

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.
Petitioner

v.

RESONANT SYSTEMS, INC.,
Patent Owner

Case IPR2024-00698
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 IPR2024-00698 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 Izumi, Cosper, Ibuki, 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 (“Cospers”)

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-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, IPR2024-00698

- 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 IZUMI GROUNDS (ALL GROUNDS) RENDER OBVIOUS LIMITATION [1.5.3]

7. Based on my review of the Patent Owner Response and the Dr. Goossen Declaration, I understand that Patent Owner does not dispute that Ground 1A discloses all limitations [1.P]-[1.5.2] and [1.6] of independent claim 1. I understand that Patent Owner argues that the Petition did not address how Izumi-Cosper discloses “a switch that receives a directional signal d from the processor,” as recited in Limitation [1.5.3]. POR, 9-14. As I discuss in more detail below, Patent Owner does not address the analysis of the “processor” limitation provided throughout the Petition’s analysis of Izumi-Cosper in Ground 1A. I further note that Patent Owner does not address the discussion of Izumi-Cosper-Ibuki, which provides an independent basis why a POSITA would have found the “microprocessor”/ “processor” elements of claim 1 to be obvious.

A. Izumi-Cosper renders obvious Limitation [1.5.3]

8. I understand that Patent Owner does not dispute that the Izumi-Cosper system includes a “switch” and a “directional signal d” as recited by Limitation [1.5.3], based on the lack of any such analysis in the Patent Owner Response.

Patent Owner argues that the petition fails to demonstrate a “processor” from which the switch receives the directional signal d. POR, 9-14. I note that the Petition and my first declaration explain how Izumi and Cospers render obvious the use of a “microprocessor”/“processor” that delivers the directional signal to the switch. Pet., 25-26 (Analysis of Limitation [1.5.1]); Pet., 28 (Analysis of Limitation [1.5.3]); Pet., 15-16, 18 (explaining why “Izumi’s ‘controller’ would have been implemented using a microprocessor and memory, in accordance with Cospers’s suggestions.”). The Patent Owner response does not specifically address this analysis. For the reasons previously presented, and as I discuss in more detail herein, Element [1.5.3] is obvious under the Izumi-Cosper Grounds.

9. I note that independent claim 1 of the ’767 patent recites the “microprocessor”/ “processor” element multiple times. Specifically, Claim 1 recites this structure in Element [1.5.1]: “a control component that includes a microprocessor.” Element [1.5.2] further recites: “executed by the microprocessor to control operation.” Claim 1 again recites it in Limitation [1.5.3]: “the processor.” The POR does not appear to address the analysis of the “microprocessor”/“processor” elements that is provided throughout the discussion of the Izumi-Cosper combination, for example at §V.A.3 of the Petition, the analysis of Limitation [1.5.1], or subsequent discussion in the Izumi-Cosper-Rossi combination (pet. 32-34, 46).

10. For example, the Petition (in §V.A.3 (Predictable Izumi-Cosper Combination)) and my first declaration expressly addressed that a POSITA would have implemented the “controller” using a “microprocessor,” in accordance with Cosper:

Izumi’s “controller” would have been implemented using a microprocessor and memory, in accordance with Cosper’s suggestions. APPLE-1003, ¶111. The microprocessor receives inputs such as signals from the sensors (e.g., including from sensors that detect position, velocity, acceleration, load, etc.), and **generates the “control signals” for control of the oscillating movement in accordance with Izumi**. APPLE-1005, [0040]; [0047]-[0050]; [0060]-[0062]; FIGS. 2, 22A, 23A; APPLE-1003, ¶111.

Pet., 15-16 (“Similar prior art systems, such as Cosper, demonstrated the conventional knowledge of . . . a microprocessor that receives inputs from the sensors and that generates control signals to control the actuators.”).

11. The Petition and my first declaration also explained multiple reasons why a POSITA would have been motivated to do so, but that the Patent Owner Response and Dr. Gossen Declaration do not appear to respond to. For example, the Petition and my first declaration pointed out that utilizing a “microprocessor

and memory” would have facilitated implementation of software instructions “that can be executed to reliably and effectively carry out the control scheme.” Pet. 18-19 (citing APPLE-1003, ¶¶118-122; APPLE-1009, [0049], [0056]; [0125]); *see also* APPLE-1003, ¶¶120-121 (indicating that Cosper expressly describes implementing control logic using “hardware” and “software,” and thus a “microprocessor” to execute the software would have facilitated effective feedback control in the combined system. Pet., 18 (citing APPLE-1009, [0049], [0056]; [0125])).

12. Moreover, the Petition explained how the “microprocessor” would have been used in the combined system: “Izumi expressly indicates that ‘the controller determines a shape and a phase of the current waveform necessary for the intended motion of the moving element,’ and “[i]n the combination, **this is carried out by a ‘microprocessor’ (in accordance with Izumi and Cosper’s suggestions).**” Pet., 25-26 (“The combination’s LRVM includes a control program (software instructions stored in memory, in accordance with Izumi and Cosper) that is executed by the microprocessor to control operation of the LRVM, consistent with Izumi’s stated control objectives.”).

13. In the combined system, the “controller” is predictably implemented as a “microprocessor” that provides a directional signal d to the switch. Izumi expressly indicates that the switching elements of the H-bridge switch are

controlled by control signals S1 to S4, respectively, “which are inputted into the base terminals by the current waveform decider 60,” and that the “current waveform decider 60” is part of the “controller 6.” Pet., 27-28 (citing APPLE-1005, [0040], [0060]).

14. Even beyond the express teachings of Izumi and Cosper highlighted in the petition, use of a “microprocessor” to implement a controller that delivers a direction signal was widely known and conventional. Pet., 19-21. For example, the Ibuki, Shahoian, Kraus, and Muthu references, for example, all corroborate my first declaration that a “microprocessor” was a known and suitable option for delivering control signals, especially by the timeframe of the ’767 patent. *See, e.g.*, APPLE-1003, ¶122 (citing APPLE-1038, [0020]-[0021] (“CPU” and “memory”); APPLE-1004, 4:16-20 (describing use of a “microprocessor” for linear actuator control), 7:46-53, FIG. 1 (“local microprocessor”); APPLE-1042, [0012] (describing use of a “microcontroller” in shaver control system), [0017], [0033]-[0034]); APPLE-1007, 2:18-35 (“processor,” “asic”); APPLE-1043, 2:19-43.).

15. Based on my knowledge and experience in the field, in view of the conventional use of microprocessors for similar applications, a POSITA would have utilized a “microprocessor” to implement Cosper’s teaching of “software” as an obvious design choice (e.g., based on a defined number of processor-types). Executing Cosper’s “software” would have called for a microprocessor and

memory. Pet. 18 (citing APPLE-1003, ¶121). This would have been immediately recognized from Cosper. Additionally, based on my knowledge and experience in the field, a POSITA would have been prompted to use a microprocessor and memory to execute Cosper's software because there were a finite number of identifiable and predictable choices for implementing Cosper's software-executing "hardware"—all of which would have been some form of microprocessor and memory. *Id.* A POSITA would have found it obvious to implement the controller of Izumi using a microprocessor in accordance with Cosper, for the reasons described above, and would have had a reasonable expectation of success in view of the common usage of a microprocessor for such applications.

16. The Patent Owner Response states that a "POSITA would understand that 'PWM control' would not require that the directional signal itself be generated by, or otherwise be 'from,' a processor." POR, 12. Even if true, this does not undermine my analysis. For example, Patent Owner's statement assumes that the "PWM control method" described by Izumi would have been performed by an "analog" circuit. But there is nothing in Izumi's text, cited by Patent Owner or otherwise, that indicates that the "PWM control method" is implemented by an analog circuit. Instead, Izumi describes the "PWM control method" as a suitable technique that overcomes potential constraints as compared to "complicated control" performed "at every half-cycle or one cycle of the moving element 1."

Izumi's description does not limit how the method is implemented. APPLE-1005, [0063].

17. Additionally, I note that nothing in this passage of Izumi, or elsewhere in Izumi, indicates that the control method shouldn't be implemented using a processor. Based on my knowledge and experience in the field, and my review of Izumi, a POSITA would have readily recognized use of a processor as a suitable implementation, especially in view of the conventional use of processors for such applications, as I discussed previously. To be clear, there is nothing in Izumi that describes the use of a *CPU* as inherently "complicated," "complex," or undesirable, but rather that certain *techniques* can be "complicated" and thus susceptible to constraints of processing speed, for example.

18. The Patent Owner Response states that "'PWM control' would not *require* that the directional signal itself be generated by, or otherwise be 'from,' a processor." POR, 12 (emphasis added). Even if true, however, that fact that an analog circuit *could* generate the signal does not make use of a microprocessor undesirable or otherwise non-obvious. The use of processors in such applications were a known suitable configuration. This is true even if it could alternatively be implemented in an analog manner. A POSITA would have recognized the conventional use of a processor, and the associated benefits in the combined system. Izumi does not describe any such constraints of using a microprocessor to

perform “PWM control,” or other suitable technique, in accordance with Izumi’s teachings, and there are none.

19. As I discussed previously, multiple reasons would have prompted a POSITA would to utilize a “processor” to implement the controller in the Izumi-Cosper combination. Based on my knowledge and experience in the field and my review of the Izumi and Cosper, even if not expressly described by Izumi alone, the use of a “microprocessor” as recited by independent claim 1 was obvious in view of Izumi-Cosper, for the reasons set forth in the Petition. *See*, Pet., 18-21, 25-27. The passage of Izumi that the Patent Owner Response addresses is not counter to these motivations. To the contrary, a POSITA would have readily implemented the combination utilizing a processor.

B. The Ibuki Grounds (Grounds 1C, 1D) and Aldrich Grounds (Grounds 2A, 2B) each further render obvious Element [1.5.3]

20. I note that, in addition to Izumi-Cosper rendering obvious the “microprocessor”/“processor” elements of independent claim 1, the Ibuki and Aldrich Grounds each further render these elements obvious. I note that the Patent Owner Response does not address the substance of the analysis set forth in Grounds 1C, 1D, 2A, and 2B, alleging only that these Grounds add “no further citations to prior art limitations [1.5.3].” POR, 9. I note that these Grounds in fact do highlight Ibuki’s or Aldrich’s teachings that are relevant to use of a

microprocessor and that further render obvious the “microprocessor”/“processor” elements of independent claim 1.

21. The Ibuki reference provides express disclosure of a microprocessor that controls oscillation, among other device functions. Pet., 49 (citing APPLE-1038, [0021]). Ibuki, like Izumi, is directed to oscillation in an electric shaver device, and discloses device control using a “CPU that executes a program stored in the ROM.” *Id.* Indeed, as set forth in the Petition and my first declaration (and ignored by the POR), “a POSITA would have been motivated to combine Izumi-Cosper and Ibuki to utilize a microprocessor and memory, facilitating implementation of software instructions that can be executed to reliably and effectively carry out the control scheme.” Pet., 50 (citing APPLE-1003, ¶171). In the combination, the CPU processes signals from various inputs and generates control outputs. *Id.*

22. In the Izumi-Cosper-Ibuki combination, the “controller” in accordance with Izumi, including a “waveform decider,” is implemented using a “microprocessor,” in accordance with Ibuki. Pet., 50-52. The “direction signal d” generated by the “waveform decider” of the “controller,” is thus received from the “microprocessor,” directly informing the analysis of the “processor” of element [1.5.3]. Pet., 27-28; 50-52.

23. Likewise, Aldrich further informs use and operation of the microprocessor in the combined system. *See*, Pet., 62. For example, in the combined system, the “microprocessor” executes a control program to control operation of the linear resonant vibration module, consistent with Izumi’s stated control objectives. *See*, Pet., 64. When sensor signals or user inputs are received by the microprocessor, the control outputs are adjusted accordingly. *Id.*, 67-68.

24. I understand that Patent Owner Response states that the Ibuki and Aldrich Grounds adds “no further citations to prior art limitations [1.5.3].” POR, 9. This does not address the relevant analysis set forth in these Grounds. For example, element [1.5.3] (“the processor”) relies on elements [1.5.1]/[1.5.2] (“microprocessor”) for antecedent basis, and Ground 1C expressly addresses this structure. Ground 1C describes the predictable implementation of a control component that includes a “microprocessor” to “receive feedback sensor data and determine appropriate control signals.” Pet., 50, 52. I further note that the Grounds expressly indicate that the switch receives the control signals “from the microprocessor.” Pet., 28. Likewise, Grounds 2A-2B further explain how the microprocessor implements feedback control in view of Aldrich’s suggestions.

25. Accordingly, based on my knowledge and experience in the field and my review of Izumi, Cosper, Rossi, Ibuki, and Aldrich, each of the Izumi-Cosper

Grounds (Grounds 1A, 1B), Ibuki Grounds (Grounds 1C, 1D), and Aldrich Grounds (Grounds 2A, 2B) render obvious Element [1.5.3].

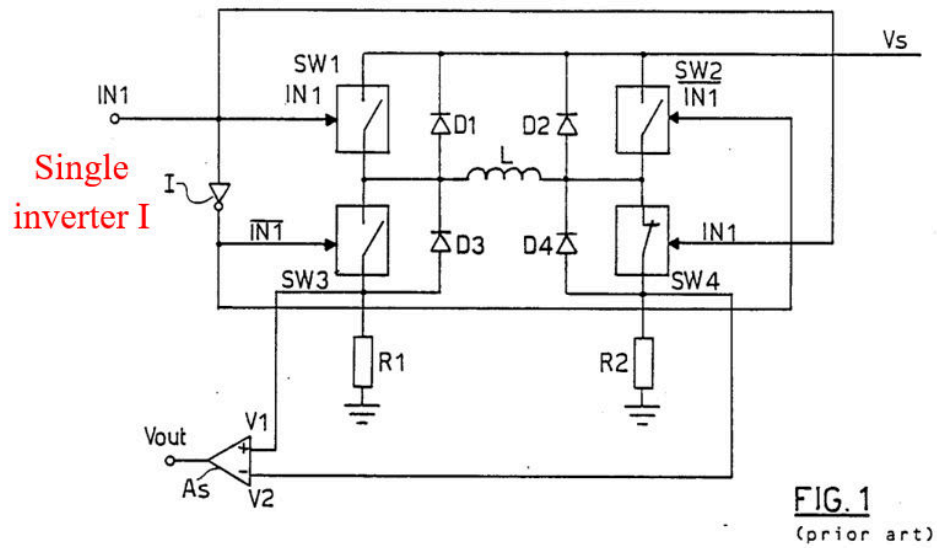
IV. GROUNDS 1B, 1D, AND 2B RENDER OBVIOUS CLAIM 2

26. 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., 30-36, 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 **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, 16. Contrary to the Patent Owner’s assertions, however, the Izumi-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 did, the Rossi Grounds render obvious claim 2 under both the plain language of the claim.

27. Rossi describes “a driving signal IN1” and an “inverted signal thereof $\overline{\text{IN1}}$, the latter being obtained by means of an inverter I.” Pet., 40 (citing APPLE-1020, 1:65-2:2). “The switching circuit of the combined system receives a direction control signal from the ‘microprocessor,’ in accordance with Izumi-

Cosper's feedback control, which is split and passed through an inverter, in accordance with Rossi," such that the resulting circuit includes complementary internal drive signals (e.g., "driving signal IN1" and "driving signal $\overline{\text{IN1}}$ ") that control respective sets of the transistors. Pet., 32. 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 $\bar{d}$."

28. 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 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)

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

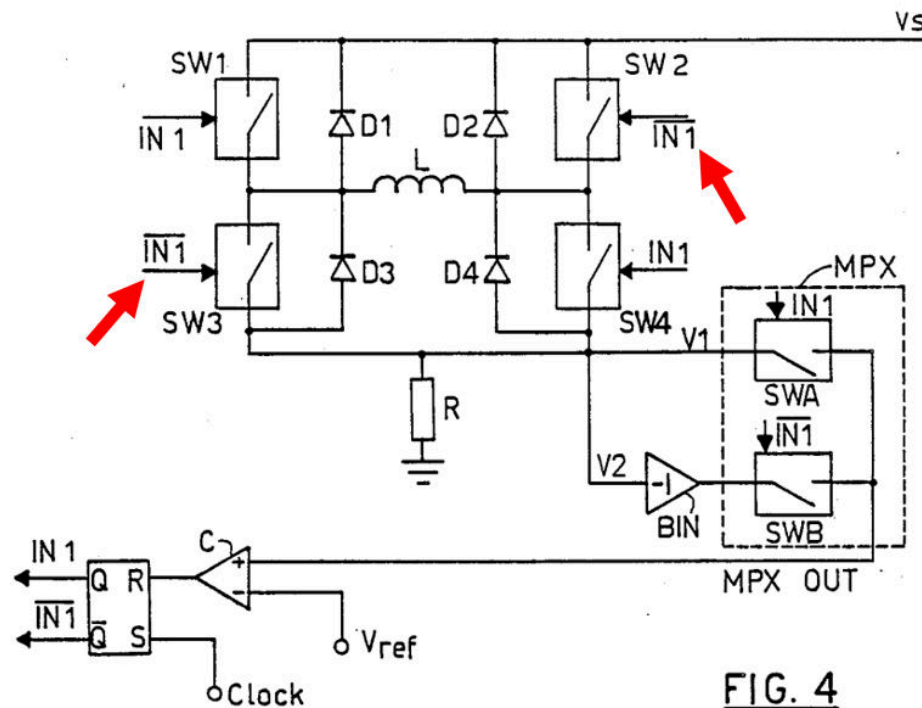


FIG. 4

APPLE-1020, FIG. 4 (Annotated)

30. 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 (" $\overline{\text{IN1}}$ ") to inputs of both of SW2 and SW3.

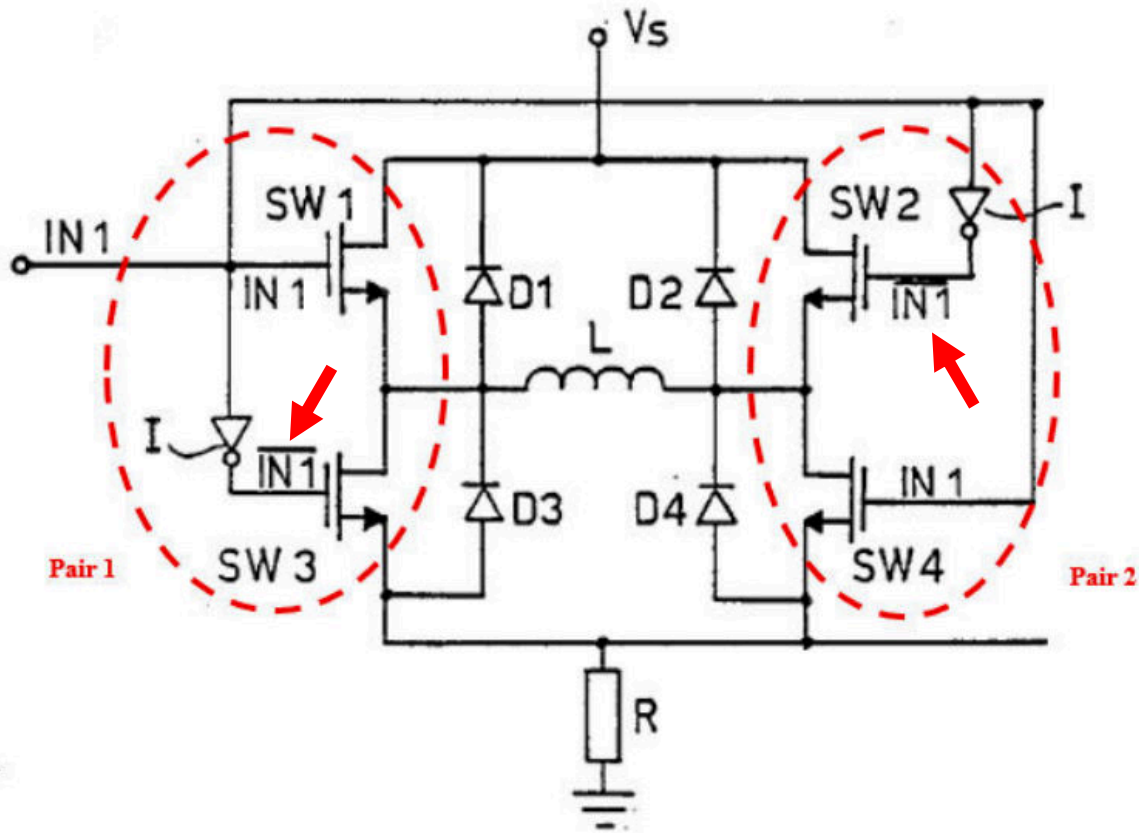
31. To be clear, the combination described by the Petition is not based on bodily incorporation of Rossi's schematic circuit diagram shown in FIG. 6, as Patent Owner appears to assert, but rather is a predictable implementation of Rossi's suggestions within Izumi-Cosper's system. A POSITA would have predictably implemented equivalent signals (" $\overline{\text{IN1}}$ ") 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.

32. To be clear, the fact that the circuit **could** possibly be built using two inverters does not render the use of a single inverter non-obvious. Indeed, 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 entirely non-equivalent signals were used instead of the equivalent signals (" $\overline{IN1}$ ") described by Rossi and illustrated in Rossi's diagrams.

33. To be clear, 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 $\overline{IN1}$ ", such that SW2 and SW3 are in a common state at the same time. "Driving signal $\overline{IN1}$ " 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 Izumi Grounds Disclose a “Vibration Sensor”

34. 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, 16-18.

Rather, the POR states that the “Petition cites 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.

35. 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.

36. 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-1005, [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-1005, [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.

37. 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 Izumi 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., 17-18. 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. Moreover, use of multiple sensors, including an accelerometer, would have predictably facilitated fewer calculations to determine particular parameters. Pet., 17.

38. 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 Cospers or for any other reason.” POR, 17-18. I disagree with this assertion, which is unsupported by any discussion of the motivations I describe above and set forth in the Petition.

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

39. The Petition specifically described Izumi and Cospers’ teachings (Grounds 1B, 1D) that address the “continuously monitors” element of claim 3. *See, e.g.*, Pet., 45-46, 57-60 (“continuously updates”). The Petition further describes operation of a control loop in the Aldrich combinations (Grounds 2A-2B) that performs continuous monitoring. Pet., 58-60, 67-68 (“loop or event handler in a feedback control system” and “feedback loop to maintain operation”).

40. I note that the teachings of the references on this point are just like the ’767 patent’s description. In the Izumi-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’ 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*, Pet., 17 (“robust feedback control loop”); APPLE-1009, [0050]-[0051], [0054], [0125]; APPLE-1005, [0044]-[0047]; *see also*, Pet., 25-26 (“‘microprocessor’ closed loop control”).

41. I understand Patent Owner Response stats that “the petition and the declaration from Dr. Hannaford that it cites fails 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, 18. 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.”).

42. Patent Owner additionally ignores the fact that the ’767 patent provides less detail than Izumi, Cosper, and Aldrch on this same issue.

VI. LEGAL PRINCIPLES

43. 15. 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

44. 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.

45. 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

46. 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.

47. 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.

48. 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

49. 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.