

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.
Petitioner

v.

RESONANT SYSTEMS, INC.,
Patent Owner

Case IPR2024-00697
Patent 8,093,767

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. 8,093,767 (“the ’767 patent”). On April 12, 2024, I provided an initial Declaration in the IPR2024-00697 proceeding involving the ’767 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 1A-2B render obvious the claims of the ’767 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 '767 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 '767 patent.

I. SUMMARY OF OPINIONS

4. Based on my experience and expertise, which is discussed in my initial declaration, and my review of Shahoian, Cosper, Ramsay, Rossi, and Aldrich, it is my opinion that all claims of the '767 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. 8,093,767 (“’767 patent”)
APPLE-1002	Excerpts from the Prosecution History of the '767 patent
APPLE-1004	U.S. Patent No. 6,982,696 (“Shahoian”)
APPLE-1005	U.S. Patent Publication No. 2005/0275294 (“Izumi”)
APPLE-1007	U.S. Patent No. 7,843,277 (“Gregorio”)
APPLE-1009	U.S. Patent Publication No. 2008/0246532 (“Cosper”)

APPLE-1020	U.S. Patent No. 4,879,641 (“Rossi”)
APPLE-1021	Jack Aldrich, et al, <i>Controller for Driving a Piezoelectric Actuator at Resonance</i> , NASA Tech Briefs, April 2008 (“Aldrich”)
APPLE-1022	Declaration of June Munford re Aldrich
APPLE-1023	U.S. Patent No. 7,027,032 (“Rosenberg”)
APPLE-1024	U.S. Patent No. 5,736,797 (“Motohashi”)
APPLE-1025	U.S. Patent No. 5,955,799 (“Amaya”)
APPLE-1026	J. Peckol, <i>Embedded Systems, A contemporary Design Tool</i> , 2008 (“Peckol”)
APPLE-1033	Resonant Systems Opening Claim Construction Brief, 7-23-cv-00077 (WDTX) (Feb. 15, 2024)
APPLE-1034	Apple, Inc. Opening Claim Construction Brief, 7-23-cv-00077 (WDTX) (Feb. 15, 2024)
APPLE-1036	Motion to Transfer Venue, 7-23-cv-00077 (WDTX)
APPLE-1038	U.S. Patent Publication No. 2005/0144784 (“Ibuki”)
APPLE-1040	U.S. Patent Publication No. 2011/0133682 (“Egger”)
APPLE-1041	U.S. Patent Publication No. 2008/0001484 (“Fuller”)
APPLE-1042	U.S. Patent Publication No. 2006/0145547 (“Kraus”)
APPLE-1043	U.S. Patent No. 6,510,995 (“Muthu”)

APPLE-1044 *Central Processing Unit*, Wikipedia,
https://web.archive.org/web/20081205054505/http://en.wikipedia.org/wiki/Central_processing_unit, (Dec. 5, 2008)

APPLE-1046 Apple, Inc. Opening Claim Construction Brief, 7-23-cv-00077
(WDTX) (March 21, 2024)

APPLE-1047 Resonant Systems, Inc.’s Responsive Claim Construction Brief,
7-23-cv-00077 (WDTX) (April 11, 2024)

APPLE-1048 Stipulation dated September 18, 2024

APPLE-1050 Transcript of May 7 Deposition of Dr. Keith Goossen

APPLE-1051 Blockley, *The New Penguin Dictionary of Civil Engineering*,
2005 (“accelerometer”)

APPLE-1052 Sinclair, *Electronics Definitions for the Digital Age*, 2007
 (“accelerometer”)

Patent Owner Response, IPR2024-00697

EX2001 Defendant Apple Inc.’s Proposed Claim Constructions,
(Resonant Systems, Inc. v. Apple Inc., Case No. 23-cv-00077-
ADA (W.D. Tex.))

EX2002 Court’s Claim Construction Order (Resonant Systems, Inc. v.
Apple Inc., Case No. 23-cv-00077-ADA (W.D. Tex.), Dkt. 91)

EX2003 Defendant Apple Inc.’s Opening Claim Construction Brief
(Resonant Systems, Inc. v. Apple Inc., Case No. 23-cv-00077-
ADA (W.D. Tex.), Dkt. 75)

EX2004 Order Modifying Scheduling Order (Resonant Systems, Inc. v.
Apple Inc., Case No. 23-cv-00077-ADA (W.D. Tex.), Dkt. 57)

EX2005 Federal Court Management Statistics, Western District of
Texas, 2018-2023

EX2006	Excerpt of Plaintiff's Infringement Contentions (ResonantSystems, Inc. v. Apple Inc., Case No. 23-cv-00077-ADA (W.D. Tex.))
EX2007	Excerpt of Defendant's Final Invalidity Contentions (Resonant Systems, Inc. v. Apple Inc., 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
EX2014	Excerpt of CRC Handbook of Chemistry and Physics (52nd Ed. 1964)
EX2015	"Why do ferromagnetic materials channel magnetic field lines?," Physics Stack Exchange, available at https://physics.stackexchange.com/questions/129782/whydo-ferromagnetic-materials-channel-magnetic-field-lines
EX2016	"Quality Factor (Q)" in Smith, J.O., Introduction to Digital Filters with Audio Applications, available at https://ccrma.stanford.edu/~jos/fp/Quality_Factor_Q.html
EX2017	Texas Instruments Precision Designs: Verified Design SLAU508, "Analog Pulse Width Modulation," by John Cald

6. 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 SHAHOIAN GROUNDS RENDER OBVIOUS INDEPENDENT CLAIM 1 (ALL GROUNDS)

7. I understand that Patent Owner asserts that “Shahoian’s high bandwidth (low Q) haptic feedback device and Cosper’s low bandwidth (high Q) scanning light source device belong to different fields of endeavor,” and Cosper’s techniques “are not pertinent to any problem Shahoian is involved with.” POR, 14. As I discuss in more detail below, this is not the case. The references provide multiple benefits that would have been recognized by a POSITA and that would have motivated a POSITA to combine the references as described in the Petition.

A. Shahoian and Cosper are analogous art to the ’767 Patent

8. 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 ’767 Patent, or if it is reasonably pertinent to the problem the ’767 Patent is purported to address, even if from a different field. I note that Patent Owner compares the references only to one another and never conducts this comparison with the ’767 Patent. Based on my review of Shahoian and Cosper, I note that they are both analogous art to the ’767 Patent.

9. The '767 Patent expressly describes its "Technical Field," indicating the invention is "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 vibrations of selected amplitudes and frequencies over a wide range amplitude/frequency space." APPLE-1001, 1:11-16.

10. Shahoian and Cosper each fall within this field of endeavor. Shahoian describes vibration-generating "linear actuators" that, consistent with the '767 Patent's field, are used in electromechanical devices such as user interface devices (e.g., "controller," "joystick," etc.). APPLE-1004, 1:18-2:34; 2:59-3:2; FIG. 1. Likewise, Cosper "generally relates to 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," and broadly indicates that "[a]ny appropriate subassembly may be used with the systems and methods described herein." APPLE-1009, [0003], [0012].

11. I further note that, in addition to being in the same field of endeavor, which independently demonstrates Shahoian and Cosper are analogous art to the '767 patent, these references are pertinent to problems with which the '767 patent is directed. For example, the '767 patent describes objectives of "more efficient

and capable vibration-generating units for incorporation into many consumer appliances, devices, and system,” and problems of prior “unbalanced electric motors” (a prior vibration technology which was not a resonating system) in achieving these objectives. APPLE-1001, 1:29-3:2 (problems of “destructive, unbalanced forces,” “relatively inefficient,” “elliptical vibrational modes,” and “only a very limited portion of the total vibrational-force/frequency space is accessible”).

12. A POSITA would have recognized Shahoian as directly pertinent to these express problems recited by the '767 patent. For example, Shahoian describes solutions to address prior art shortcomings of vibrations that “tend to all feel the same” and that “cannot be significantly varied.” APPLE-1004, 1:45-67. Shahoian describes example embodiments that provide linear oscillation, directly relevant to overcome shortcomings of “unbalanced” rotary motors recited by the '767 patent that only generate vibration in a “very limited portion of the total vibrational-force/frequency space.” APPLE-1004, Abstract; APPLE-1001, 1:29-3:2.

13. A POSITA would have likewise recognized Cosper as directly pertinent to the problems recited by the '767 Patent. Cosper describes feedback control techniques that promote “efficient” oscillation and that provide vibration modes beyond “elliptical” vibration, including “linear” oscillation. APPLE-1009,

[0005]-[0013], [0048]-[0057], [0067]. Cosper 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.*

14. I understand that the Patent Owner Response states that “Cosper’s field of endeavor has nothing to do with haptic feedback or high bandwidth vibrations,” and “[r]ather, Cosper describes an optical beam scanner.” POR, 11-12. I disagree with this statement because it is not an accurate description of Cosper and is inconsistent with how a POSITA would understand Cosper in view of Cosper’s description of systems that are not limited to optical beam scanners. Cosper includes teachings relevant to a range of systems, including with respect to its description of FIG. 1, which shows linear oscillation not limited to optical beam scanners. A POSITA would have recognized that Shahoian and Cosper each provide solutions directly pertinent to the purported problems the ’767 patent attempted to solve.

B. A POSITA would have been motivated to combine Shahoian and Cosper

15. 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

Shahoian and Cospers. For example, a POSITA would have recognized that combining Cospers's suggestions for "feedback input" from more than one sensor with Shahoian would have enhanced the vibration performance of Shahoian's linear actuator. Pet., 14-18 (citing APPLE-1003, ¶¶108-115). Shahoian already describes producing specific vibration outputs using a drive waveform provided by a microprocessor, and Cospers describes using feedback to drive an oscillating assembly in a desired manner. Pet., 15 (citing APPLE-1009, Abstract, [0050]-[0052]; *see also* Pet., 15-16 (promoting highly accurate characterization of movement of the mass and preferred haptic sensations for the user); Pet., 16-17 (facilitate user selection of operational states). Each of these reasons provide independent bases why a POSITA would have been motivated to combine Shahoian and Cospers.

16. Additionally, based on my analysis of Shahoian and Cospers, a POSITA would have understood the applicability of Cospers's suggestions to Shahoian. I noted that this is especially the case based on Cospers's express teachings of the relevance of its techniques to systems having structure like that of Shahoian. For example, Cospers describes oscillation of a movable subassembly including a mass and a bias. APPLE-1009, [0012], FIG. 1. This is just like Shahoian, which describes a "linear actuator" including a mass (e.g., movable "magnet head") and a bias (e.g., "flexures"). And in both Shahoian and Cospers, a

controller generates outputs to control oscillation of the movable mass. Pet. 23-24. Shahoian describes a “local microprocessor” that executes “software instructions,” like Cospir. *See, e.g.*, APPLE-1009, [0049] (“control logic (e.g., hardware, software, firmware, or combinations thereof included with a controller”); FIG. 1 (“controller”); cl. 1, cl. 13 (“software”). In view of this substantial overlap, a POSITA would have predictably looked to Cospir in order to implement enhanced monitoring and control of oscillation when implementing a system in accordance with Shahoian. *Id.* I note that Cospir expressly indicates that “[a]ny appropriate subassembly may be used with the system and methods described herein,” and a POSITA would have certainly recognized the applicability of Cospir’s techniques to an actuator like that described by Shahoian. APPLE-1009, [0012], FIG. 1; *see also id.*, [0049]-[0056].

17. I understand that the Patent Owner Response alleges that “[w]hen Shahoian mentions the gain due to operating near resonance, it describes it as an effect that **must be counteracted** in order to achieve the desired ‘flat’ frequency response, not a desirable effect to take advantage of.” POR, 11. This statement is incorrect and contrary to Shahoian’s actual description. The POR’s statement appears to be based on an incorrect assumption that a flat response is necessarily “the desired” response and that gain from operating near resonance thus “must be counteracted.” *Id.*; EX1050, 31:22-32:5. Shahoian’s plain description is directly

contrary to the incorrect theory in the Patent Owner Response. Shahoian expressly states that the gain due to vibration at the resonance frequency “can” be compensated for “if desired,” and in doing so, acknowledges circumstances both where gain from resonance may be desired and circumstances where compensation may be desired. APPLE-1004, 7:54-62; EX2011, 31:14-19;

This gain at higher frequencies is due primarily to the vibration occurring at the resonance frequency of the mechanical system including actuator, foam, housing, etc., and, **if desired, can be** compensated for in other embodiments to obtain a more flat response by providing compensating frequencies that will provide the desired response (e.g. from a look-up table or firmware).

APPLE-1004, 7:54-62 (emphasis added). Patent Owner’s theory that Shahoian teaches gain from resonance “must be” counteracted to achieve a desired response (POR, 11) is simply contrary to Shahoian’s express teaching that the gain “can be” compensated for “if desired.” A POSITA would have recognized from Shahoian and Cosper the predictable benefits of leveraging such gain, such as where a larger vibration output is desired, in an efficient manner. Pet., 14-18. For example, a POSITA would have recognized from Shahoian and Cosper the predictable benefit of leveraging the gain to achieve a greater magnitude of vibration output in an energy efficient manner.

18. The assertion in the Patent Owner's Response that "Shahoian's high bandwidth (low Q) haptic feedback device and Cosper's low bandwidth (high Q) scanning light source device belong to different fields of endeavor," is inconsistent with Shahoian's and Cosper's actual teachings and inconsistent with how a POSITA would have understood the teachings of Shahoian and Cosper. POR, 14. A POSITA would have readily recognized the benefits of Cosper's techniques, and would have been prompted to combine them with Shahoian to avail Shahoian of such benefits, for the reasons I described above and as set forth in the petition and my first declaration. The Shahoian-Cosper combination includes multiple sensors in order to facilitate precise vibration output having desired characteristics, including oscillation at a resonant frequency and over a range of frequencies suggested by Shahoian, based on the express teachings of Shahoian and Cosper. This is especially the case where, as I noted above, Cosper expressly suggests application of its techniques to "[a]ny appropriate subassembly," without limitation as to the end-use application or range of frequencies the system may be controlled to output. APPLE-1009, [0012].

IV. GROUNDS 1B, 1C, AND 2B RENDER OBVIOUS CLAIM 2

19. The Petition describes how the combination provides the claimed "directional-signal splitter/inverter that generates two complementary internal

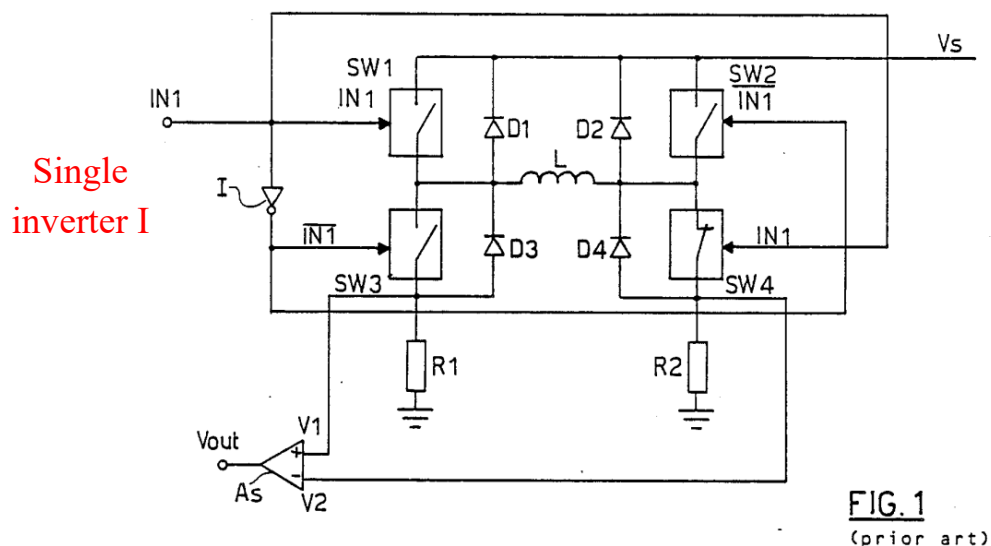
signals, d and $\bar{d}$,” and “a second switch of the pair controlled by internal signal $\bar{d}$.”

See, e.g., Pet., 31-37, 40-45. The arguments in the Patent Owner Response regarding claim 2 appear to be based on assumptions that the Rossi combination set forth in the petition is **i)** limited to two separate inverter components that generate two non-equivalent internal signals $\bar{d}$, and that **ii)** claim 2 excludes configurations in which the signal “received by SW2 is generated by a different inverter ‘I’” than the signal received by SW3. POR, 17. Contrary to the Patent Owner’s assertions, however, the Shahoian-Cosper-Rossi combination as set forth in the petition is not limited to utilizing two separate inverter components. *See*, Pet., 31-35. Moreover, even if it were, the Rossi Grounds render obvious claim 2 under both the plain language of the claim and Patent Owner’s substitute interpretation.

20. Rossi describes “a driving signal $IN1$ ” and an “inverted signal thereof $\overline{IN1}$, the latter being obtained by means of an inverter I.” Pet., 40 (citing APPLE-1020, 1:65-2:2). “In the predictable combination, the Shahoian-Cosper actuator system would have included an H-bridge switch circuit having a control signal input, splitter and control signal inverter, in accordance with Rossi,” such that the resulting circuit includes complementary internal drive signals (e.g., “driving signal $IN1$ ” and “driving signal $\overline{IN1}$ ”) that control respective sets of the transistors. Pet., 33. To be clear, a POSITA would have recognized that Rossi discloses use of

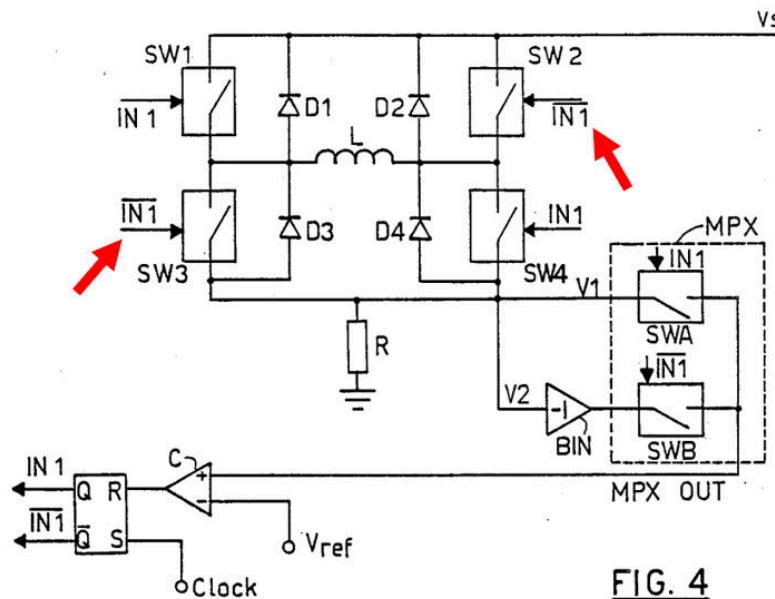
the same signal as inputs to SW2 and SW3—Rossi uses the same label signal $\overline{\text{IN1}}$ for both signals. This alone provides independent support that the combination renders obvious “a second switch of the pair controlled by internal signal $\bar{d}$.”

21. Based on my knowledge and experience in the field and my review of Rossi, a POSITA would have recognized from Rossi's straightforward description, the conventional use of an inverter to generate inverted signal $\overline{\text{IN1}}$ for input into SW2 and SW3 using conventional techniques. Rossi's FIG. 1 expressly describes and illustrates configurations using a single inverter, followed by lines drawn to inputs of each of SW2 and SW3:



APPLE-1020, FIG. 1 (Annotated)

22. Similarly, FIG. 4 illustrates equivalent signals input to SW2 and SW3 (signal “ $\overline{\text{IN1}}$ ”) without limitation of the configuration used to generate signal “ $\overline{\text{IN1}}$.”



APPLE-1020, FIG. 4 (Annotated)

23. Rossi describes FIG. 6 as a circuit diagram of an embodiment of the circuit of FIG. 4, utilizing analog switches implemented by means of MOS transistors,” and it is illustrated as a schematic circuit diagram. APPLE-1020, 2:62-64. Based on my knowledge and experience in the field and my review of Rossi, a POSITA would have recognized that, when implementing a circuit shown in FIG. 6, specific components and structural details would be selected in order to implement as a physical device, including specific part numbers, the physical layout of the components (e.g., on a circuit board), and other implementation

details. A POSITA would have readily recognized, based on Rossi's description, various configurations to implement the logical circuit layout illustrated in FIG. 6, including the conventional use of a single inverter. Rossi itself expressly describes and illustrates use of a single inverter, and nothing in Rossi limits this embodiment (e.g., illustrated in FIG. 6) from use of the known technique of a single inverter.

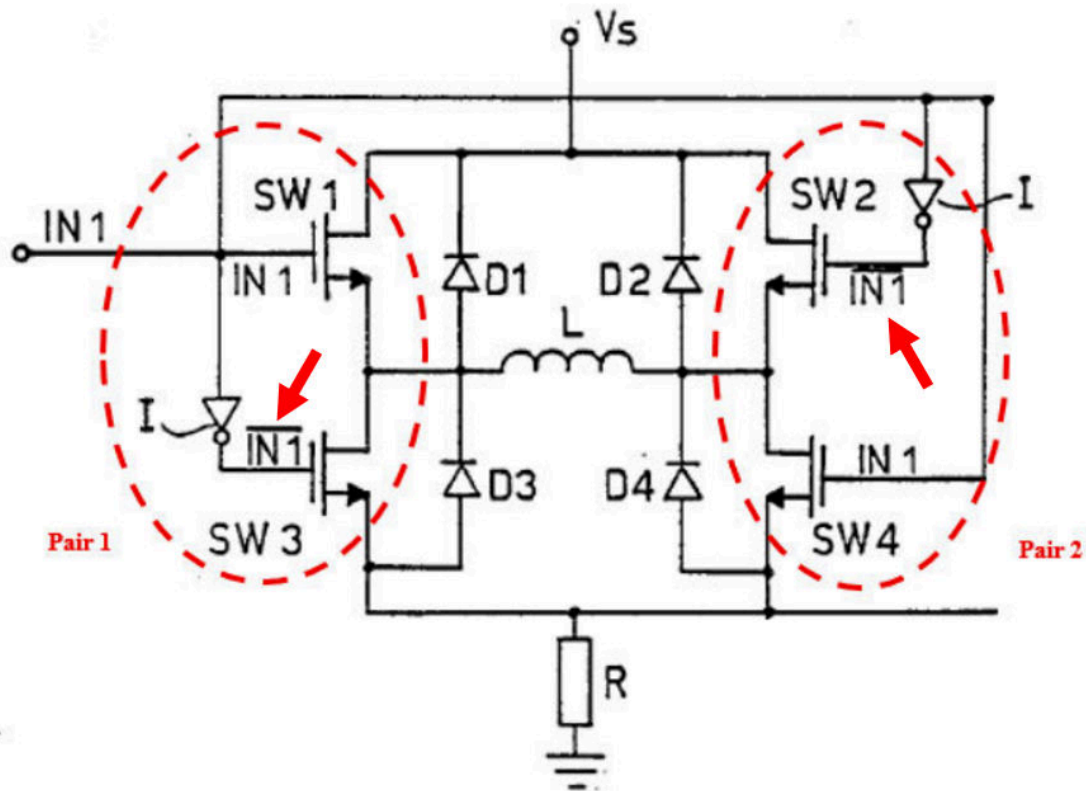
Id. A POSITA would have recognized predictable benefits of utilizing a single inverter, including to facilitate a reduced number of components and associated manufacturing simplicity, and effectuating Rossi's objective of delivering equivalent signals (" $\overline{IN1}$ ") to inputs of both of SW2 and SW3.

24. The combination described by the Petition is not based on bodily incorporation of Rossi's schematic circuit diagram shown in FIG. 6, as Patent Owner appears to assert, but rather is a predictable implementation of Rossi's suggestions within Shahoian-Cosper's system. A POSITA would have predictably implemented equivalent signals (" $\overline{IN1}$ ") input to SW2 and SW3, and would have done so using a single inverter component, as a matter of routine implementation based on Rossi's express teachings. Pet., 32. This is especially the case where Rossi illustrates such implementations interchangeably, expressly indicating the use of equivalent signals as inputs for SW2 and SW3, without limitation on whether the signals are generated with a single inverter or two inverters.

25. The fact that a functioning circuit **could** possibly be built using two inverters does not render the use of a single inverter non-obvious. Rossi itself utilizes both configurations, which would have been recognized by a POSITA as an obvious design choice to effectuate the circuit schematic it illustrates in an efficient manner utilizing few components. Patent Owner's analysis appears to be based on speculation that Rossi utilizes signals input to SW2 and SW3 that are not-equivalent, but this is not supported, and in fact contrary, to Rossi's description and circuit diagrams. APPLE-1050, 58:6-9 ("could you remind me what in the text tells you that? A. Nothing. I don't think anything in the text tells me that.")). Moreover, the system would not function effectively as taught by Rossi to control pairs of the switches simultaneously, including SW2 and SW3, to carry out Rossi's switching technique, if non-equivalent signals were used instead of the equivalent signals (" $\overline{\text{IN1}}$ ") described by Rossi and illustrated in Rossi's diagrams.

26. Even if implemented using multiple splitter/inverter components (which a POSITA would not have been limited to), Patent Owner fails to demonstrate the claim language excludes such a configuration. As set forth in Element [2.4], a second switch of each pair (SW2 and SW3) is controlled by equivalent "driving signal $\overline{\text{IN1}}$ ", such that SW2 and SW3 are in a common state at the same time. "Driving signal $\overline{\text{IN1}}$ " is input to both SW2 and SW3 and, as expressly indicated by Rossi, is the inverted signal of IN1. *See, e.g.*, APPLE-1020,

1:65-2:2; 2:4-12; 2:56-3:2 (“IN1” and “its inverted signal $\overline{\text{IN1}}$ ”); 3:44-55; FIG. 1, 4, 6.



APPLE-1020, FIG. 6 (Partial, annotated)

V. ALL GROUNDS RENDER OBVIOUS EACH ELEMENT OF CLAIM 3

A. The Shahoian Grounds Disclose a “Vibration Sensor”

27. Dependent claim 3 recites a “vibration sensor” in addition to the “sensors” recited in independent claim 1. I understand that Patent Owner does not dispute that the Petition identified a “vibration sensor” provided by an accelerometer that is distinct from the sensors mapped for claim 1. POR, 17-18. Rather, the POR states that the Petition “cites to nothing in Cosper or any other

reference that is allegedly an accelerometer.” POR, 18. This statement appears to overlook Cosper’s teachings highlighted in the Petition.

28. Cosper describes use of an accelerometer. For example, Cosper describes “one or more sensors 14 may detect position, velocity, **acceleration**, etc.” APPLE-1009, [0050]. Consistent with Cosper’s express description, an accelerometer *is* a sensor that detects acceleration, and would have been recognized as such by a POSITA in view of Cosper’s description. APPLE-1051, 3 (“sensor for measuring acceleration”); APPLE-1052, 3 (“a device that senses or measures the acceleration applied to it”). A POSITA would have recognized that Cosper discloses an accelerometer through its express description of a sensor that detects acceleration. *Id.* I note that Cosper not only recites use of a sensor that detects acceleration, but additionally lists a type of sensor—a “capacitive” sensor-- of which an accelerometer is commonly constructed.

29. I additionally note that Cosper describes use of multiple sensors in combination to detect acceleration and position, velocity, etc. Cosper describes use of “one **or more** feedback inputs from one **or more** sensors.” APPLE-1009, [0050]; *see also* [0125] (“one or more sensors (e.g., optical sensors, electrical sensors, motion sensors, etc.) may be used to provide information to the control circuitry”). Cosper also specifically describes “[f]eedback on the position, velocity, **and/or** acceleration of the mass,” providing express disclosure of

position, velocity **“and”** acceleration in combination. APPLE-1009, [0010].

Based on my knowledge and experience in the field and my review of Cosper, Cosper’s description would have been understood by a POSITA as describing an accelerometer, in combination with other sensors, as recited by Claim 3.

30. Even if Cosper did not expressly describe the “vibration sensor” element of claim 3 (which it does, for the above reasons), a POSITA would have found it obvious in view of Shahoian and Cosper. Utilizing additional sensors, including an acceleration sensor in addition to position, velocity, and/or other sensors, would have facilitated information about real-time motion of the magnet head to promote characterization of the movement, and a robust feedback control loop. Pet., 15-16. Additional feedback would have been readily available from the accelerometer and other sensors to facilitate reliable and accurate characterization of the movement, and/or more efficient characterization (e.g., reduced lag time), enhancing the system feedback control.

31. I understand that Patent Owner states that the “petition and Dr. Hannaford fail to explain why a POSITA would be motivated to use this particular combination of sensors, in a way that would satisfy claim 3, either to achieve the oscillation near resonance desired in Cosper or for any other reason.” POR, 19. I disagree with this assertion. As I discuss above, and as set forth in the petition and my first declaration, several reasons would have motivated a POSITA to combine

Shahoian and Cospers to use such a combination of sensors. The Patent Owner Response does not appear to acknowledge or address these reasons.

B. The Shahoian Grounds Disclose the Control Program “Continuously Monitors” Output From the Vibration Sensor

32. The Petition specifically described Shahoian and Cospers’s teachings (Grounds 1B, 1D) that address the “continuously monitors” element of claim 3. *See, e.g.*, Pet., 45-46, 56-60 (“continuously updates”). The Petition further describes operation of a control loop in the Aldrich combinations (Grounds 2A-2B) that performs continuous monitoring. Pet., 54-60, 68 (“loop or event handler in a feedback control system” and “feedback loop to maintain operation”).

33. I note that the teachings of the references on this point are just like the ’767 patent’s description. In the Shahoian-Cospers-Rossi combination, the control program continuously monitors output from the vibration sensor (accelerometer) to adjust the frequency at which the control program changes the voltage state of the directional signal d (IN1) delivered to the H-bridge circuit. *See, e.g.*, Pet., 45-46. In particular, the combination uses a control loop to implement the feedback control. In accordance with Cospers’s suggestions, based on the output from the vibration sensor, the current waveform decider of the microprocessor adjusts the frequency at which the control program changes the voltage state of the directional signal d (control signal from the microprocessor to “IN1” of the H-bridge circuit.),

implementing the feedback loop to maintain oscillation according to the desired parameters. *See*, APPLE-1009, [0050]-[0051], [0054], [0125]; APPLE-1005, [0044]-[0047].

34. I understand Patent Owner Response states that “the petitions and the declarations from Dr. Hannaford that they cite fail to point to anything in the prior art references that teaches ‘continuous’ monitoring or to explain why it would have been obvious to modify the prior art to perform such ‘continuous’ monitoring.” POR, 19. But this statement is not followed by any discussion of the explanation in the Petition regarding use of a control loop, which provides “continuous” monitoring. Such a control loop was a widely-known and conventional technique. I understand Dr. Goossen likewise acknowledge such loops to provide “continuous” monitoring, as recited by claim 3. *See*, APPLE-1050, 36:12-37:10 (“[T]he control program is a set of software. You are running code, and it is operating a loop. And every time it goes through the loop, it would have to read in the output of the sensor.”).

35. Patent Owner additionally ignores the fact that the ’767 patent provides less detail than Shahoian, Cosper, and Aldrich on this same issue.

VI. LEGAL PRINCIPLES

36. 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

37. 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.

38. 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

39. 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.

40. The application that led to the '767 patent (U.S. Appl. No. 12/782,697) was filed on May 18, 2010 and claims priority to U.S. Provisional Application 61/179,109 filed on May 18, 2009. APPLE-1001 at cover page. For purposes of my analysis here, I have applied a date of May 18, 2009 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 May 18, 2009.

41. 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.

VII. CONCLUSION

42. 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: 28-May-2025



BLAKE HANNAFORD, PH.D.