

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.
Petitioner

v.

RESONANT SYSTEMS, INC.,
Patent Owner

Case IPR2024-00983
Patent 11,152,882

SUPPLEMENTAL DECLARATION OF BLAKE HANNAFORD, PH.D.

I, Dr. Blake Hannaford, hereby declare the following:

1. I have been retained on behalf of Apple Inc. (“Petitioner”). I understand that Petitioner is in an *inter partes* review before the Patent Trial and Appeal Board (“PTAB” or “Board”) of U.S. Patent No. 11,152,882 (“the ’882patent”). On May 30, 2024, I provided an initial Declaration in the IPR2024-00983 proceeding involving the ’882 patent. I have been asked to review and respond to the Patent Owner Response and the Declaration of Dr. Goossen (EX2009). In my analysis, I have focused on portions of the Patent Owner’s Response and Declaration that propose new issues or rationales. In this supplemental declaration, I provide additional analysis regarding whether the references cited in Grounds 1-2H render obvious the claims of the ’882 patent, and this analysis is response to assertions in the Patent Owner Response. I note that, where the Patent Owner Response and Dr. Goossen Declaration present conclusions without evidence or analysis contrary to the petition, I adhere to the analysis in my prior testimony.

2. My findings, as explained below, are based on my study, experience, and background in the fields discussed below. I have also relied on my review and analysis of the prior art, information provided to me in connection with this case, and information I have independently reviewed.

3. I received no compensation for this declaration beyond my normal hourly compensation based on my time actually spent analyzing the '882 patent, the prior art publications cited below, and the issues related thereto, and I will not receive any added compensation based on the outcome of any IPR or other proceeding involving the '882 patent.

I. SUMMARY OF OPINIONS

4. Based on my experience and expertise, which is discussed in my initial declaration, and my review of Alexander, Cosper, Gregorio, Fuller, Muramatsu, and Ramsay, it is my opinion that all claims of the '882 patent are rendered obvious based on the Grounds I discuss herein.

II. MATERIALS CONSIDERED

5. In preparing this supplemental declaration, I have considered my own knowledge and experience, and have analyzed the following publications and materials, in addition to other materials I cite in my declaration:

APPLE-1001	U.S. Patent No. 11,152,882 to Robin Elenga, et al. ("the '882 Patent")
APPLE-1002	Excerpts from the Prosecution History of the '882 Patent ("the Prosecution History")
APPLE-1003	Declaration of Dr. Blake Hannaford
APPLE-1005	U.S. Patent Publication No. 2013/0237751 ("Alexander")
APPLE-1006	U.S. Patent Publication No. 2008/0246532 ("Cosper")

APPLE-1007	U.S. Patent No. 7,843,277 (“Gregorio”)
APPLE-1008	U.S. Patent Publication No. 2008/0001484 (“Fuller”)
APPLE-1009	U.S. Patent No. 5,952,806 (“Muramatsu”)
APPLE-1010	U.S. Patent Application Publication No. 2008/0294984 to Erin B. Ramsay, et al. (“Ramsay”)
APPLE-1011	Resonant Systems Proposed Claim Constructions, 7-23-cv-00077 (WDTX) (Feb. 15, 2024)
APPLE-1012	Apple, Inc. Proposed Claim Constructions, 7-23-cv-00077 (WDTX) (Feb. 15, 2024)
APPLE-1013	Apple, Inc. Opening Claim Construction Brief, 7-23-cv-00077 (WDTX) (March 21, 2024)
APPLE-1014	U.S. Patent No. 7,005,811 (“Wakuda”)
APPLE-1015	Resonant Systems Infringement Contentions, ’882 Patent, 7-23-cv-00077 (WDTX)
APPLE-1016	Resonant Systems, Inc.’s Responsive Claim Construction Brief, 7-23-cv-00077 (WDTX) (April 11, 2024)
APPLE-1017	Stipulation dated September 18, 2024
APPLE-1019	Transcript of May 9 Deposition of Dr. Keith Goossen
APPLE-1020	Transcript of May 7 Deposition of Dr. Keith Goossen
Patent Owner Response, IPR2024-00983	
EX2001	Court’s Claim Construction Order (<i>Resonant Systems, Inc. v. Apple Inc.</i> , Case No. 23-cv-00077-ADA (W.D. Tex.), Dkt. 91)

EX2002	Claim Construction Memorandum and Order (<i>Resonant Systems, Inc. v. Apple Inc.</i> , Case No. 23-cv-00077-ADA (W.D. Tex.), Dkt. 103)
EX2003	Order Modifying Scheduling Order (<i>Resonant Systems, Inc v. Apple Inc.</i> , Case No. 23-cv-00077-ADA (W.D. Tex.), Dkt. 57)
EX2004	Amended Scheduling Order (<i>Resonant Systems, Inc. v. Apple Inc.</i> , Case No. 23-cv-00077-ADA (W.D. Tex.), Dkt. 95, Ex. 1)
EX2005	Federal Court Management Statistics, Western District of Texas, 2018-2023
EX2006	Excerpt of Defendant's Final Invalidity Contentions (<i>Resonant Systems, Inc. v. Apple Inc.</i> , Case No. 23-cv-00077-ADA (W.D. Tex.))
EX2009	Declaration of Keith W. Goossen, Ph.D.
EX2010	Curriculum Vitae of Keith W. Goossen, Ph.D.
EX2011	Transcript of Deposition of Blake Hannaford, Ph.D., Jan. 27, 2025
EX2012	Transcript of Deposition of Blake Hannaford, Ph.D., Jan. 28, 2025
EX2013	Transcript of Deposition of Blake Hannaford, Ph.D., Jan. 29, 2025

In this Declaration, I refer to portions of the cited references as examples. A POSITA would have viewed the references in their entirety, and I have done so in my analysis.

III. THE ALEXANDER-COSPER GROUND (GROUND 1) RENDERS OBVIOUS ALL CHALLENGED CLAIMS

6. Based on my review of the Patent Owner Response and the Dr. Goossen Declaration, I understand that Patent Owner does not dispute that all elements of the claims were demonstrated to be in the prior art as discussed in Ground 1 (Alexander-Cosper). I understand that Patent Owner argues a POSITA would not have been motivated to combine Alexander with Cosper, alleging Alexander and Cosper are not analogous art to the '882 Patent and that Alexander would not have been modified in view of Cosper. As I discuss in more detail below, I disagree with Patent Owner's assertions because they are contrary to Alexander and Cosper's teachings. The common technical field, problems, objectives, and end-use devices that are shared with the '882 Patent demonstrate that Alexander is analogous art to the '882 Patent, and there are a number of reasons supported by the references demonstrating that a POSITA would have been prompted to combine Alexander and Cosper, including to avail the system of Cosper's techniques of multiple sensors and feedback control in linear oscillating systems, with a reasonable expectation of success.

A. Alexander and Cosper are analogous art to the '882 Patent

7. I understand that a prior art reference is considered analogous art if it is from the same field of endeavor as the claimed invention of the '882 Patent, or if it is reasonably pertinent to the problem the '882 Patent is purported to address

even if from a different field. Based on my review of Alexander and Cosper, I note that they are both analogous art to the '882 Patent.

i. Alexander is in the “same field of endeavor” as the '882 Patent.

8. The '882 Patent expressly describes its “Technical Field” as “related to vibration-generating devices and, in particular, to vibration modules that can be incorporated into a wide variety of different types of electromechanical devices and systems to produce predetermined vibration responses.” APPLE-1001, 1:11-16.

9. Alexander falls within this field of endeavor. Alexander describes vibration-generating devices, including vibration-generating devices in the form of a “linear actuator” that has a mover and a stator and a “controller operable to control the relative motion between said stator and mover.” APPLE-1005, Abstract, [0037], [0056], cl. 4 (“predetermined”). The motion is controlled to output predetermined vibration responses (e.g., “motion profiles.”). *Id.* Like the '882 Patent, the “linear actuators” described by Alexander can be implemented for incorporation into various electromechanical devices. APPLE-1001, Abstract. I note that independent claims 1 and 4 of Alexander broadly recite a “linear actuator” (cl. 1) and “method of controlling the motion of a linear actuator” (cl. 4), and do not include language limited to the types of devices into which the linear actuator is incorporated. APPLE-1005, cls. 1-6.

10. The overlap between Alexander and the '882 Patent also includes the specific use applications of actuator products. For example, the '882 Patent and Alexander both describe vibrating products for human physical interaction. Alexander describes an example use for its linear actuator in a “handheld unit” (e.g., “sexual appliance”). APPLE-1009, Abstract. The '882 Patent likewise describes devices having an “external massage arm” that provides a “linearly oscillating massage-foot member” for “massaging human skin.” APPLE-1001, 12:12-36, FIGS. 17-19. This overlap of the specific types of products further confirms that Alexander is in the same field of endeavor as the '882 Patent.

ii. Alexander is “reasonably pertinent” to the problems identified in the '882 Patent.

11. Alexander is pertinent to the same problems identified by the '882 Patent. The '882 patent describes objectives of “more efficient and capable vibration-generating units for incorporation into many consumer appliances, devices, and system,” and the problems achieving these objectives using prior art “unbalanced electric motors.” APPLE-1001, 1:29-3:2. For example, the '882 Patent describes problems of “destructive, unbalanced forces,” “relatively inefficient” operation, “elliptical” vibrational modes, and that “only a very limited portion of the total vibrational-force/frequency space” is accessible. *Id.* As I

discuss in more detail below, a POSITA would have considered Alexander's teachings pertinent to these problems.

12. First, I note that Alexander was identified by the Examiner and applied in a rejection during original prosecution of the '882 Patent. APPLE-1002, 145-179. The application of Alexander by the Examiner during prosecution of the application leading to the '882 Patent demonstrates that a POSITA would have found Alexander's teachings reasonably pertinent to the problems of the '882 patent, as the Patent Office itself found Alexander worthy of consideration when evaluating the '882 Patent. A POSITA would have found Alexander's teachings pertinent to the objectives of producing predetermined vibration responses in vibration modules, and to shortcomings of unbalanced electric motors, that the '882 Patent recites. Like the '882 patent, Alexander generates motion profiles in the context of oscillating linear and curvilinear actuators. APPLE-1005, [0022]. Further, Alexander describes specific techniques and configurations that address such problems. This includes feedback control techniques and the use of multiple sensors to characterize and generate oscillation according to predetermined motion profiles. APPLE-1005, [0034]-[0035] ("A feedback control system is used to control the position and motion of the mover," and "allows precise control of the position of the tube."), [0035], [0037] ("Using feedback control of the mover position, a variety of position and motion parameters of the linear motor can be

controlled by the control system, including: mover stroke, mover speed, and mover acceleration.”), [0039]. Here again, this is like the ’882 patent, which describes the “CPU receives input 730 from 30 one or more electromechanical sensors 732 that generate a signal corresponding to the strength of vibration currently being produced by the linearly oscillating mass 734,” for example. APPLE-1001, 8:29-36.

13. Additionally, the type of oscillation described by Alexander is also in common with the ’882 Patent. Both Alexander and the ’882 Patent describe sinusoidal output, for example. *Compare* APPLE-1005, [0037] (“sine wave motion”) and [0055] (“fast sinusoidal stroke”) *with* APPLE-1001, 24:47-48 (“The desired vibration response of the ORM is a sine-wave-like 3702 oscillation. . .”), 25:24 (“achieve the sine-wave-like vibration response”).

14. The fact that both Alexander and the ’882 Patent both describe devices for the same product applications also highlights that Alexander is pertinent to the problems referenced by the ’882 Patent. Both Alexander and the ’882 patent describe applications involving direct physical contact and thus both address problems common to generating vibration suitable to massage human skin. APPLE-1005, Abstract; APPLE-1001, 12:12-36 (“In this ORM, the spring member 1702 is extended to provide an external massage arm 1704 that extends out from the housing to provide a linearly oscillating 15 massage-foot member 1706 for

massaging human skin or some other substrate, depending on the application.”),
FIGS. 17-19.

iii. Cospir is in the “same field of endeavor” as the ’882 Patent.

15. Cospir is also within the same field as the ’882 Patent. Cospir describes “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.” APPLE-1009, [0003], [0012]. A POSITA would have recognized Cospir’s broad applicability, especially in view of Cospir’s express indication that “[a]ny appropriate subassembly may be used with the systems and methods described herein.” *Id.*

16. I understand that the Patent Owner Response alleges that Cospir’s field of endeavor and problems addressed “have nothing to do with Alexander’s,” and that “Cospir is not about linear motors at all, and Alexander is not about resonant motors at all.” POR, 16. I disagree with these statements because they do not accurately describe Alexander and Cospir and are inconsistent with how a POSITA would have understood the references, especially in view of Cospir’s teachings that are not limited to optical beam scanners or rotational movement, for example. A POSITA would have recognized that Alexander and Cospir each provide solutions pertinent to the purported problems the ’882 Patent attempted to solve.

17. I understand that the POR asserts that “the two embodiments shown [in Cospers] describe rotational motion of the moving mass.” POR, 15. Here again, however, I note that the Patent Owner Response and Dr. Goossen’s Declaration do not address Cospers’s actual teachings that are not limited to rotational motion or optical beam scanner devices, such as Cospers’s discussion with reference to FIG. 1. Cospers expressly discloses linear motion and linear actuators/motors. APPLE-1006, [0047]-[0057] (“linear” mode of movement); FIG. 1 (illustrating “linear” oscillation of subassembly); APPLE-1005, [0022] (the terms ‘motor’ and ‘actuator’ may be used interchangeably”).

iv. Cospers is “reasonably pertinent” to the problems identified in the ’882 Patent.

18. A POSITA would have likewise recognized Cospers as directly pertinent to the problems recited by the ’882 Patent. Cospers describes feedback control techniques that promote “efficient” oscillation and that provide vibration modes beyond “elliptical” vibration, including “linear” oscillation. APPLE-1006, [0005]-[0013], [0048]-[0057], [0067]. Cospers describes sensor techniques for monitoring oscillation of the movable mass, and feedback control to promote oscillation according to particular characteristics (at a resonant frequency), facilitating enhanced vibration output and promoting efficient operation. *Id.* And

as I noted above, Cosper expressly describes and illustrates linear oscillation. *See, e.g.,* APPLE-1006, FIG. 1.

B. A POSITA would have been motivated to apply Cosper's teachings of feedback control when implementing a handheld device consistent with Alexander

19. As I discuss in more detail below, there are multiple predictable benefits that would have been recognized by a POSITA (discussed in the Petition and my first declaration) that would have motivated a POSITA to combine Alexander and Cosper. Multiple straightforward motivations are expressly supported by Cosper's stated benefits and advantages. *See, Pet.,* 11-17.

i. A POSITA would have been motivated to combine Alexander and Cosper to enhance vibration output.

20. A POSITA would have been led to combine Alexander and Cosper to effectively implement position sensors for feedback control, enhancing Alexander's stated objectives of improving precision of oscillation output by implementing effective position sensing for feedback control, as described in the Petition and my first declaration. *Pet.,* 14-15. I understand that the Patent Owner Response does not specifically address this rationale, which provides an independent reason why a POSITA would have been motivated to combine Alexander and Cosper.

21. A POSITA would have additionally been motivated to implement feedback control to maintain oscillation near a resonant frequency. A POSITA would have recognized, especially based on Cosper's express teachings, that doing so would have predictably facilitated efficient operation of Alexander's device, facilitating increased amplitude/velocity for a given input when operating at such frequencies, and relatedly promote efficient power usage (e.g., from the battery) in obtaining this output. A POSITA would have recognized the benefits of obtaining a given amplitude or velocity output while facilitating a more lightweight and/or compact design. For example, generating a given amplitude or velocity when operating in resonant condition would have been predictably achieved with relatively less current. Relatedly, a POSITA would have recognized that a resonant system can facilitate reduced weight and/or volume compared to non-resonant systems. I note that a POSITA likewise would have recognized that such a configuration would thus enhance user satisfaction and the user's perception of the device. Pet., 13-14; APPLE-1003, ¶¶70-71.

22. I understand that the Patent Owner Response indicates that neither "Petitioner nor its expert Dr. Hannaford cites to anything **in Alexander** that shows this would be beneficial." POR, 18 (emphasis added). This is not accurate. Alexander discusses a "handheld" device that is powered by a "battery." APPLE-1005, Abstract, [0021]-[0025], [0052]. A POSITA would have readily recognized

the desirability of generating a desired amplitude/velocity for a given input in such a battery-powered device. This is a common design parameter in a variety of battery-powered consumer products. Additionally, the straightforward motivations are supported, for example, by the express teachings of Cosper. For example, Cosper expressly indicates that it is “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.” APPLE-1006, [0005]-[0006].

ii. A POSITA would have implemented the Alexander-Cosper combination with a reasonable expectation of success.

23. The Patent Owner Response and Dr. Goossen’s Declaration focus on discrete operating scenarios. See POR, 18-23. Alexander, in contrast, describes a variety of structures and operating profiles for different preferences and use cases, of which the benefits articulated in the Petition would have been recognized by a POSITA. In particular, a POSITA would have readily selected dimensions and operating configurations to attain the recognized benefits of resonance for one or more appropriate frequencies/stroke lengths, without hindering the ability of the device to output a range of motion profiles selected by the user. A POSITA was not limited to Patent Owner’s proposed scenario in which resonance would occur at 1 Hz and at a six-inch stroke length using a “square wave” pattern. POR, 18-21.

24. For example, Alexander discloses varied structural configurations and geometries, expressly enumerating configurations that have only “one magnet” or multiple magnets (e.g., six magnets), and indicates that the “spacing and orientations of the magnets may vary based on the design.” APPLE-1005, [0023], [0025]-[0026]. Alexander describes a configuration in which a magnet “phase” (including “a magnet-spacer-magnet-spacer set”) has a length of two inches, and three magnet phases are provided to facilitate a six-inch stroke. A POSITA would have recognized from Alexander’s description that, where only “one magnet” is used (APPLE-1005, [0023]), the stroke length would be shorter. For example, a POSITA would have recognized length to be as short as an inch or less, scaling down from the number of magnets in the six-inch stroke example. I note that the Patent Owner Response does not address configurations that use just “one magnet,” for example. POR, 18-21.

25. Based on my knowledge and experience in the field and my review of Alexander and Cosper, a POSITA would have readily implemented Cosper’s teachings in Alexander according to parameters desired for a particular application. As one example, a POSITA would have readily configured the combined system to provide resonant operation at a stroke length near the middle of a maximum stroke length. *Id.* Alexander was not limited to a stroke length of six inches. In the combined system, a POSITA would have readily implemented other stroke

lengths, including shorter stroke lengths. Thus, in an example implementation, a POSITA would have predictably implemented the combination to have a stroke length of 1 in. for example. Relatedly, a POSITA would have recognized a range of frequencies, especially based on Alexander's express teachings of "fast" and motion profiles. *See*, APPLE-1005, [0055]. Moreover, a POSITA would have recognized the variety of motion patterns (e.g., "sinusoidal") that were desirable in Alexander's device. And, a POSITA would have readily configured the bias member to provide resonance at a particular combination of such parameters, such as at a midpoint of the maximum stroke length, facilitating selection of stroke lengths above and below a resonant operating condition. Such configurations would have predictably achieved the benefits of enhanced output and power-efficient operation. A POSITA would have recognized this would have especially been the case in a scenario in which the device is operated at resonance for a meaningful duration. Moreover, such a configuration would avail the user of an additional motion profile to choose from. Indeed, a POSITA would have recognized this overall effective operation in greater amplitude/velocity configurations, even if some frequencies, stroke lengths, etc., might require additional power.

26. Based on my knowledge and experience in the field, a POSITA would have had a reasonable expectation of success in implementing the Alexander-

Cosper combination. Selecting a bias member and implementing in a housing was within the basic skills of a POSITA, and would have been readily implemented, especially in view of Cosper's teachings. Selecting a bias member and packaging it in a housing such as Alexander's was not new, and a POSITA would have readily configured the bias member to accommodate a range of operating profiles, consistent with Alexander's objectives, such as by selecting a bias member to promote resonance when operating near a middle of a maximum stroke length.

27. I understand that the Patent Owner Response asserts that Petitioner and Dr. Hannaford "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." POR, 20. I note here again that nothing in Alexander limits operation to 1 Hz, and a POSITA would have recognized use of other frequencies. APPLE-1005, [0037]-[0039]). I understand that Patent Owner cites the '882 Patent as disclosing frequencies "even above 350 Hz," but the combination does not require operation at 350 Hz or any other heightened frequency. Even the '882 Patent itself describes operation of resonant modules at significantly lower frequencies. See APPLE-1001, FIG. 10. To be clear, the combination is not incompatible even with Patent Owner's example of a six inch stroke length. As set forth in the Petition, a POSITA would have recognized the benefits of implementing the bias member to promote resonance when operating at

smaller portion of the maximum stroke length (e.g., an inch or less), and/or at a higher frequency.

28. I additionally note that, even in implementations that have a large stroke length or that are capable of oscillation according to a “square wave pattern,” Patent Owner does not identify any meaningful incompatibility. POR, 18-19. Here again, a POSITA would not have been limited to operating at resonance at the full stroke length, and would have readily configured the system to provide resonance at a relatively shorter stroke length and slightly higher frequency, for example, avoiding the artificial problems suggested by Patent Owner. And, as discussed above, a POSITA would have recognized the overall benefits to the system flowing from resonant operation in some selectable motion profiles, even if some other selectable motion profiles did not operate at resonance.

IV. THE GREGORIO GROUNDS RENDER OBVIOUS STEPS 4519 AND 4520 OF THE “CONTROL COMPONENT”

29. I understand that Patent Owner does not dispute that the Gregorio Grounds (2A-2H) render obvious all limitations [1pre]-[1c] and [10pre]-[10e] of independent claims 1 and 10. Instead, the Patent Owner Response is directed to isolated aspects of Limitation [1d] and [10f], and argues that the Petition did not address how the Gregorio grounds disclose “computing the control based upon target frequency and current position and velocity.” POR, 24-30. The Patent

Owner Response on this point is inconsistent with Gregorio's actual teachings and the analysis set forth in the Petition.

A. The Gregorio Grounds render obvious steps 4519 and 4520 (Grounds 2A-2D)

30. Based on my knowledge and experience in the field and my analysis of Gregorio, the Gregorio Grounds render obvious step 4519 ("control logic reads the position and velocity data from the sensor") and step 4520 ("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 "). For example, Gregorio's control component receives outputs from the one or more sensors when Gregorio's sensed position signals are received by its control component as outputs of its sensing device(s) (e.g., a Hall sensor). Pet., 47-48; APPLE-1003, ¶177. Gregorio's control component reads/derives position and velocity data from the sensor(s) (step 4519). Pet., 48.

31. Additionally, Gregorio's determined resonant frequency provides a "target frequency," and the control component provides control signals computed based on the target frequency ω_t (e.g., a determined resonance frequency) and the current position (e.g., sensed by the Hall sensor) and velocity (speed) of the moving mass (step 4520). Pet., 46-49. I note that Gregorio expressly indicates the drive signal is "adjusted to maximize the haptic feedback **based on** the determined

resonant frequency,” which would have further highlighted to a POSITA that appropriate control is computed based on the target frequency ω_t . APPLE-1007, 2:3-9 (emphasis added).

32. I understand the Patent Owner Response alleges that the Petition shows only “that a POSITA could have determined velocity from the position data, not that the POSITA would have been motivated to do this.” POR, 27. In fact, however, a POSITA would have recognized multiple benefits of deriving velocity from the position data, and that its control calculations be based on this information. Pet., 47-49.

33. For example, a POSITA would have found obvious that computing velocity from position beneficially provided the controller with information relevant to the current motion of the movable mass, and further facilitated determination of acceleration (dv/dt). Pet., 48. Determining velocity and acceleration from position was ubiquitous and common in such applications. And, a POSITA would have especially recognized benefits of doing so in view of Gregorio’s description of determining the “derivative of the speed of the mass (dv/dt).” APPLE-1007, 4:42-48.

34. For example, velocity information would have facilitated enhanced characterization of the movement of the mass accurately and in real-time by detecting the change in position over time, furthering Gregorio’s objective of

detecting and controlling to achieve oscillation at a resonant frequency. Pet., 48-49; APPLE-1019, 29:4-15. This would have been recognized by a POSITA as furthering Gregorio's objective of detecting and controlling movement of the mass to achieve oscillation at a resonant frequency. Likewise, deriving velocity from position would have facilitated further derivation of the change in velocity over time (dv/dt), again equipping the control system with additional information to reliably and accurately advance Gregorio's objective of oscillation at a resonant frequency.

35. A POSITA would have also recognized the signal processing advantages associated with derivation of velocity, including the sharper peak associated with velocity or acceleration (dv/dt). Relatedly, a POSITA would have recognized, in effectuating Gregorio's objective of determining resonant frequency, that conventional tracking methods would have benefited from the use of velocity, for example as inputs to a band-pass filter or Kalman filter. A POSITA would have likewise recognized the benefits of using a derivative of the speed of the mass as an indicator of "how far the mass will rise above the zero crossing," which can be determined at various points, separate from a measurement of a particular max position. APPLE-1007, 4:42-48.

36. I understand that the Patent Owner Response indicates that "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.” POR, 26-27. As I noted above, even if Patent Owner’s proposal were viable, the technique of calculating dv/dt was conventional. Moreover, unlike Patent Owner’s proposal, calculating dv/dt is expressly mentioned by Gregorio to calculating “how far the mass will rise above the zero crossing” in determining the resonant frequency. APPLE-1007, 4:42-48. Such calculating was a known effective option for effectuating Gregorio’s objective.

37. To be clear, I note that Patent Owner Response indicates that 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.” This is incorrect. The Gregorio Grounds never call for “both position sensing and back-EMF speed sensing in the same system.

B. Gregorio in view of Muramatsu renders obvious steps 4519 and 4520 (Grounds 2E-2H)

38. The Gregorio Grounds render obvious steps 4519 and 4520 as I described above. Additionally, I note that steps 4519 and 4520 are rendered obvious further in view of Muramatsu as set forth in Grounds 2E-2H.

39. Muramatsu discloses conventional techniques of computing control outputs from position and/or velocity of a moving object and using pre-computed values in lookup tables. Pet., 65-68 (citing “calculates a current velocity X’ on the basis of the current position X and the previous position.”). APPLE-1009, 6:23-27. Muramatsu provides yet a further example of calculating velocity from position, and using the calculated velocity in control output determination, further demonstrating the obviousness of steps 4519 and 4520. A POSITA would have recognized the use of position measurements at multiple (e.g., two) points as a conventional and reliable technique for determining velocity, and facilitating effective characterization of the motion of Gregorio’s moveable mass in determining resonant frequency in the feedback control system.

V. LEGAL PRINCIPLES

40. I have been informed about certain legal principles regarding patentability and related matters under United States patent law, which I have applied in performing my analysis and arriving at my technical opinions in this matter.

A. Anticipation

41. I have been informed that a patent claim is invalid as “anticipated” if every element of a claim, as properly construed, is found either explicitly or inherently in a single prior art reference. Under the principles of inherency, I

understand that if the prior art necessarily functions in accordance with, or includes the claimed limitations, it anticipates.

42. I have been informed that a claim is invalid if the claimed invention was known or used by others in the U.S., or was patented or published anywhere, before the Applicant's invention. I further have been informed that a claim is invalid if the invention was patented or published anywhere, or was in public use, on sale, or offered for sale in this country, more than one year prior to the filing date of the patent application (the so-called critical date). I have also been informed that a claim is invalid if an invention described by that claim was described in a U.S. patent granted or an application for a patent (or in a published application for a U.S. patent) that was filed by another in the U.S. before the date of invention for such a claim.

B. Obviousness

43. I have been informed that a patent claim is invalid as "obvious" in light of one or more prior art references if it would have been obvious to a person of ordinary skill in the art at the time of the alleged invention, taking into account (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so called "secondary considerations" of non-obviousness, which include: (i) "long felt need" for the claimed invention, (ii) commercial success attributable to the claimed

invention, (iii) unexpected results of the claimed invention, and (iv) “copying” of the claimed invention by others.

44. The application that led to the '882 patent (U.S. Appl. No.16/806,925) was filed on March 2, 2020 as a continuation-in-part of U.S. Application No. 15/043,584 filed February 14, 2016, which claims the benefit of Provisional Application No. 62/116,144, filed February 13, 2015. For purposes of my analysis here, I have applied a date of February 13, 2015 as the date of the alleged invention in my obviousness analysis, although in many cases the same analysis would hold true even if the date of the alleged invention occurred earlier than February 13, 2015.

45. I have been informed that a claim can be obvious in light of a single prior art reference or multiple prior art references. To be obvious in light of a single prior art reference or multiple prior art references, there must be a reason that would have prompted a POSITA to modify the single prior art reference, or combine two or more references, in a manner that provides the elements of the claimed invention. This reason may come from a teaching, suggestion, or motivation to combine, or may come from the reference(s) themselves, the knowledge or “common sense” of a POSITA, or from the nature of the problem to be solved, and this reason may be explicit or implicit from the prior art as a whole. I have been informed that, under the law, the predictable combination of familiar

elements according to known methods is likely to be obvious when it does no more than yield predictable results. I also understand it is improper to rely on hindsight in making the obviousness determination.

VI. CONCLUSION

46. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

Respectfully submitted,

Date: 03-Jun-2025



BLAKE HANNAFORD, PH.D.