of motion about said axis to which said system is subjected, said output means including a phase detector for the [electric] signal and means for generating an output signal indicative of the angular rate of motion.

Prosecution continued with paper number 17, an Office action again rejecting, inter alia, claim 1 under 35 U.S.C. 103 on a newly cited reference, Hart (U.S. Pat. No. 3,258,617).

In Amendment F filed March 10, 1985 claim 1 was amended for the fourth time:

1. (Four Times Amended) An angular rate sensor system comprising:

(a) a tuning fork [having] formed from a single crystal of piezoelectric [properties] material, said tuning fork having two tines and a common shaft disposed in a plane, said common shaft serving as an output shaft, said tuning fork providing a balanced resonant sensor responsive solely to a component of angular motion about the longitudinal axis of the output shaft, causing a torsional deflection of said output shaft;

(b) driving means coupled to said tines for causing them to vibrate at a drive frequency; [and]

(c) [output] electrode means, responsive to [said] piezoelectric[al properties] signals, positioned on said tuning fork for [deriving a] sensing said piezoelectric signals representative of the angular rate of motion about said axis to which said system is subjected[,] and [said]

(d) output means including a phase detector for [the] said piezoelectric signals and means for generating an output signal indicative of the angular rate of motion.

In fact, all independent claims were amended to incorporate "single crystal" analogous language. In his accompanying remarks, applicants' attorney focused upon and argued the uniqueness of applicants' single crystal tuning fork configuration.

Responsive to Amendment F, the Examiner again rejected claim 1 under 35 U.S.C. 103 as unpatentable over Christensen (U.S. Pat. No. 3,206,986) in view of Hart '617.

In both responsive Amendments F, filed March 10, 1985, and Amendment G, filed November 1, 1985, the single crystal turning fork configuration became the focus of arguments distinguishing the claims over the cited prior art.

> The construction of Applicants' invention is in direct contrast with devices such as the Watson device (U.S. Pat. No. 4,479,098, Figure 1), the Christenson device (U.S. Pat. No. 3,206,986), and other devices which require two or more individual elements to be attached to form the vibrating and sensing elements of the sensors. ...
>
> The provision of an angular sensor system having a balanced resonant sensor consisting of a single, tuning fork-shaped piezoelectric crystal is novel and is not suggested by the prior art. (Amendment F, pg. 10)
>
> Referring specifically to the claims, it will be appreciated that each of the claims develop the distinguishing features that characterize the present invention as patentable over the cited art. For example, independent Claim 1 recites "a tuning fork formed from a single crystal of piezoelectric material,..." (Amendment F, page 11)

In Amendment G, several pages of remarks distinguishing the "single crystal" limitation of the claims over the cited art appear:

> Applicants have disclosed and claimed an angular sensor system having a balanced resonant sensor consisting of a single, tuning fork-shaped piezoelectric crystal. The important structural elements of Applicants' invention are clearly set forth in all pending claims, such as, for example Claim 1, with the structural limitation of (1) a single crystal piezoelectric material, (2) shaped in the form of a tuning fork with two tines and a common shaft being of paramount importance in distinguishing the present invention from the combination of Christensen. Although the placement of the electrodes according to Applicants is important, it is the provision of a single, unitary crystal of piezoelectric material forming one

> or more tuning forks that permits Applicants to obtain a stable, balanced vibrational system resistant to errors caused by environmental effects, such as mechanical shock and vibration. Just as important, it is this structure of balanced tines manufactured from a unitary crystal of piezoelectric material that results in meaningful output signals from the sensor that are readily reproducible.
>
> Applicants' structure is not to be found in either of the cited prior patent publications. For example, in the primary reference, Christensen discloses an assembled tuning fork structure made of a polycrystalline piezoelectric ceramic material, barium titanate. Such a structure immediately presents two problems not found in Applicants' structure: (1) the use of a polycrystalline material; and (2) the use of a composite structure, both of which factors have a significant adverse effect on the stability and reproducibility of the output signals from the angular rate sensor system constructed in accordance therewith. (Amendment G, pg. 3)

Distinguishing the claims over Christensen and Hart, applicants' attorney argued:

> An additional factor in destabilizing the Christensen output signal is the use by Christensen of a composite structure. A multiple piece structure inherently generates "aging" problems, both within the structure itself as the properties of the different materials change relative to one another over time, and in the "adhesive" used to form the connection between the various elements. Moreover, unless the crystal structures are closely matched, it is extremely difficult to analyze the output signals from the sensor due to the transitional effects of passing vibrational and electrical energy through different crystalline structures.
>
> The second reference, Hart, suggests forming the vibrational structure from a single quartz crystal in the shape of a rectangular-prismatic block. It is well recognized that prior patents are references for only what they clearly disclose or suggest, and it is not

> proper to use such a reference to modify prior art structures in a manner not suggested by the prior art reference. Application of Randol 425 F.2d 1268, 1271 (C.C.P.A. 1970). The Hart reference contains no teachings or suggestions to utilize a single crystal in a tuning fork design. The problem presented by such a single, monolithic structure, in terms of an angular rate sensor system, lines in the creation of unwanted vibrational harmonics by this "unbalanced" vibrating beam. (Amendment F, pp. 3-4)

The Hart and Christensen references are, in my opinion, the two most relevant prior art references with regard to the tuning fork structure. Christensen both in the drawings such as Figure 1 and in column 3 beginning at line 37 teaches bimorph vibrating side members 15 which are coupled by a cross bar 14 which may be a single piezoelectric crystal but is preferably two strips 20 which are assembled by suitable adhesive to form a bimorph. Accordingly, it is manifest that not only were crystal bimorph vibrating elements in an angular movement sensor old but also that the use of a single crystal was apparently not. In Hart, United States Pat. No. 3,258,617, a resonant piezoelectric device for detecting inertial rotation is disclosed which utilizes, as illustrated in Figure 3 and subsequent figures, a layered piezoelectric element. This reference presents a three layer resonating element in an angular rotation sensor as old and, like Christensen, defines the prior art over which the single crystal limitation of the claim distinguishes.

It is apparent from the foregoing and additional statements not reproduced here that the claim limitation "single crystal" was and is critical to the patentability of Claim 1.

V. The Accused Devices

A. The EWT 57 Sensor

The EWT 57 is an angular rate sensor manufactured by MACO and made out of one sheet of quartz. (Deposition of Hiroaki Mouri, pg. 46.) The tuning fork has been characterized as a unimorph tuning fork (Deposition of Koji Yamamoto, p. 57).

With the exception of apparently one sample, which may have been shown to a customer (Deposition of Hiroaki Mouri, pg. 84, 85), Mr. Mouri and three other witnesses testified to the lack of commercial activity in the United States: Hiroaki Mouri: product never provided or imported to U.S. (Mouri Deposition, pg. 49); Motoki Ogata: product never sent to U.S. (Ogata Deposition, pg. 28); Jun-Ichi Yukawa: product never sent to U.S. (Yukawa Deposition pg. 129) and Koji Yamamoto: never been sold in U.S. (Yamamoto Deposition pg. 40).

The U.S. patent statute defines infringement at 35 U.S.C. §271(a) as, without authority, making, using, offering to sell or selling a patented invention.

Because I do not find the de minimus activity of the defendants to be responsive to any of the prohibitions of 35 U.S.C. 271(a), infringement of the '663 patent by the EWT 57 cannot be found.

B. THE EWT S52, EWT S53, EWT S62 & EWT S82 Sensors

The EWT S52, S53, S62 and S82 sensors are all angular rate sensors having a bimorph tuning fork. (Deposition of Koji Yamamoto, pg. 57) That the tuning forks of these devices are manufactured from two separate waters of crystalline quartz which are directly bonded together with their electric axes reversed does not appear to be in dispute.

What appears also not to be in dispute is that the direct bonding process creates a small boundary layer or interface of disrupted, possibly amorphous material having a thickness on the order of 20 nanometers.

1. The first limitation interpreted by the Court and relevant to an infringement analysis relates to the claim limitation "a single crystal of piezoelectric material" which the Court has construed as meaning:

> A single piece of natural or synthetic piezoelectric or semi-conductor material whose atoms are arranged with some degree of geometric regularity and which produces a relatively stable output signal when mechanical force is applied.

Judge Cohn's construction both remains true to the "single crystal" language of the claim and acknowledges the possibility of dislocations or other minor irregularities in the crystal (lattice) structure. It does not, however, encompass a structure having two distinct arrangements of atoms each independently having some degree of geometric regularity and certainly does not encompass a boundary layer or interface between the two crystal layers.

I am mindful of the fact that an infringement analysis routinely reads a claim on an accused device with the implied language of "at least", e.g., "at least one sensor", "at least one driver means" when the limitation itself is sensor or driver means. However, since the prior art discloses bimorph vibrating elements in angular rate sensors and since applicants argued strongly and repeatedly to distinguish their single crystal construction over the prior art, I conclude that it is improper to read into this claim limitation the phrase "at least". To do so, also ignores the claim language

itself which recites that the "tuning fork is formed from a single crystal of piezoelectric material."

BEI's argument and the opinion of its expert, Dr. Errol P. Eernisse regarding the direct bonding or boundary layer and its miniscule thickness are misplaced. Regardless of the thickness or even the existence of such a layer, the tuning forks of these angular rate sensors are bimorphs - made up of two crystals with their electrical axes reversed. These are not single crystals as the Court has construed this language. Hence, these accused devices do not respond to this claim limitation as construed by Judge Cohn.

Consideration of this limitation under the doctrine of equivalents necessitates application of the precepts of Warner-Jenkinson Co. v. Hilton Davis Chemical Co., 520 U.S. 17, 41 U.S.P.Q.2d 1865 (1997) and Festo Corporation v. Shoketsu Kinzoku Kogyo Kabushiki Co., Ltd., 535 U.S. 722, (2002).

In Warner-Jenkinson, the Court recognized that prosecution history estoppel does not arise in every instance of claim amendment. In Festo, the court sought to correct an overzealous Federal Circuit Court that had sought to eliminate any flexible estoppel application. Here, the very limitation at issue is the same limitation, that when added to the claims, conferred patentability thereupon. Since the amendment was clearly undertaken to overcome prior art, it had a substantial reason related to patentability and under both Warner-Jenkinson and Festo, prosecution history estoppel applies. The doctrine of equivalents is therefore not available to BEI with regard to the single crystal claim limitation.

2. The second limitation relates to the language the "tuning fork providing a balanced resonant sensor responsive solely to a component of angular motion about the longitudinal axis of the output shaft."

Matsushita acknowledges that its accused angular rate sensors have a cross axis sensitivity of ± 5%, (Document MAT-1007391) and therefore argues that they do not respond to this claim limitation. Furthermore, Matsushita argues that the accused devices are responsive to linear acceleration, vibration and temperature. BEI, on the other hand focuses accurately upon the claim language: "a tuning fork responsive solely to a component of angular motion."

The component which is "responsive solely" is the tuning fork, not the angular rate sensor. Thus, it is the output of the tuning fork, not the angular rate sensor assembly that is of interest. This acknowledges the real world wherein the tuning fork may not be perfectly orthogonally positioned within its housing and thus exhibit some cross axis sensitivity.

More probative of this issue is, however, interpretation of the word "solely". If this were interpreted with the utmost strictness, it is unlikely any tuning fork would respond to it, including the patentees! A claim interpretation that excludes the patentees' own embodiments is rarely, if ever, correct and requires highly persuasive evidentiary support. Vitronics Corp. v. Conceptronic 90 F.3d 1576, 39 U.S.P.Q.2d 1573 (Fed. Cir. 1996). Moreover, the term "substantially" is understood as being incorporated into limitations of every patent claim. Astra Aktiebolag v. Andrex Pharms, Inc., 222 F. Supp.2d 423, (S.D.N.Y. 2002). Accordingly, I find that the tuning fork of the accused devices literally satisfies this limitation.

In view of this finding, it is unnecessary to study the accused devices and claim limitation from the standpoint of the doctrine of equivalents.

It is basic patent law that all limitations of a claim are material. Glaxo, Inc. v. Novopharm, Ltd., 110 F.3d 1562 (Fed. Cir. 1997). Because each limitation of a claim is material and essential, and because I find the accused devices lacking the "tuning fork formed from a single crystal of piezoelectric material", I conclude that literal infringement cannot be found. Smithkline Diagnostics, Inc. v. Helena Labs, Corp., 859 F.2d 878, 8 U.S.P.Q.2d 1468 (Fed. Cir. 1988). Similarly, and as addressed above, prosecution history estoppel prohibits the application of the doctrine of equivalents to this claim limitation and I therefore find that infringement of paradigm claim 1 cannot be found under the doctrine of equivalents. Hence, it is my recommendation that BEI's Motion for Summary Judgment of Infringement be denied and that Matsuhita's Motion for Summary Judgment of Non-Infringement be granted.

VI. The Single Crystal Support Issue

Although not apparently an issue in this litigation, I feel compelled to record my observations regarding the claim limitation "single crystal" and certain issues and legal consequences relating thereto.

The gravity of these observations will be appreciated if the parties recall what surely was the perceived ambiguity of the phrase, the difficulty of interpretation and the disparity between the parties interpretive positions. Matsushita alone provided, over time, three distinct interpretations of this claim limitation. (Order on Claim Construction, footnote 4)

Although patent specifications are properly relied upon to support and explicate the claims, one looks in vain for any use of the "single crystal" phrase in the entire patent relating to the configuration of the tuning fork, much less any explanation, characterization or definition of the phrase.

Rather, the only appearances of the phrase "single crystal" or an analogous term are in the claims. Chronologically, the first appearance of the phrase is in an Amendment (Amendment F) filed by the applicants on March 10, 1985, nearly three and one-half years after the application resulting in the '663 patent was filed.

35 U.S.C. §112, first paragraph, mandates "a written description of the invention, ... in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains ... to make and use the same, ..." Such written description is necessary to support the claims and prove that the inventors were in possession of the invention as of the filing date. This requirement is tied to 35 U.S.C. §132 which provides that "No amendment shall introduce new matter into the disclosure of the invention."

Whether arising under §112, or §132, the test for claim support is whether the disclosure as originally filed reasonably conveys to one skilled in the art that the inventors had possession of later claimed subject matter at the time of filing. Ralston Purina Co. v. Far-Mar-Co., Inc., 772 F.2d 1570, 227 U.S.P.Q. 177 (Fed. Cir. 1985).

Claims amended with limitations that are not supported by the original disclosure should be rejected under 35 U.S.C. 112, first paragraph, as lacking support. However, it appears that this was not done. It is true that the patentees have the benefit of both the presumption of validity pursuant to 35 U.S.C. §282 and the

presumption of administrative correctness. Brooktree Corp. v. Advanced Microdevices, Inc., 977 F.2d 1555, 24 U.S.P.Q.2d 1401 (Fed. Cir. 1992). Nonetheless, the allowed claims containing the "single crystal" limitation (and analogous language) would appear to be vulnerable to a validity challenge based upon §112, on a defective oath or a statutory bar. Litton Systems, Inc. v. Whirlpool Corp., 728 F.2d 1423, 221 U.S.P.Q. 97 (Fed. Cir. 1984) and Railroad Dynamics, Inc. v. A. Stucki Co., 727 F.2d 1506, 220 U.S.P.Q. 929 (Fed. Cir. 1984).

Inasmuch as my knowledge and understanding of the testimony and the exhibits in this action is limited to that material submitted by the parties supporting or opposing the various motions for summary judgment, there may be testimony and exhibits addressing this issue. At the moment, however, I see none. Moreover, since this issue clearly impacts BEI's Motion that the asserted patent is not invalid and, to a lesser extent, affects as well its Motion seeking a finding of compliance with the best mode requirement, with the Court's concurrence, I have deferred consideration of both.

Respectfully submitted,

David D. Murray