

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

RESONANT SYSTEMS, INC.,
Patent Owner.

Case No. IPR2024-00983
U.S. Patent No. 11,152,882

PATENT OWNER'S RESPONSE

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Case No. IPR2024-00983

U.S. Patent No. 11,152,882

PATENT OWNER'S EXHIBIT LIST

<i>Exhibit No</i>	<i>Description</i>
2001	Court's Claim Construction Order (<i>Resonant Systems, Inc. v. Apple Inc.</i> , Case No. 23-cv-00077-ADA (W.D. Tex.), Dkt. 91)
2002	Claim Construction Memorandum and Order (<i>Resonant Systems, Inc. v. Apple Inc.</i> , Case No. 23-cv-00077-ADA (W.D. Tex.), Dkt. 103)
2003	Order Modifying Scheduling Order (<i>Resonant Systems, Inc. v. Apple Inc.</i> , Case No. 23-cv-00077-ADA (W.D. Tex.), Dkt. 57)
2004	Amended Scheduling Order (<i>Resonant Systems, Inc. v. Apple Inc.</i> , Case No. 23-cv-00077-ADA (W.D. Tex.), Dkt. 95, Ex. 1)
2005	Federal Court Management Statistics, Western District of Texas, 2018-2023
2006	Excerpt of Defendant's Final Invalidity Contentions (<i>Resonant Systems, Inc. v. Apple Inc.</i> , Case No. 23-cv-00077-ADA (W.D. Tex.))
2007	[Reserved]
2008	[Reserved]
2009	Declaration of Keith W. Goossen, Ph.D.
2010	Curriculum Vitae of Keith W. Goossen, Ph.D.
2011	Transcript of Deposition of Blake Hannaford, Ph.D., Jan. 27, 2025
2012	Transcript of Deposition of Blake Hannaford, Ph.D., Jan. 28, 2025
2013	Transcript of Deposition of Blake Hannaford, Ph.D., Jan. 29, 2025

I. INTRODUCTION

The Board granted institution on several enumerated grounds of obviousness, each based in large part on Alexander, Cosper, Gregorio, and Muramatsu. The arguments presented herein and the additional evidence submitted, such as the testimony of Patent Owner's expert Dr. Keith Goossen (Ex. 2009), demonstrate that Petitioner has failed to establish obviousness of the challenged claims and that Petitioner's grounds should be rejected.

II. SUMMARY OF ARGUMENT

The Petition's Ground 1 fails to establish that Alexander and Cosper are analogous art or that a POSITA would be motivated to combine Alexander's non-resonant linear motor with Cosper's resonant rotating motor. Grounds 2A-2H fail to show any disclosure of steps 4519 and 4520 under the proper construction of the phrase "control component."

III. BACKGROUND

A. Background to the '882 Patent

Many electronic devices such as mobile phones and game controllers make use of components that produce vibrational forces. The '882 Patent teaches and claims oscillating resonant modules that produce vibrations by back-and-forth oscillation of a weight or member along a path. This oscillation is controlled using an algorithm that receives a control curve or control

pattern for the ORM that specifies the frequency of the driving oscillations with respect to time and that also receives outputs from one or more sensors that output indications of the positions of the mass.

B. Related litigation

The '882 Patent is asserted in litigation against Apple. There is no other pending litigation. There are no other instituted IPRs regarding the '882 Patent, and no patent related to the '882 Patent by continuation or continuation-in-part is subject to any pending IPR.

IV. LEVEL OF ORDINARY SKILL IN THE ART

Patent Owner believes that a POSITA at the time of the invention would have had (1) a bachelor's degree in electrical engineering, mechanical engineering, or a comparable field of study, and (2) at least two years of professional experience with electro-mechanical control systems, or other similarly relevant industry experience. Additional relevant industry experience may compensate for lack of formal education or vice versa.

Petitioner offers a similar level of ordinary skill in the art. Patent Owner does not believe that any of the arguments herein would change if the Board were to adopt Petitioner's definition for the level of ordinary skill rather than Patent Owner's.

V. LEGAL STANDARDS

The petitioner has the burden to clearly set forth the basis for its challenges in the petition. *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) as “requiring IPR petitions to identify ‘with particularity ... the evidence that supports the grounds for the challenge to each claim’”). A petitioner may not rely on the Board to substitute its own reasoning to remedy the deficiencies in a petition. *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348, 1355 (2018) (“Congress chose to structure a process in which it’s the petitioner, not the Director, who gets to define the contours of the proceeding.”); *In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d 1364, 1381 (Fed. Cir. 2016) (rejecting the Board’s reliance on obviousness arguments that “could have been included” in the petition but were not, and holding that the Board may not “raise, address, and decide unpatentability theories never presented by the petitioner and not supported by the record evidence”); *Ariosa Diagnostics v. Verinata Health, Inc.*, 805 F.3d 1359, 1367 (Fed. Cir. 2015) (holding that “a challenge can fail even if different evidence and arguments might have led to success”); *Wasica Finance GMBH v. Continental Auto. Systems*, 853 F.3d 1272, 1286 (Fed. Cir. 2017) (holding that new arguments in a reply brief are “foreclosed by statute, our precedent, and Board guidelines”).

The Board “may reject even uncontroverted expert testimony when it is intrinsically unpersuasive.” *Granite Constr. Co. v. United States*, 962 F.2d 998, 1006 (Fed. Cir. 1992). The petitioner cannot satisfy its burden of proving obviousness by employing “mere conclusory statements.” *Magnum*, 829 F.3d at 1380.

An obviousness determination requires finding that a POSITA would have been motivated to modify or combine teachings in the prior art. *In re Stepan Co.*, 868 F.3d 1342, 1345–46 (Fed. Cir. 2017). Obviousness concerns “whether a skilled artisan not only *could have made* but *would have been motivated to make* the combinations or modifications of prior art to arrive at the claimed invention.” *Belden Inc. v. Berk-Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015). The “mere fact that these possible arrangements existed in the prior art” does not provide a motivation to substitute the arrangement in one prior art embodiment with the arrangement in another.” *Virtek Vision International ULC v. Assembly Guidance Systems, Inc.*, 97 F.4th 882, 887 (Fed. Cir. 2024). Because a motivation to modify or combine is part of the *prima facie* case for obviousness that must be set forth in the petition, a petitioner should not be permitted to present “an entirely new rationale to explain why one of skill in the art would have been motivated to combine” in its reply. *Intelligent Bio-*

Systems, Inc. v. Illumina Cambridge Ltd., 821 F.3d 1359, 1370 (Fed. Cir. 2016).

“An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.” 35 U.S.C. § 112 ¶ 6. Even were a claim does not utilize the word “means,” § 112 ¶ 6 will apply if “the claim term fails to recite sufficiently definite structure or else recites function without reciting sufficient structure for performing that function.” *Williamson v. Citrix Online, LLC*, 792 F.3d 1339, 1349 (Fed. Cir. 2015).

For a reference to be considered in the obviousness analysis, it must be analogous *to the invention of the challenged claims*. *Corephotonics, Ltd. v. Apple Inc.*, 84 F.4th 990, 1003–04 (Fed. Cir. 2023) (“Prior art references are applicable to the obviousness inquiry only when they are analogous to the claims being challenged.”) There are two tests for defining the scope of analogous art: “(1) whether the art is from the same field of endeavor, regardless of the problem addressed and, (2) if the reference is not within the field of the inventor’s endeavor, whether the reference still is reasonably pertinent to the

particular problem with which the inventor is involved.” *Id.* (quoting *Airbus S.A.S. v. Firepass Corp.*, 941 F.3d 1374, 1379 (Fed. Cir. 2019)).

VI. CLAIM CONSTRUCTION

1. Preambles of Claims 1 and 10

In the related district court litigation, the parties have agreed that the preambles of claims 1 and 10 are limiting. (Ex. 2002 at 10.) Apple’s petition in this IPR does not address that question. Some arguments in this Response nominally assume that the preambles are limiting. But these arguments would apply with equal force if the Board instead determined that the preambles were not limiting. Limitations [1b] and [1d] of claim 1 and limitations [10b], [10d], and [10f] of claim 10 each require at least one “oscillating resonant module,” so an oscillating resonant module is required even if the preambles are not limiting.

2. “control component”

In its institution decision, the Board determined that the term “control component” of independent claims 1 and 10 is a means-plus-function term. (Paper 8 at 14.) In the related district court litigation, the parties had agreed that this term was a means-plus-function term, and the district court had adopted a means-plus-function construction. (Ex. 2002 at 39–43.) Patent Owner agrees with Apple, the district court, and the Board that the “control

component” limitations recite a function without reciting sufficient structure for performing that function and therefore that they are means-plus-function terms.

In the institution decision, the Board adopted the district court’s construction for the “control component terms”:

Function: receiving control signals input to the oscillating resonant module; receiving outputs from the one or more sensors; controlling oscillation of the mass to produce a vibration response according to the received control signals by generating, using one or more of the received sensor outputs, control outputs to an actuator that drives the mass to oscillate.

Structure: a microcontroller, a processor, a microprocessor, or a CPU that performs the algorithm shown in Figure 45 or the algorithm described in the corresponding text. See, e.g., 31:19–32:13, and equivalents thereof. (Paper 8 at 11–12.)

In particular, the Board (and the district court) determined that the corresponding structure include an algorithm shown in the following Figure 45 and described in lines 31:19–32:13 of the specification (’882 Patent, Figure 45.):

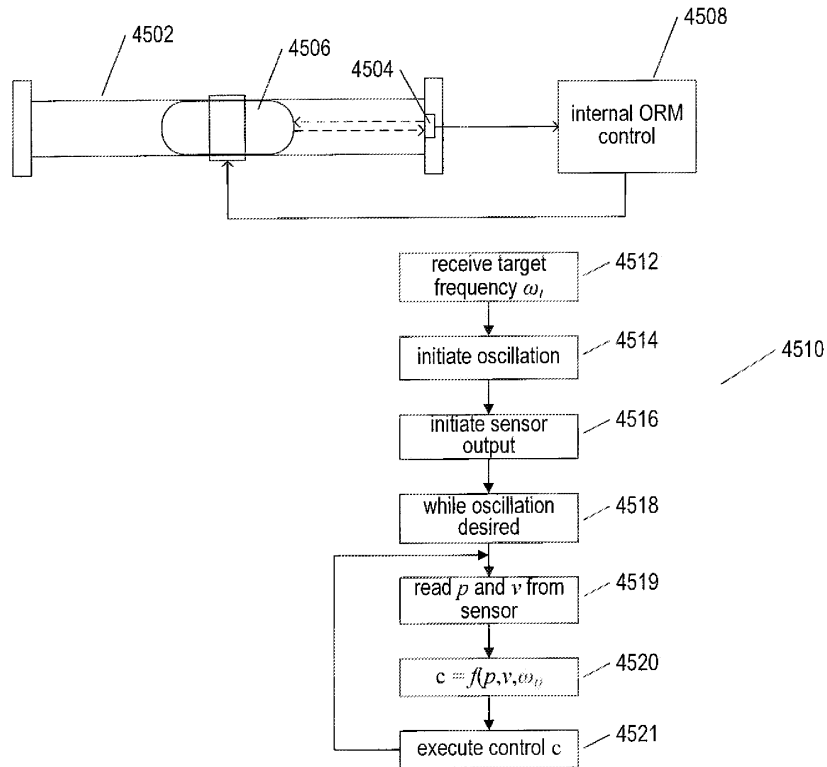


FIG. 45

Among other things, this algorithm requires step 4519 “read p and v from sensor” and step 4520, which the specification describes as including “the appropriate control is computed based on the target frequency ω_t and the current position and velocity of the moving mass p and v .” (’882 Patent at 31:44–46.)

While the parties had taken different positions on the corresponding structure for the “control component” terms in the district court litigation, they had agreed that at least in the case where the corresponding structure was a processor, CPU, or microprocessor, it must be programmed with an algorithm that includes at least step 4520 of computing control outputs based upon target frequency and current position and velocity. (Ex. 2002 at 39–40, 42.) For each of the grounds, the petition relies on a processor and algorithm to satisfy the

“control component” limitations. (Petition at 26, 37–38, 44, 53, 59, 61–63.)

Accordingly, even if the Board were to revisit its construction of “control component” from the institution decision, under any of the positions taken by either party in the district court litigation or in this IPR concerning the corresponding structure for control component, the algorithms of the processors that Apple’s petition relies upon must include at least step 4520.

As with the preambles, some of the arguments in this Response assume the claim construction adopted by the Board in the institution decision for the “control component” terms, but these arguments would also apply under any of the means-plus-function constructions proposed by the parties in the district court litigation. (*See* Ex. 2009, ¶¶ 59-60.)

VII. OBVIOUSNESS

A. Ground 1

1. Alexander and Cospers Are Not Analogous Art and a POSITA Would Not Have Been Motivated to Combine

Each independent claim of the ’882 Patent requires an “oscillating resonant module.” At his deposition, Dr. Hannaford explained that he understood the term “resonant” to mean “a use of the phenomenon of resonance or reliance on that phenomenon.” (Ex. 2013 at 10:16–22.) He explained resonance as follows (Ex. 2013 at 11:2–11):

THE WITNESS: Resonance is a very general phenomenon of systems that can -- that have components which store and release energy. So a very typical example is a mass connected to a spring. Both the mass and the spring store energy but in different ways.

Another one is electrical resonance where a circuit is tuned to a frequency with an inductor and a capacitor, and then the mathematics associated with those circuits have very similar properties, which, in many case, cause the system to oscillate.

Patent Owner's expert Dr. Goossen agrees at a high level with Dr. Hanford's explanation of resonance. (Ex. 2009, ¶ 63.) As Dr. Goossen explains, a system cannot be resonant unless it can store and transfer energy between two or more different forms. A mass on a spring is a typical example. Extending or contracting the spring from its resting position requires energy. Some of that energy is lost, for example due to friction; the loss is called damping. But other than damping, the energy is not lost but rather stored in a different form. For example, the compressed spring will tend to return to a relaxed state, and will move the mass back towards the center, converting the stored energy into kinetic energy. (*Id.*)

When a periodic external force is applied to a resonant system, the amplitude of the resulting oscillation varies with the frequency of the external

force. (Ex. 2009, ¶ 64.) For example, in the idealized case of an undamped or slightly damped oscillator, there is a resonant frequency at which the resulting amplitude will be greatest for a given input. (*Id.*) On the other hand, a strongly damped system, or a system with little or ability to store energy, will not exhibit resonance. (*Id.*)

Alexander discloses a specific type of linear actuator that lacks any mechanical ability to store energy. (Ex. 2009, ¶ 66.) In particular, unlike the embodiments of the '882 Patent, each of which includes either springs or magnets to provide a restoring force and thus resonant oscillation, Alexander teaches a linear actuator with a “mover” or “shaft” that can freely slide within the stator assembly. (Ex. 1005, ¶¶ [0023]–[0025]; Ex. 2009, ¶ 66.) The components of this assembly are in the following figure (Ex. 1005, Fig. 1A):

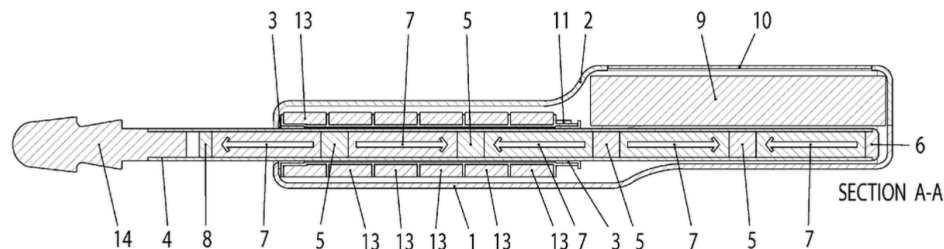


Figure 1A

Here, the stator is formed of a number of wire coils 13, and the mover is formed of tube 4, which comprises magnet(s) 7. (Ex. 1005, ¶ [0023].) There

are no springs, and there are no permanent magnets in the stator such as the “disk-like magnets [that] act much like springs” (’882 Patent at 6:51-55) as disclosed in the ’882 Patent. (Ex. 2009, ¶ 67.)

In short, Alexander does not disclose an oscillating resonant module as claimed. (Ex. 2009, ¶ 68.) As Dr. Goossen points out, reviewing Alexander’s teachings and considering the expected physical behavior of the disclosed system reveals a system with little or no ability to store energy (*e.g.* with springs or with stationary magnets), and thus little or no resonant behavior. Petitioner’s expert Dr. Hannaford confirmed this when he was asked at his deposition whether he believed that “the embodiments taught in Alexander would exhibit resonance associated with the movement of the mover within the stator,” and he testified that he did not recall his report “containing any opinion about oscillation in Alexander alone.” (Ex. 2013 at 20:3–10.)

The Petition does not show, or even suggest, that Alexander discloses or renders obvious an oscillating resonant module as claimed. For example, the Petition’s discussion of the preamble of claim 1 states that Alexander creates a “vibration,” without any suggestion that the limitation “resonant” is met. (Petition at 17; *see also* Ex. 1003, ¶ 79.) Rather, the Petition’s argument for “resonant” is only based on the combination of Alexander and Cosper, which would purportedly include “a bias member, based on Cosper’s suggestions.”

(Petition at 11–12, 15–17.) Therefore, the Petition requires combining Alexander and Cosper to form an oscillating resonant module as claimed. Petitioner does not show that Alexander and Cosper are analogous art or that a POSITA would be motivated to combine them with a reasonable expectation of success.

a. Alexander and Cosper are not analogous art.

The Petition has not shown that Alexander and Cosper are analogous art. Alexander’s stated field of endeavor is “linear motors, and more particularly, to programmable electro-magnetic sex toys using a linear motor.” (Ex. 1005, ¶ [0002].) A POSITA reading Alexander would understand that it discloses a non-resonant linear motor; specifically, a motor lacking any spring or other restoring force that could create a resonant effect. (Ex. 2009, ¶¶ 66-69, 70.) Alexander teaches a control system designed for its non-resonant linear motor, which is specifically intended to achieve motion patterns different from harmonic or resonant motion, such as a “‘square wave’ pattern”, or a profile with “fast extension of the mover [and] slow retraction of the mover.” (Ex. 1005, ¶¶ [0038], [0055].)

Cosper, on the other hand, is specifically directed to “control over mechanical resonant system[s].” (Ex. 1006, title.) Its recited field of invention is

“systems and methods for control of a mass and bias (e.g., ‘elastomeric members’) subassembly, including oscillating mechanical systems, that operate in an oscillatory mode at or near their mechanical resonant frequency.” (Ex. 1006, ¶ [0003].) Cosper teaches that, within its field of related art (Ex. 1006, ¶ [0005]–[0006]):

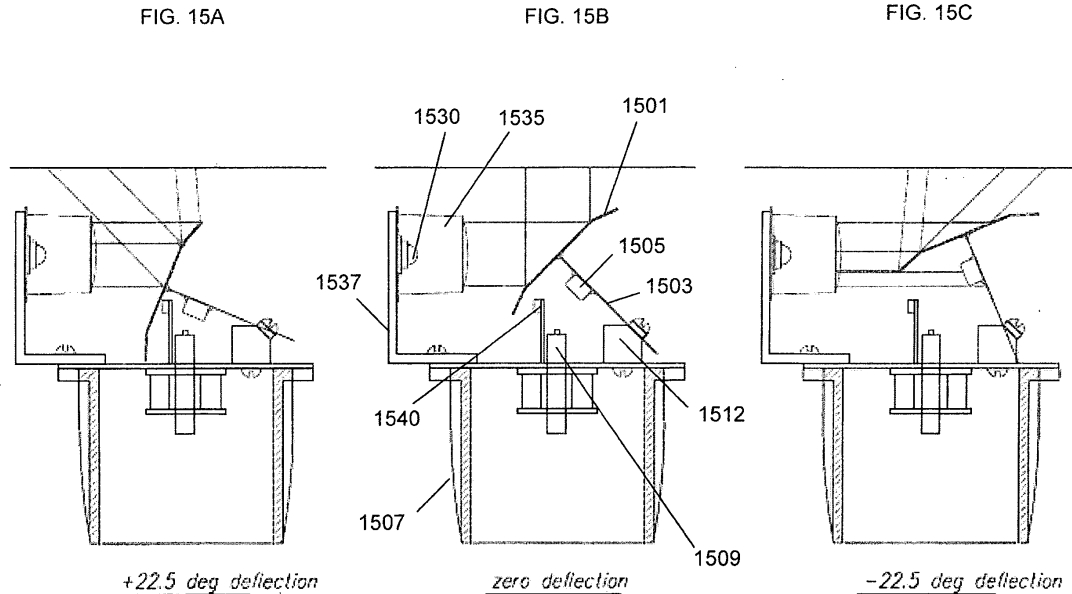
Mechanical systems typically have a resonant frequency, a natural frequency at which the system tends to move or oscillate when an impulse is applied. Moving the system at non-resonant frequencies may require significantly more energy. Accordingly, it may be desirable to move and control a mechanical system at or near its resonant frequency to achieve the maximum system movement for a reduced or minimal amount of energy.

The resonant frequency of a mechanical system tends to vary over time, with changes in mass, mechanical or elastomeric properties, ageing, friction, wear or dampening to name but a few. Maintaining a mechanical system moving at its resonant frequency requires significantly less energy, but may involve greater complexity.

Driving a mechanical resonant system for low loss, and a high Q, at or near its resonant frequency using an external frequency references may require a highly stable frequency source. It may also require that the resonant frequency of the mass and spring mechanism itself be very stable.

Rather, Cosper describes an optical beam scanner, e.g., where a “light source is used in conjunction with a resonant engine (not shown) having a mirror and a bias, and a mirror driver that oscillates the mirror at or near a resonant frequency of the mirror and bias” and “[a]s a result, the spot of light from the light source is effectively scanned over the target.” (Ex. 1006, ¶ [0067].)

While Cosper does use the words “linear . . . movement” in abstract, the two embodiments shown describe rotational motion of the moving mass. (Ex. 2009, ¶ 73.) The embodiment shown in fig. 2 describes “the electromagnetic coil 207 can be excited by electrical current to create a magnetic field that interacts with the magnet 209 to load the bias 205 and thereby move the mirror 201 around the light source 203, projecting the light from the opening in the housing 220 in the process.” (Ex. 1006, ¶ [0073].) The second embodiment shown in Figure 15 shows clearly rotational movement (Ex. 1006, Fig. 15.):



Cosper's field of endeavor and problems addressed have nothing to do with Alexander's. (Ex. 2009, ¶ 74.) At the most general level, Alexander is directed to the field of linear motors, and Cosper is directed to resonant motors. (*Id.*) The only overlap is "motors." Cosper is not about linear motors at all, and Alexander is not about resonant motors at all. (*Id.*)

Cosper is also, plainly, not about sex toys. (Ex. 2009, ¶ 75.) Cosper does not describe haptics or tactile applications at all. (*Id.*)

Moreover, Alexander at the very least is not from the same field of endeavor as the challenged '882 patent claims. Claim 1 and its dependent claims are directed to an "oscillating resonant module." Claim 10 and its dependent

claims are directed to a device containing including one or more such modules. As explained above, the teachings of Alexander are all for sex toys with non-resonant linear motors. These teachings are not in the field of oscillating resonant modules. (Ex. 2009, ¶ 76.)

Nor are the teachings of Alexander reasonably pertinent to the particular problem the inventors of the '882 patent were involved with. The problems that the inventors were seeking to solve are problems of control, and in particular of control in the presence of resonance. ('882 patent at title, abstract, 2:66–3:14, 4:51–5:9.) Because Alexander does not utilize or address resonance, its teachings are not pertinent to the problem of achieving control in the presence of resonance. (Ex. 2009, ¶ 77.)

To the extent that Apple identifies in its reply a field of endeavor or problem for the '882 patent claims that differs from the endeavor or problem identified above, Alexander and Cosper differ so dramatically from one another in their fields of endeavor and problems they address (as explained above) that they cannot both be in the same field of endeavor or be pertinent to the same problem as the '882 patent claims. (Ex. 2009, ¶ 78.) They cannot both be analogous art.

b. No Motivation to Combine

The Petition also does not and cannot show that a POSITA would be motivated to combine Alexander and Cosper in order to achieve all the limitations of the '882 Patent.

For example, the Petition's analysis a POSITA would be motivated to combine Alexander and Cosper in order "to provide the option of oscillation at or near a resonant frequency," specifically in order to enjoy "the advantage of facilitating increased system movement for a reduced or minimal amount of energy, in at least some operating scenarios (e.g., when oscillating over at least a portion of the available stroke)." (Pet. at 12-13; Ex. 1003, ¶ 71.) Neither Petitioner nor its expert Dr. Hannaford cites to anything in Alexander that shows this would be beneficial. In fact, the Petition's analysis and Dr. Hannaford's opinion at least partially contradicts itself.

Alexander specifically teaches that it is desirable for the "stroke" of the system (*i.e.*, how far it travels back and forth) to be a controllable parameter, and for the stroke to be as long as six inches. (Ex. 1005, ¶¶ [0037], [0040], [0055], [0059]; Ex. 2009, ¶ 81.) A POSITA would therefore recognize that Alexander already possesses an advantageously wide system movement. (Ex. 2009, ¶ 81.) The Petition and Dr. Hannaford give no explanation why increasing the system movement even further beyond the disclosed six-inch stroke

would be beneficial. And their suggestion that this benefit might be provided only for “a portion of the available stroke” implies that there might be an overall reduction of stroke length. (Ex. 2009, ¶ 81.)

A POSITA would also recognize that changing Alexander from a non-resonant to a resonant design would likely decrease or eliminate its ability to provide the full functionality disclosed in the reference. (Ex. 2009, ¶ 82.) For example, Alexander teaches that its non-resonant system can provide a range of preferable motion patterns, such as a “‘square wave’ pattern”, or a profile with “fast extension of the mover [and] slow retraction of the mover.” (Ex. 1005, ¶¶ [0038], [0055]; Ex. 2009, ¶ 82.) These motion patterns would be impaired, rather than helped, by the addition of resonance. (Ex. 2009, ¶ 82.)

For example, in a non-resonant system producing a “square wave” pattern, such as Alexander’s disclosure of “cycl[ing] between 1 inch extension and 4 inch extension, back and forth, at, for example, 1 Hz intervals,” (Ex. 1005, ¶ [0038].) there is essentially no power required during the non-moving parts of the “square,” *i.e.* the dwell time at the 1 inch and 4 inch positions respectively. (Ex. 2009, ¶ 83.) But in a resonant system, *e.g.* where a spring or elastomeric member has been added, the coils must constantly supply a force at extension to counteract the spring/elastomeric restoring force. (*Id.*)

Producing that force accomplishes no useful work (because there is no motion), but consumes electrical power, all of which is wasted as heat. (*Id.*) Neither the Petition nor Dr. Hannaford addresses this shortcoming.

A POSITA would also not have a reasonable expectation of success in the proposed combination. (Ex. 2009, ¶ 84.) In the Petition's theory, the POSITA would add Cospers's "bias member" to Alexander's embodiment. (Petition at 11-12; Ex. 1003, ¶ 66.) Petitioner's expert Dr. Hannaford states without evidence that "the bias member would have been readily selected with characteristics to facilitate operation at a resonant frequency over at least a portion of the mover's stroke." (Ex. 1003, ¶ 66.) Again, Alexander's embodiment preferably has a stroke length of at least six inches. (Ex. 2009, ¶ 81.) A POSITA reviewing Alexander would recognize that many of its features are specifically tuned for a long stroke length, measured in inches not millimeters. (Ex. 2009, ¶ 84.) The only frequency mentioned in Alexander is 1 Hz. (Ex. 1003, ¶ 38.)

Neither Petitioner nor its expert Dr. Hannaford discusses the practical application of Alexander's system in any detail. In particular, they do not and cannot explain any context in which it would be desirable or safe to operate a sex toy with a stroke length of several inches at a frequency substantially above 1 Hz. (Ex. 2009, ¶ 84.) In contrast, the '882 Patent discloses modules

operating at substantially higher frequencies, even above 350 Hz. ('882 Patent at Fig. 3; *see also id.* at 2:48 (prior unbalanced electric motors could only operate at around 80 Hz).)

As Dr. Goossen explains, modifying Alexander to resonate at 1 Hz would require a spring constant of 4 N/m, or 0.023 lbf/in. (Ex. 2009, ¶ 85.) This would be a very weak spring. (*Id.*) At a displacement of three inches (half of the six-inch stroke), the maximum restoring force would be approximately 0.3 N, which is approximately the same as the force of gravity on a 31 gram object. (*Id.*) The Petition and Dr. Hannaford do not and cannot show that a bias member could provide any plausible benefit for resonant operation in the 1 Hz range, as taught by Alexander. (*Id.*)

It is not clear what Dr. Hannaford means by “operation at a resonant frequency over at least a portion of the mover’s stroke.” If adding the bias member reduces the total stroke, then it would be disadvantageous as described above. But if the bias member only provides resonant operation within a portion of the stroke, *i.e.* behaves in a non-resonant manner outside that portion of the stroke, then the behavior of the overall system would be seriously impaired. (Ex. 2009, ¶ 86.)

As Dr. Goossen explains, the resonant behavior of the bias member is only well behaved in region where the spring constant of the bias member is

actually constant, *i.e.* where the system response is linear. (Ex. 2009, ¶ 87.)

Outside that region (where the spring/elastomer is expended or compressed too much), the spring “constant” will begin changing, and the system behavior will become nonlinear. (*Id.*) At some point, the spring/elastomer will permanently deform and even break. (*Id.*) But a POSITA would recognize that even before that point, the system will suffer unpredictable and negative effects from nonlinearity. (*Id.*)

And neither the Petition nor Dr. Hannaford shows that a POSITA would have been able to select a bias member with a working or linear range large enough to cover the full stroke length of Alexander’s embodiment that would be physically compatible with the overall system. (Ex. 2009, ¶ 88.) There needs to be a place to put the spring or elastomeric member. Typically springs would be placed at the end of the movable component, as in the ’882 Patent’s Fig. 40A:

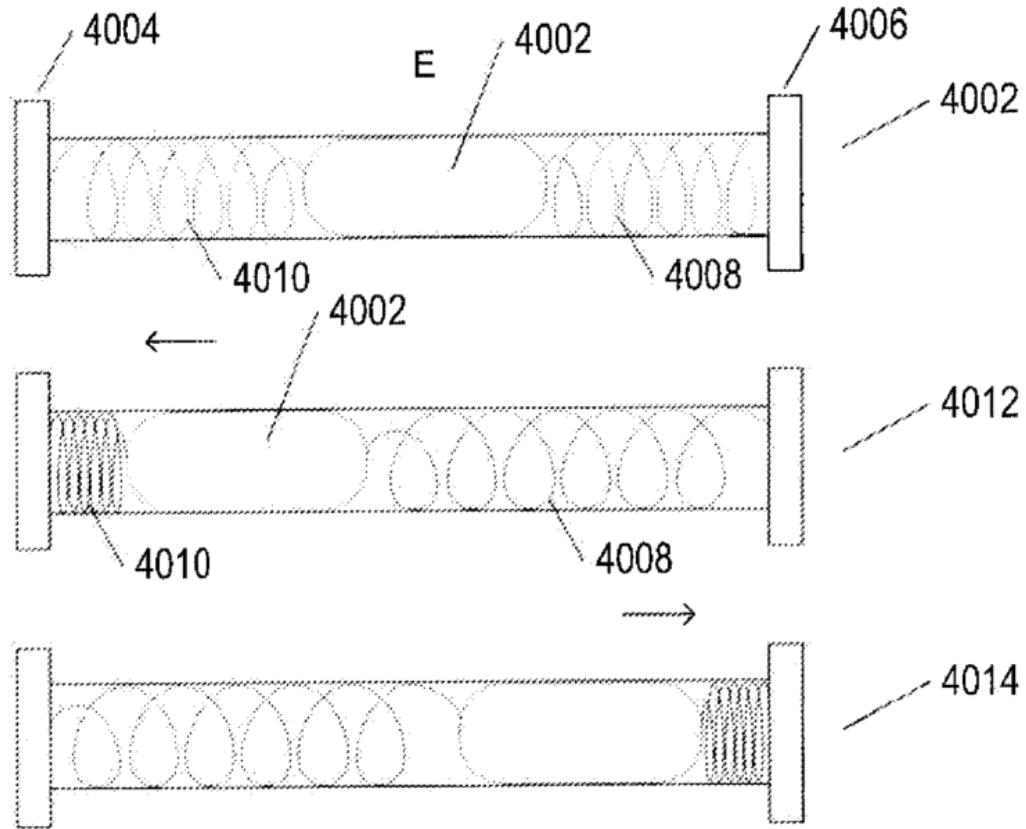


FIG. 40A

As Dr. Goossen explains (Ex. 2009, ¶ 89), there is not space in Alexander's embodiment for such a spring, particularly in the "double-ended" embodiment (Ex. 1005, Fig. 9B.):

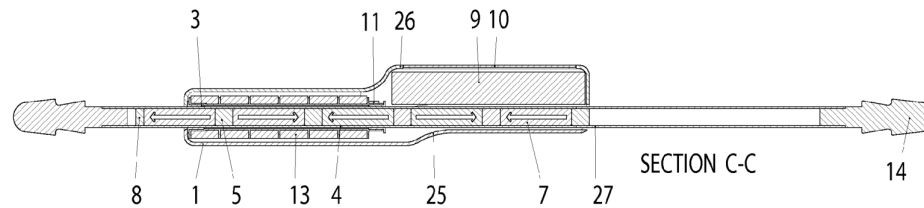


Figure 9B

The Petition thus fails to show that a POSITA would have been motivated to add Cosper’s resonant operation to Alexander’s non-resonant linear motor—much less that a POSITA could reasonably expect such a combination to be successful. Because the Petition’s claim mapping for Ground 1 requires that combination, even for literally the third word of Claim 1 (“resonant”), the Petition fails to show that Claim 1 is obvious. The Claim 10 analysis fails for the same reason (as to at least limitation [10b]).

B. Grounds 2A-2H

1. Failure to Satisfy Steps 4519 and 4520 of “control component”

a. Ground 2A

For Grounds 2A-2H, for the “sensor” limitations of claims 1 and 10, the petition points to an embodiment of Gregorio utilizing a position sensor such as a “Hall sensor” or “optical sensor.” (Petition at 43, 53; ’882 patent at 4:7–

13.) In Gregorio, this embodiment is an alternative to an embodiment that makes use of measurement of “back EMF.” (Ex. 1007 at 3:65–4:7, 4:10–14.) As Gregorio says, in the position sensor embodiment, the sensed position signal is used “instead of the back EMF.” (Ex. 1007 at 4:10–14.)

The back EMF measurement does not measure position. (Ex. 2009, ¶ 92.) Rather, as Gregorio explains, the back EMF is a “voltage generated by the internal motion inside LRA 18.” (Ex. 1007 at 4:26–27.) If the mass in Gregorio is stationary (even momentarily), the back EMF voltage will be zero, independent of what its position is at that point in time. (Ex. 2009, ¶ 92.) As Dr. Hannaford testified, the back EMF voltage is proportional to the velocity of the magnet. (Ex. 2012 at 17:15–21; Ex. 2013 at 34:5–35:6.) For example, he testified (Ex. 2013 at 34:5–35:6):

Q. Okay. So would you agree that Gregorio’s back EMF measurement would not provide a measurement of the position of the magnet?

A. Very generally, back EMF is caused by a magnet’s velocity, and the voltage of a back EMF-based sensor is proportional to the velocity of the magnet relative to a coil. Velocity—a POSITA would have several means to convert a velocity measurement to a position measurement.

Is—I’ll—that’s my answer, I guess.

Q. Suppose that the only piece of information you had was the back EMF voltage measurement from Gregorio's system at a single point in time. Would a POSITA have a way of deducing from that single value the position of the mass—or magnet of Gregorio?

A. I—I don't recall that this is anything that I formed an opinion on in my report. Answering your question in the abstract, in a digital system, probably not.

An analog circuit could convert, as I said before, by a process known as integration. It could convert the velocity signal to a position, and that could be sampled at a single point in time.

While it may be possible to deduce position from integrating velocity measurements over a period of time, Gregorio does not describe doing so. (Ex. 2009, ¶ 93.) Rather, Gregorio provides a detailed description of control utilizing the back EMF signal alone. (Ex. 1007 at 4:15–5:55.) In particular, “the LRA vibration amplitude is measured based upon the derivative of the speed of the mass (dv/dt), which is based on the back EMF.” (Ex. 1007 at 4:44–46.) No similar description is provided for how control would be achieved if a position sensor such as a Hall sensor was used, but a POSITA desiring to measure amplitude using a position sensor would do so by comparing position

measurements directly, rather than by deriving velocity from position measurements and then taking a derivative of the derived velocity. (Ex. 2009, ¶ 93.)

The petition argues that a POSITA would have found it obvious to determine velocity from Gregorio’s position data. (Petition at 48.) But at most the petition shows that a POSITA could have determined velocity from the position data, not that the POSITA would have been motivated to do this. (*See* Ex. 2009, ¶ 94.) The asserted benefits of an “alternative source of velocity information” or enhanced redundancy and reliability are generic, conclusory, and unsupported by any reasoning. (Petition at 48; Ex. 1003, ¶ 178.) The stated purpose for tracking the motion of the mass in Gregorio is to determine the resonant frequency. (Ex. 1007 at 3:65–67.) Petitioner and Dr. Hannaford do not explain how adding a velocity value to the position value provided by the sensor in Gregorio furthers the goal of determining the resonant frequency. To the extent that the position measurement is inaccurate or unreliable, velocity values calculated from the position measurement will be no better and are not really an “alternative source” of anything. (Ex. 2009, ¶ 94.) Petitioner and Dr. Hannaford do not explain how a velocity derived from position data would improve redundancy or reliability over using the position data itself. (*Id.*)

The petition asserts that Gregorio performs step 4520, computing the control based upon target frequency and current position and velocity, but it

fails to show this is the case. (Petition at 48–49.) In particular, the petition mixes teachings from two alternative embodiments, one embodiment that uses back EMF and measures speed (Ex. 1007 at 4:42–48), and a distinct embodiment that uses position measurements from a Hall sensor, optical sensor, etc. (Ex. 1007 at Abstract, 6:55–58, 1:43–46, cl. 11) Gregorio expressly presents these as alternatives, with the position signal being used in an embodiment “instead of the back EMF signal.” (Ex. 1007 at 4:10–14; Ex. 2009, ¶ 95.) The petition provides no evidence that Gregorio suggests using both position sensing and back-EMF speed sensing in the same system or that a POSITA would have been motivated to modify Gregorio’s embodiments in order to do this. (Ex. 2009, ¶ 95.)

Step 4520 further requires computing control signals based on the target frequency and the current position and velocity. The petition and Dr. Hannaford’s declaration fail to show that there is a signal that is actually based on all three of these parameters. (Ex. 2009, ¶ 96.) Both the petition and Dr. Hannaford’s declaration rely upon lines 2:3–9 of Gregorio as purportedly showing this (Petition at 49; Ex. 1003, ¶ 179), but these lines refer to “determin[ing]” the resonant frequency and do not mention using position and velocity. (Ex. 1007 at 2:3–9.) Nowhere does Gregorio describe computing control signals

based on both position and velocity, let alone on both together with a target frequency. (Ex. 2009, ¶ 96.)

For these reasons, the petition fails to show that Gregorio discloses or renders obvious the “control component” of limitations [1d] and [10f], under the proper construction of this term in claims 1 and 10. (Ex. 2009, ¶ 97.) Claims 2–6, 17, 19, and 20 depend on claims 1 and 10 and rely on the same disclosures to satisfy limitations [1d] and [10f] and thus fail to show obviousness for the same reasons. (Petition at 50–51, 53–55.)

b. Grounds 2B–2D

Grounds 2B, 2C, and 2D rely on the same disclosures of Gregorio for steps 4519 and 4520 in limitations [1d] and [10f] as Ground 2A. (Petition at 59, 61–65.) These grounds thus fail to show obviousness for the same reasons as Ground 2A.

c. Grounds 2E–2H

Grounds 2E–2H rely upon combination with Muramatsu to satisfy limitations in dependent claims 3–6. The petition does not argue that the combination with Muramatsu satisfies limitations [1d] or [10f] in any way different than the combinations in Grounds 2A–2D. (Petition at 65–71.) Importantly, Muramatsu does not describe or teach a system that oscillates or that exhibits resonance. (Ex. 2009, ¶ 99.) Rather, Muramatsu is concerned with providing

a variable resistance force to a user interacting with a manipulator, for example in a virtual reality system. (Ex. 1009 at 1:56–2:44; Ex. 2009, ¶ 99.) Muramatsu does not use the words oscillate, oscillation, resonance, or frequency. It does use the words “vibrate” and “vibrations,” but solely in the context of explaining how an acoustic piano works and that a hammer in the piano causes a string to vibrate. (Ex. 1009 at 1:14–36.) There is no mention of a key or other manipulator being used by the user vibrating. (Ex. 2009, ¶ 99.)

Because Muramatsu is not concerned with oscillations or with frequencies, its teachings concerning data tables do not make use of a target frequency, as required in step 4520 of the “control component” algorithm. (Ex. 2009, ¶ 100.) Accordingly, Muramatsu does not teach a “control component” that satisfies limitation [1d], and the petition offers no argument for how combining with Muramatsu would remedy the deficiencies the of Grounds 2A–2D with respect to limitation [1d]. (*Id.*) For these reasons, the combinations in Grounds 2E–2H fail to satisfy limitation [1d] for the same reasons as the art in Grounds 2A–2D and they therefore fail to satisfy dependent claims 3–6.

VIII. CONCLUSION

For the reasons set forth above, Resonant Systems respectfully requests that the Board affirm the validity of all challenged claims.

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CERTIFICATE OF WORD COUNT

I certify that there are 5,962 words in this paper, excluding the portions exempted under 37 C.F.R. § 42.24(a)(1), according to the word count tool in Microsoft Word.

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CERTIFICATE OF SERVICE

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