

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Issue Date: January 10, 2012
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Title: LINEAR-RESONANT VIBRATION MODULE

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**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT
NO. 8,093,767 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

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APPLE-1001	U.S. Patent No. 8,093,767 (“’767 patent”)
APPLE-1002	Excerpts from the Prosecution History of the ’767 patent
APPLE-1003	Declaration of Dr. Blake Hannaford
APPLE-1004	U.S. Patent No. 6,982,696 (“Shahoian”)
APPLE-1005	U.S. Patent Publication No. 2005/0275294 (“Izumi”)
APPLE-1006	U.S. Patent Publication No. 2008/0294984 (“Ramsay”)
APPLE-1007	U.S. Patent No. 7,843,277 (“Gregorio”)
APPLE-1008	RESERVED
APPLE-1009	U.S. Patent Publication No. 2008/0246532 (“Cosper”)
APPLE-1010-19	RESERVED
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-1027-32	RESERVED
APPLE-1033	Resonant Systems Proposed Claim Constructions, 7-23-cv-00077 (WDTX) (Feb. 15, 2024)
APPLE-1034	Apple, Inc. Proposed Claim Constructions, 7-23-cv-00077 (WDTX) (Feb. 15, 2024)
APPLE-1035	RESERVED
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APPLE-1037	U.S. Patent App. No. 09/608,125 (“Schena”)
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APPLE-1040	U.S. Patent Publication No. 2011/0133682 (“Egger”)
APPLE-1041	U.S. Patent Publication No. 2008/0001484 (“Fuller”)
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APPLE-1045	RESERVED
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)

LISTING OF CLAIMS

Claim 1	
[1.P]	A linear resonant vibration module comprising:
[1.1]	a housing;
[1.2]	a moveable component;
[1.3]	a power supply;
[1.4]	a driving component that drives the moveable component in each of two opposite directions; and
[1.5.1]	a control component that includes a microprocessor and that controls supply of power from the power supply to the driving component to cause the moveable component to linearly oscillate, the control component including, in addition to the microprocessor,
[1.5.2]	a control program, stored in one of a separated electronic memory or within the processor, that is executed by the microprocessor to control operation of the linear resonant vibration module, and
[1.5.3]	a switch that receives a directional signal d from the processor and that selects a corresponding direction of the two opposite directions in which the driving component drives the moveable component,
[1.6]	the control component receiving output signals from sensors within the linear resonant vibration module during operation of the linear resonant vibration module and adjusting one or more operational control outputs of the control component according to the received output signals from the sensors in order that subsequent operation of linear resonant vibration module produces desired outputs from the one or more sensors

	corresponding to one or more operational control parameters.
Claim 2	
[2.1]	The linear resonant vibration module of claim 1 wherein the switch comprises: a directional-signal d input;
[2.2]	a voltage input;
[2.3]	a directional-signal splitter/inverter that generates two complementary internal signals, d and $\bar{d}$, corresponding to directional-signal d; and
[2.4]	two pairs of solid-state switches, a first switch of each pair controlled by internal signal d and a second switch of the pair controlled by internal signal $\bar{d}$, that apply the input voltage in a first direction to the driving component when the d is in a first voltage state and that apply the input voltage in a second direction to the driving component when the d is in a second voltage state.
Claim 3	
[3.1]	The linear resonant vibration module of claim 2 wherein the linear resonant vibration module further includes a vibration sensor; and
[3.2]	wherein the control program continuously monitors output from the vibration sensor in order to adjust the frequency at which the control program changes the voltage state of the directional signal d.
Claim 4	
[4]	The linear resonant vibration module of claim 2 wherein the control program receives user input from one or more input features, including one or more of buttons, dials, switches, and other user-input features.

Claim 5	
[5.1]	The linear resonant vibration module of claim 4 wherein, when the control program receives user input directing a change in vibration strength, the control program changes the current provided from a power supply to the driving component; and
[5.2]	wherein, when the control program receives user input directing a change in vibration frequency, the control program changes the frequency at which the control program changes the voltage state of the directional signal d.

Apple Inc. (“Apple” or “Petitioner”) petitions for IPR of claims 1-5 (“Challenged Claims”) of U.S. Patent No. 8,093,767 (“’767 patent”). As explained in this petition, there exists a reasonable likelihood that Apple will prevail with respect to at least one of the Challenged Claims.

I. REQUIREMENTS FOR IPR UNDER 37 C.F.R. § 42.104

A. Grounds for Standing Under 37 C.F.R. § 42.104(a)

Petitioner certifies that IPR is available and Petitioner is not barred/estopped.

B. Challenge Under 37 C.F.R. § 42.104(b) and Relief Requested

Petitioner requests IPR based on the following grounds, as further explained in this Petition and supported by a declaration from Dr. Blake Hannaford (APPLE-1003):

Ground	Patent Claims	§103 Basis
1A	1	Shahoian-Cosper
1B	1-4	Shahoian-Cosper-Rossi
1C	5	Shahoian-Cosper-Rossi-Ramsay
2A	1	Shahoian-Cosper-Ramsay-Aldrich
2B	1-5	Shahoian-Cosper-Ramsay-Aldrich-Rossi

Each applied reference pre-dates U.S. provisional application 61/179,109, filed on May 18, 2009, which is the earliest filed application from which the ’767 patent claims priority:

Reference	Date	Pre-AIA Section
Shahoian (APPLE-1004)	Jan. 3, 2006 (issued)	§102(b)
Cosper (APPLE-1009)	Apr. 9, 2007 (filed) Oct. 9, 2008 (published)	§102(a), §102(b) ¹
Rossi (APPLE-1020)	Nov. 7, 1989 (issued)	§102(b)
Aldrich (APPLE-1021)	April 2008 (published) (APPLE-1022)	§102(b)
Ramsay (APPLE-1006)	Nov. 27, 2008 (published)	§102(a)

None of the above references were applied in a substantive office action or cited during original prosecution.

II. SUMMARY OF THE '767 PATENT

A. Brief Description

The '767 patent relates to linear resonant vibration modules ("LRVM"). APPLE-1001, 1:9-10, Abstract; APPLE-1003, ¶¶58-64. The vibrational forces of the LRVM "are produced by a linear oscillation of a weight or component." APPLE-1001, 3:63-66. The LRVM includes a feedback control mechanism to maintain the frequency of the vibration close to a resonant frequency. APPLE-

¹ The '767 patent claims lack §112 support in the provisional application. But even if entitled to provisional priority, Cosper is prior art under §102(a).

1001, 4:12. The “frequency of vibration falls close to the resonant frequency of the LRVM, [and] results in optimal power consumption with respect to the amplitude and frequency of vibration produced by the LRVM.” APPLE-1001, 4:10-15; APPLE-1003, ¶64.

B. Prosecution History

The ’767 patent issued on January 10, 2012 from U.S. Patent Application No. 12/782,697 (“’697 application”), filed May 18, 2010. APPLE-1002, 197; APPLE-1003, ¶65. In response to an initial office action, Applicant cancelled the single pending claim and filed new claims 2-20 that “include a control component that includes a microprocessor.” *Id.*, 87. Independent claim 2 and dependent claims 3-6 were rejected over Oba(US2005/0231045) and Orr(US2005/0275508) and never allowed, but a final office action identified dependent claims 7-11, as allowable subject matter. APPLE-1002, 36, 52. Applicant cancelled the rejected claims, and amended claim 7 by incorporating the features of rejected base claims. APPLE-1003, ¶¶65-71.

A notice of allowance followed, ending prosecution prematurely and without consideration of more pertinent art such as Shahoian, Cosper, Rossi, Izumi, Ramsay, and Aldrich, none of which were cited during original prosecution. APPLE-1003, ¶¶66-71. Indeed, none of the art applied by the Examiner was directed to pertinent disclosures related to linear actuator modules found in haptics

in mobile devices. *Id.* While the '767 patent touts its linear resonant vibration module as an “invention,” it is beyond reasonable debate that those of skill in the art were aware of linear vibration modules that included microprocessor and feedback control features recited in the '767 patent claims. *Id.*

III. LEVEL OF ORDINARY SKILL

A person of ordinary skill in the art at the time of the '767 patent (a “POSITA”) would have had a degree in mechanical engineering, electrical engineering, physics, or a related technical field, and at least 2-3 years of experience related to the design or development of systems incorporating linear actuators; additional years of experience could substitute for the advanced-level degree. APPLE-1003, ¶¶30-31.

IV. Claim Construction under 37 C.F.R. §§ 42.104(b)(3)

All claim terms should be construed according to the Phillips standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. § 42.100. The Board has repeatedly explained that “claim terms need only be construed to the extent necessary to resolve the controversy.” *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011). As the prior art discloses the claims under each of the constructions offered in the Petition, the Board need not construe the claims to resolve unpatentability. *Id.*

A. Means-Plus-Function Terms

Certain claims recite “driving component” and “control component.” These terms do not recite “means for” and thus a presumption exists that these terms are not subject to 35 U.S.C. §112(¶6). This Petition therefore applies the plain and ordinary meaning of these terms, demonstrating unpatentability of each term consistent with its plain and ordinary meaning.

And yet, because Petitioner has endeavored in the District Court to overcome the presumption against construing under §112(¶6), Petitioner also applies herein a means-plus-function (“MPF”) approach to claim construction under 35 U.S.C. §112(¶6) and demonstrates unpatentability of each term to the extent construed under 35 U.S.C. §112(¶6). APPLE-1034, 3-8. That is, to equip the Board to resolve unpatentability under any plausible construction, Petitioner demonstrates unpatentability of the claims under a plain meaning interpretation of these terms (e.g., as set forth in Grounds 1A-1C) and also under the means-plus-function interpretation (e.g., as set forth in Grounds 2A-2B). Petitioner acknowledges 37 C.F.R. 42.104(b)(3), to the extent that §112(¶6) is deemed to apply, and it has fully addressed the attendant requirement to “identify the specific portions of the specification that describe the structure, material, or acts corresponding to each claimed function” for each means-plus-function limitation, and sets forth the corresponding analysis and construction under 35 U.S.C. §112(¶6) for each term below.

Therefore, regardless of the interpretation adopted, the instant record demonstrates that the implicated terms are plainly satisfied in view of the overlap between the prior art cited herein and the '767 patent specification.² *General Electric Co. v Vestas Wind Systems A/S*, IPR2018-00928, Paper 9, 12-16 (PTAB Nov. 5, 2018) (“rule [37 C.F.R. 42.104(b)(3)] does not prohibit a petitioner from submitting more than one construction”); *Intel Corp. v Qualcomm Inc.*, IPR2018-01340, Paper 8, 11-13 (PTAB Jan. 15, 2019).

1. “driving component” (all claims)

As agreed by Patent Owner in co-pending litigation, “driving component” should be interpreted according to the means-plus-function construction, including the identified corresponding structures, as set forth here. Claim 1 recites the “driving component” performs a specified function (“drives the moveable component”). The Petition identifies the '767 patent's columns 4, 5, 9 and 10 as the “specific portions of the specification that describe the structure” corresponding to the recited function of “driv[ing] the moveable component in

² The claims also recite “moveable component,” which is satisfied based on any interpretation based on the overlap between the cited art and the '767 specification.

each of two opposite directions.” 37 CFR §42.104(b)(3); APPLE-1034, 7. In particular, the ’767 patent describes one or more coils that receive alternating current as a structure that performs the recited function. For example, the ’767 patent describes “a coil of conductive wire 420” such that “[w]hen an electric current is applied to the coil 420 in a first direction 422, a corresponding magnetic force 424 is generated in a direction parallel to the axis of the cylindrical chamber, which accelerates the weight 404 in the direction of the magnetic force 424,” and “[a]s the weight reverses direction, as shown in FIG. 4D, current is applied in an opposite direction 430 to the coil 420, producing a magnetic force 432 in an opposite direction from the direction of the magnetic force shown in FIG. 4B, which accelerates the weight 404 in a direction opposite to the direction in which the weight is accelerated in FIG. 4B.” APPLE-1001, 4:44-60, Figures 4A-4G; *see also* 5:25-37; 5:49-6:14; 8:64-9:6; 9:7-20; 9:33-45; FIGS. 5A-5B (“coil 514”); FIG. 6 (“coil 626”); FIGS. 10-11 (“electromagnet”); FIG. 12 (“coil 1202 and 1204”); FIG. 13 (“coils 1302 and 1304”); FIG. 14 (“driving coils 1412 and 1414”); FIGS. 15-17 (“coil 1510”); APPLE-1003, ¶¶28-29. For the purpose of analyzing the prior art grounds, the Petition treats these structures and their equivalents as the corresponding structure.

To be clear, all Grounds include disclosure of the specific structures described by the ’767 patent for performing this function, and, regardless of

whether this term is subject to §112(¶6) or plain and ordinary meaning, all
Grounds set forth why this element was provided in the prior art publications.

2. “control component . . .” (all claims)

The claim 1 language recites the “control component” performs a specified function (“controls supply of power from the power supply to the driving component to cause the moveable component to linearly oscillate”). The ’767 patent’s column 6-7 and associated description of the flowcharts shown in FIGS. 7A-7C are the “specific portions of the specification that describe the structure” corresponding to the recited functions. 37 CFR §42.104(b)(3); APPLE-1034, 3-5; APPLE-1046, 19. For the purpose of analyzing the prior art grounds, the Petition treats “control component” as including a microprocessor and switch, as recited in claim 1, and the microprocessor is programmed with an algorithm (refer to analysis of “control program” below, and shown in FIGS. 7A-7C of the ’767 patent). In particular, the structure includes a microprocessor; a switch that receives a directional signal d from the processor and that selects a corresponding direction of the two opposite directions in which the driving component drives the moveable component; a control program, stored in one of a separated electronic memory or within the processor, that is executed by the microprocessor wherein the control program performs the algorithm shown in Figs. 7A–C and described at 6:15–8:3; and equivalents thereof. APPLE-1001, 6:15-7:2-8:50-62; APPLE-1034, 3-5;

APPLE-1003, ¶¶21-27; APPLE-1046, 19-20.

Claim 1 recites further functions of the “control component” of “control[ling] operation of the linear resonant vibration module,” “receiving output signals from sensors within the linear resonant vibration module during operation of the linear resonant vibration module,” and “adjusting one or more operational control outputs of the control component according to the received output signals from the sensors” The corresponding structure is the algorithm described at col. 6, line 15 to col. 8, line 3, with reference to the “control flow diagrams that illustrate the control program” at FIGS. 7A-7C. APPLE-1001, 6:18-19 (“FIG. 7A provides a control-[fl]ow diagram for the high-level control program.”); 7:3-4 (“FIG. 7B provides a control-flow diagram for the routine ‘monitor’ called in step 712 of FIG. 7A.”); 7:50-51 (“FIG. 7C provides a control-flow diagram for the routine ‘control,’ called in step 716 in FIG. 7A.”); APPLE-1003, ¶¶24-27. The Petition treats this structure and its equivalents as the corresponding structure.

Patent Owner has argued in co-pending litigation that “control component” should be interpreted according to plain and ordinary meaning. APPLE-1033, 2; APPLE-1047, 9. Patent Owner also proposes an alternative means-plus-function construction that omits much of the disclosed algorithm of the ’767 patent. APPLE-1046, 19-20; APPLE-1047, 10-14.

Regardless, the claims are unpatentable. Specifically, the claims are

demonstrated unpatentable in Grounds 2A-2B that apply a means-plus-function interpretation of the recited control component. As Grounds 2A-2B demonstrate how the prior art addresses the claims according to the narrower means-plus-function interpretation, Grounds 2A-2B likewise address each element of the claim according under plain and ordinary meaning. And, the claims are demonstrated unpatentable in Grounds 1A-1C, as well as 2A-2B, that apply the plain and ordinary meaning interpretation and Patent Owner's alternative means-plus function construction based on Grounds 1A-1C.

V. DETAILED EXPLANATION OF GROUNDS

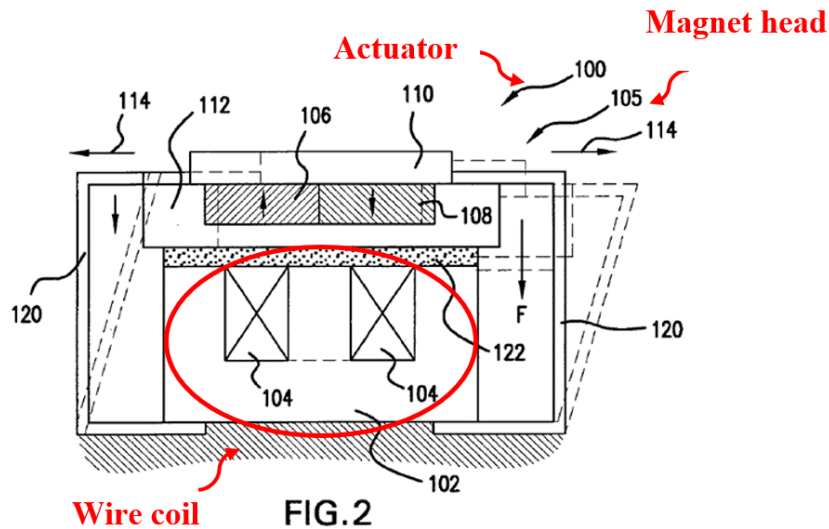
A. GROUND 1A: Shahoian-Cosper renders obvious claim 1 (plain and ordinary meaning)

Under the plain and ordinary meaning of “control component,” and Resonant's means-plus-function interpretation, claim 1 is obvious based on the Shahoian-Cosper combination. APPLE-1003, ¶¶107-137.

1. Shahoian

Shahoian describes a “force feedback interface device” having a “linear actuator” that includes a moving magnet. APPLE-1004, Abstract; 2:1-3:2; 3:9-10; 3:21-5:39; 6:3-7:63. The actuator of the “force feedback interface device” is used to provide haptic feedback to a user (e.g., as part of a “handheld game device or computer”). APPLE-1004, 6:3-6. The actuator includes a “wire coil 104” and a moveable “magnet head 105,” which consists of two magnets 106 and 108.

APPLE-1004, 3:9-10, 6:14-32, FIG. 2; *see also* FIGS. 1, 3-5; APPLE-1003, ¶¶72-80.



APPLE-1003, ¶73 (APPLE-1004, FIG. 2 (annotated)).

A “local microprocessor” executing software instructions provides the actuator with a drive waveform, which generates bi-directional linear movement of the magnet head. APPLE-1004, 7:29-53; *see also* 4:10-30; FIG. 1; APPLE-1003, ¶¶74-76. An H-bridge switch is used to provide the drive signal to the actuator, and facilitates switching of the signal. APPLE-1004, 7:46-53; APPLE-1003, ¶¶78-79. Input devices 39 (e.g., buttons) are used to provide additional commands to the microprocessor. APPLE-1004, 4:44-49; FIG. 1.

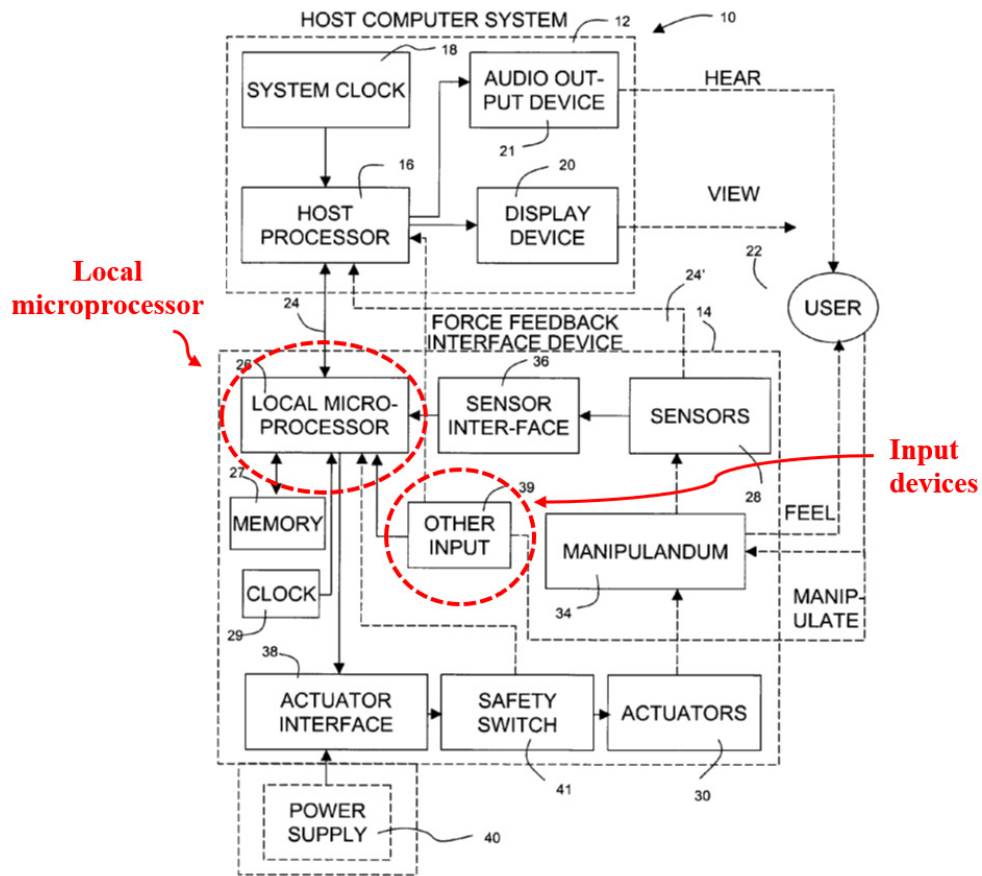


Figure 1

APPLE-1003, ¶75 (APPLE-1004, FIG. 1 (annotated)).

2. Cosper

Cosper describes a feedback control system for maintaining resonant oscillation of a linear actuator. APPLE-1009, [0049]-[0050]; FIG. 1; APPLE-1003, ¶¶81-82.

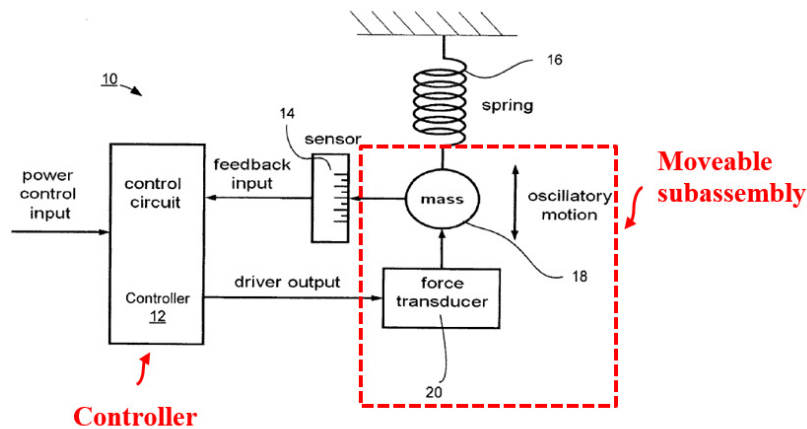


FIG. 1

APPLE-1003, ¶84 (APPLE-1009, FIG. 1 (annotated)).

A controller utilizes a combination of control logic, hardware, and software to drive and maintain the moveable subassembly at or near resonance. *Id.*;

APPLE-1003, ¶¶81-84. Multiple sensors are included to monitor parameters of the moving mass and provide data to the control circuit, including sensors configured to measure position, velocity, and/or acceleration, or other related data of the moving mass. APPLE-1009, [0050] (“detect position, velocity, acceleration, etc. for the subassembly” or “load or driving force applied”); [0054]; [0058]; [0069]; [0125]; [0127]; cls. 1-2, 7, 12, 17, 23, 28; Abstract (“position or motion”); APPLE-1003, ¶¶85-88. “Feedback on the position, velocity, and/or acceleration of the mass” is input to the controller, and the controller processes the feedback signal and generate drive signals “to maintain mechanical oscillation at the mechanical resonant frequency of the system.” *Id.*, [0008]-[0010]; *Id.*

3. Predictable Shahoian-Cosper Combination

A POSITA would have been motivated to implement a feedback control system, in accordance with Cosper, in Shahoian's "linear actuator" module to achieve known benefits. APPLE-1003, ¶¶108-115. Shahoian's actuator outputs vibrations having amplitude and frequency controlled by a microprocessor. *See*, APPLE-1004, 7:29-54. Similar prior art systems, such as Cosper, demonstrated the conventional knowledge of using a feedback system to precisely monitor and control vibrations of the actuator. *Id.*

In the resulting system, Shahoian's module that provides haptic feedback would have included multiple sensors, such as sensors that "detect position, velocity, acceleration, etc.," or a "load or driving force," respectively, in accordance with Cosper. APPLE-1003, ¶¶109-110; APPLE-1009, [0049]-[0050]. The sensors would monitor the moving mass of the actuator during operation, and communicate detected sensor data to the microprocessor, which would in turn adjust a control signal to drive the actuator, thereby facilitating vibration according to desired characteristics. *Id.*

Moreover, Cosper specifically describes common user device features, such as an "on/off" switch for "controlling the power to the control logic/control circuit 12," and a user input for adjusting a "mode" of operation, which would have been beneficially implemented in the combined system. APPLE-1009, [0053], [0106].

Multiple reasons would have prompted a POSITA to implement feedback control and user-input features in Shahoian's actuator in accordance with Cosper's suggestions. APPLE-1003, ¶¶108-115.

First, a POSITA would have been motivated to combine Shahoian with Cosper's suggestions for continuous feedback control to achieve the benefit of enhancing the vibration performance of Shahoian's actuator. Shahoian describes that a drive waveform, provided by a microprocessor, is used to cause the actuator to produce a specific vibration output. APPLE-1004, 6:40-44; 7:29-53; APPLE-1003, ¶111. A POSITA would have predictably looked to other teachings such as Cosper in order to implement and further this objective, especially where Cosper expressly describes driving an oscillating assembly based on feedback (e.g., to achieve a particular oscillation frequency, such as resonant frequency). APPLE-1009, Abstract; [0050]-[0052].

Second, a POSITA would have been motivated to combine Shahoian and Cosper to achieve the benefit of monitoring the real-time movement of the actuator with a high level of resolution using multiple sensors, thereby enhancing the ability to output vibration according to particular parameters while rendering the vibrational output less susceptible to external influences (e.g., such as external forces on the device). APPLE-1003, ¶112. A POSITA would have recognized, based on Cosper's description, that including sensors to monitor aspects of position

and/or movement of the mass during operation (e.g., that detect “position,” “velocity,” “acceleration”, and/or “load”/“driving” force), would facilitate characterization of movement of the mass with a high degree of accuracy in real-time. *Id.*; APPLE-1009, [0050]. Indeed, Cosper discloses that “[a]ny appropriate sensor may be used (e.g., optical, magnetic, capacitive, etc.)” to “detect any appropriate parameter that may correlate to the position of the subassembly,” and “one or more sensors 14 may detect position, velocity, acceleration, etc. for the subassembly (e.g., of bias 16 and/or mass 18).” *Id.* A POSITA would have also recognized that the feedback control in accordance with Cosper would have facilitated preferred sensations for the user (e.g., even when external forces may be acting on the device). APPLE-1003, ¶112.

Third, a POSITA would have found it obvious to modify Shahoian’s vibrational system to include user inputs to facilitate device operation, in accordance with Cosper. APPLE-1009, [0053] (“on/off switch,” “a control for increasing the oscillation rate,” “any other appropriate control.”). For example, a POSITA would have been prompted to modify Shahoian’s vibrational system to include an “on/off switch” as a user input to the “microprocessor” in order to provide a user power control. APPLE-1009, [0106] (“a user control (e.g., switch, dial, button, etc.) may be present on the outside of the housing. A power switch may be provided to turn the device “on” or “off””). The power button would have

been an obvious implementation choice that beneficially provides the user with control over operation of the device, and to selectively deliver power based on the user input. APPLE-1003, ¶114. Likewise, a POSITA would have been prompted to include a “user control” to adjust an operational state or “mode,” in accordance with Cosper, to facilitate user selection/customization of the vibration output. *Id.* Indeed, this is especially the case where Shahoian refers to “input devices,” but does not expressly provide all implementation details. *Id.* (citing APPLE-1004, 4:44-44; 5:26-39). A POSITA would have predictably looked to user inputs of Cosper to implement user inputs that enhance the system by facilitating further user control. *Id.*

This evidence is consistent with the law, which confirms that a POSITA would have been prompted to combine Shahoian and Cosper when doing so was the application of known techniques (Cosper’s use of “feedback input” from more than one sensor, and “user input”) to a known system (Shahoian’s linear actuator module) ready for improvement to yield predictable results (benefits articulated above). *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007) (“[W]hen a patent ‘simply arranges old elements with each performing the same function it had been known to perform’ and yields no more than one would expect from such an arrangement, the combination is obvious.”). A POSITA would have had a reasonable expectation of success in making the proposed modifications, especially

based on the similarity of the resonant system architectures in Shahoian and Cosper. APPLE-1004, 7:54-63; APPLE-1009, [0049], [0053]-[0055]; APPLE-1003, ¶¶114-115. Indeed, use of feedback control in haptic systems such as that described by Shahoian were known and predictably implemented. APPLE-1003, ¶115 (citing APPLE-1007, 1:39-47).

4. Application to Challenged Claims

[1.P] A linear resonant vibration module comprising:

The Shahoian-Cosper combination includes an LRVM (the combination of local microprocessor 26, actuators 30, and actuator interface 38, alone or together with power supply 40). APPLE-1003, ¶¶116-117; APPLE-1004, 4:10-24. The actuator includes “a linear moving magnet actuator for providing haptic feedback.” APPLE-1004, Title; Abstract; FIG. 2.

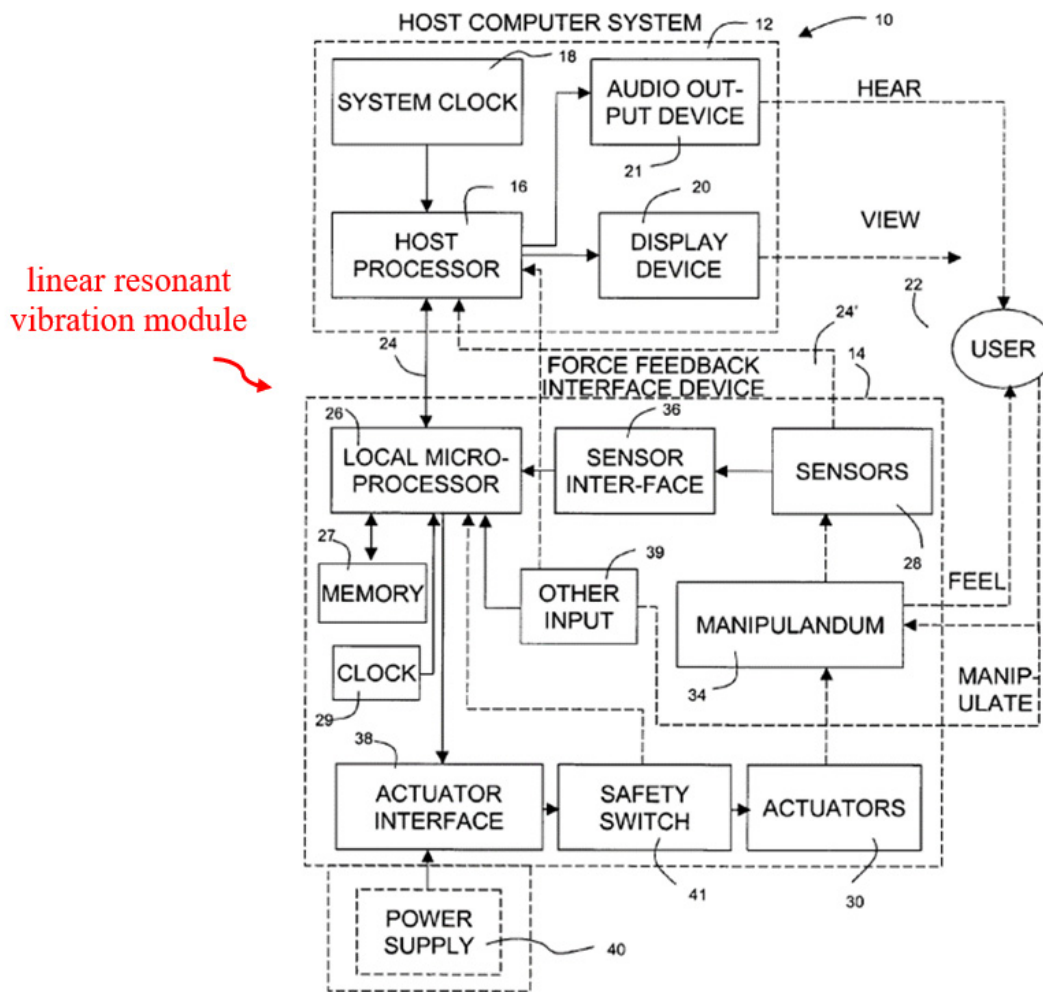


Figure 1

APPLE-1003, ¶117 (APPLE-1004, FIG. 1). The interface device and its components, are part of a system that includes, for example, a “handheld game device or computer,” or other system. APPLE-1004, 3:20-42 (“host computer system 12 can be . . . a handheld game device or computer.”).

In the combined system, the actuator can be controlled to produce periodic motion in alternately opposite directions across a single axis at a resonant

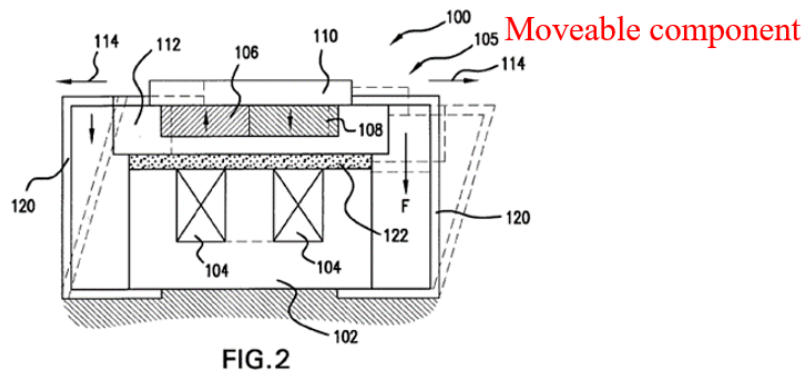
frequency. APPLE-1003, ¶¶117-118; *supra*, §V.A.3 (Shahoian-Cosper combination); *infra*, Analysis of [1.4]-[1.6].

[1.1] a housing;

The combination's LRVM includes a "housing" (Shahoian's "housing of the actuator"). *See, e.g.*, APPLE-1004, 2:51-52 ("[t]he flexible members can also be coupled to a housing of the actuator as the ground surface."); cl. 6; APPLE-1003, ¶119.

[1.2] a moveable component;

The combination's LRVM includes a moveable component (Shahoian's movable "magnet head"). APPLE-1003, ¶120.



APPLE-1003, ¶120 (APPLE-1004, FIG. 2. (annotated)); APPLE-1004, 2:3-5 ("magnet head" that is "moved in a degree of freedom based on an electromagnetic force caused by a current flowed through the coil."), 6:14-35 ("moving-magnet actuator"); 6:62-7:16 ("move in its linear degree of freedom"); 7:29-53.

[1.3] a power supply;

The combination's LRVM includes a power supply (Shahoian's "actuator interface 38," alone or together with "power supply 40"). APPLE-1003, ¶121. The "[p]ower supply 40" is "coupled to actuator interface 38 and/or actuators 30 to provide electrical power," via the "actuator interface." APPLE-1004, 5:35-37.

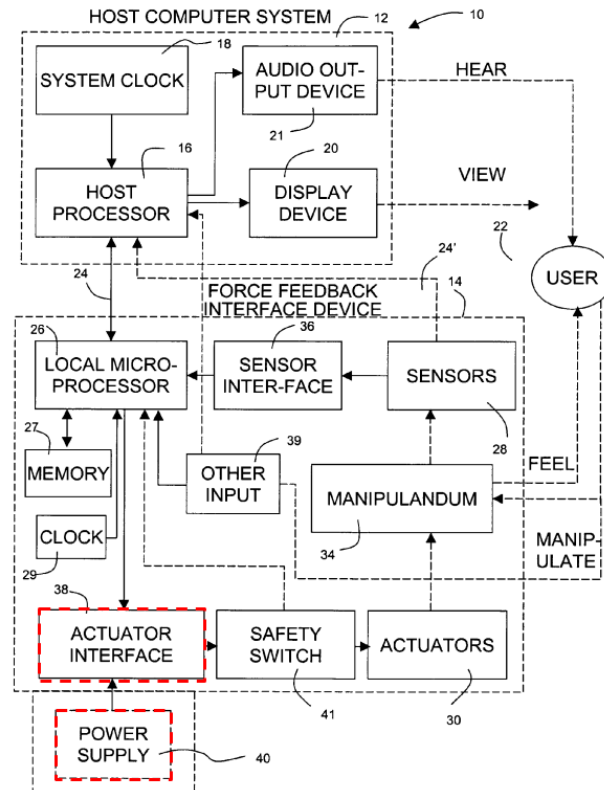


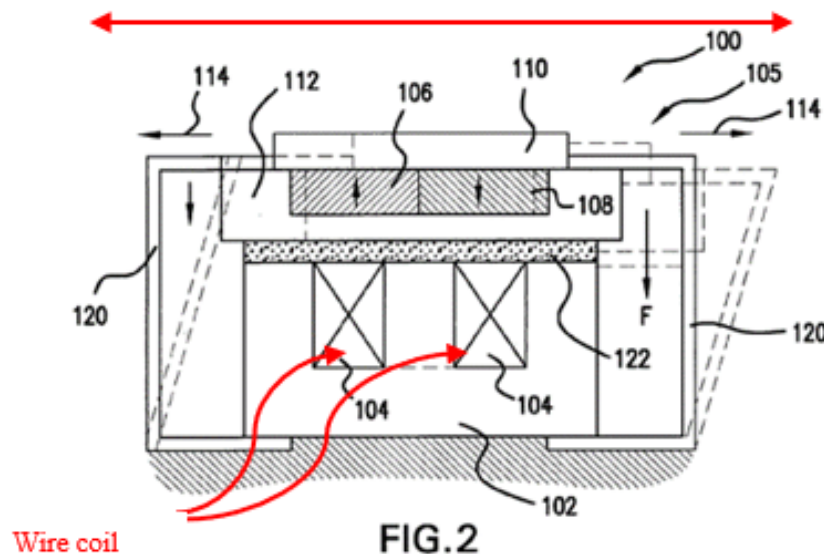
Figure 1

APPLE-1003, ¶121 (APPLE-1004, FIG. 1. (annotated)).

[1.4] a driving component that drives the moveable component in each of two opposite directions;

The combination's LRVM includes a driving component (Shahoian's "wire coil" with oscillating current) that drives the moveable component (Shahoian's movable "magnet head") in each of two opposite directions. APPLE-1003, ¶¶122-

123. For example, Shahoian's wire coil 104 drives the movable "magnet head" in each of two opposite directions based on direction of current through the wire coil. *Id.* "The actuator 100 operates by producing a force on the magnet head 105 in the linear directions indicated by arrows 114 when a current is flowed through the coil 104." APPLE-1004, 6:26-28.



APPLE-1003, ¶122 (APPLE-1004, FIG. 2 (annotated)).

To be clear, the combination includes a driving component according to the means-plus-function interpretation. *Supra*, IV.A.1. Shahoian's "wire coil" is positioned to generate a magnetic field that acts on the movable magnet, driving the movable magnetic weight bi-directionally, like the coil recited by the '767 patent. APPLE-1004, Abstract ("The magnet head is moved in a degree of freedom based on an electromagnetic force caused by a current flowed through the

coil.”), 2:15-17, 2:34-41, 6:14-25; APPLE-1001, 4:44-60, Figures 4A-4G; *see also* 5:25-37, 5:49-6:14; 9:7-20, 9:33-45, FIGS. 5A-5B (“coil 514”), FIG. 6 (“coil 626”), FIGS. 10-11 (“electromagnet”), FIG. 13 (“coils 1302 and 1304”), FIG. 14 (“driving coils 1412 and 1414”), FIGS. 15-17 (“coil 1510”).

[1.5.1] a control component that includes a microprocessor and that controls supply of power from the power supply to the driving component to cause the moveable component to linearly oscillate, the control component including, in addition to the microprocessor,

The combination’s LRVM includes a control component that includes a microprocessor (Shahoian’s “local microprocessor”) programmed to execute a vibration control program (Shahoian’s “software instructions” modified in accordance with Cosper (*infra*, Ground 1A, Analysis of Element [1.5.2])), and a switch (Shahoian’s H-bridge switch (*infra*, Ground 1A, Analysis of Element [1.5.3])). *Supra*, V.A.3 (Shahoian-Cosper combination). APPLE-1003, ¶¶124-135, ¶¶108-115.

The control component controls supply of power from the power supply (Shahoian’s “actuator interface 38” alone or together with “power supply 40”) to the driving component (Shahoian’s “wire coil” with oscillating polarity current) to cause the moveable component (Shahoian’s “magnet head”) to linearly oscillate. APPLE-1003, ¶125; APPLE-1004, 4:16-20, 7:46-53; FIG. 1 (illustrating control of the “actuator interface” by the “microprocessor”). For example, Shahoian

describes controlling the supply of power to the driving component via an “H-bridge” switch circuit, which is a “well-known” (APPLE-1004, 7:48-54) circuit that controls power to the “wire coil” in alternating directions to drive the moveable magnet head. *Id.* Indeed, Figure 1 of Shahoian illustrates control of the “actuator interface” by the “local microprocessor.” APPLE-1003, ¶125 (describing Shahoian’s FIG. 1 that includes control signal from local microprocessor to actuator interface, and associated description that the microprocessor controls the actuator interface to drive the actuator).

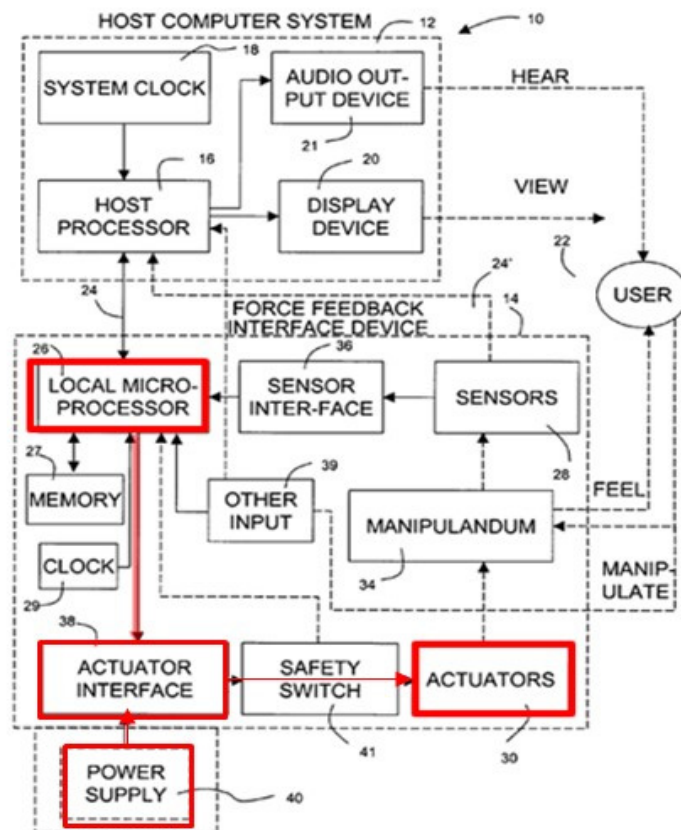


Figure 1

APPLE-1003, ¶125 (APPLE-1004, FIG. 1 (annotated)). The “H-bridge” switch receives power and applies current in both directions to the wire coil based on the control signals from the “microprocessor.” *Id.*; *infra*, Ground 1A, Analysis of [1.5.3].

To be clear, Shahoian expressly describes that the “microprocessor” (e.g., local microprocessor 26”) is provided with “software instructions” and controls “input and output signals,” and that the “drive waveform” is “supplied by the local microprocessor 26,” further confirming that the “microprocessor” controls supply of power from the power supply through control signals output by the “microprocessor” to control the direction of current and/or magnitude through the wire coil (via the “H-bridge” switch). APPLE-1004, 4:16-30 (“reading sensor signals and calculating appropriate forces”); *see also* 4:46-53; 4:56-61; 5:4-6 (“actuators 30 transmit forces . . . in response to signals received from microprocessor.”); APPLE-1003, ¶126.

[1.5.2] a control program, stored in one of a separated electronic memory or within the processor, that is executed by the microprocessor to control operation of the linear resonant vibration module,

The combination’s LRVM includes a control program (Shahoian’s “software instructions” modified in accordance with Cosper), stored in a separated electronic memory (Shahoian’s local memory 27), that is executed by the microprocessor (Shahoian’s “local microprocessor”) to control operation of the LRVM. APPLE-

1003, ¶127; APPLE-1004, 4:10-24 (“[m]icroprocessor 26 can be provided with software instructions to . . . handle/control input and output signals.”); 4:49-54 (“Local memory 27, such as RAM and/or ROM, can be coupled to microprocessor 26 in interface device 14 to store instructions for microprocessor 26 and store temporary and other data (and/or registers of the microprocessor 26 can store data).”). In the combined system, the “local microprocessor” executes the software instructions to control operation of the LRVM based on the feedback system, in accordance with Cospers. APPLE-1003, ¶¶127-128.

To be clear, the control component of the combined system includes a control program that receives the value of an output signal (e.g., from a respective sensor in accordance with Cospers), compares that value to a different value (e.g., associated with a “set-point”), and adjusts one or more operational control outputs based on that comparison, in accordance with Cospers’s description of maintaining oscillation at a resonant frequency. APPLE-1009, Abstract, [0009]-[0010], [0011], [0050], [0055], [0057]-[0058]; APPLE-1003, ¶127; *infra*, Ground 1A, Analysis of Element [1.6].

[1.5.3] a switch that receives a directional signal d from the processor and that selects a corresponding direction of the two opposite directions in which the driving component drives the moveable component;

The combination’s LRVM includes a switch (“H-bridge circuit”). APPLE-1003, ¶129; APPLE-1004, 4:46-53 (“The drive signal can be supplied by a well-

known H-bridge circuit or other amplifier circuit, as also disclosed in co-pending application no. 09/608,125 . . . which is incorporated by reference herein.”); 7:29-53 (“bi-directional mode”); APPLE-1037, 13:24-14:18. The “H-bridge circuit” receives a directional signal d (each control signal input to each transistor 52, 54, 56, 58) from the processor (Shahoian’s “local microprocessor”) and selects a corresponding direction of the two opposite directions in which the driving component (Shahoian’s “wire coil”) drives the movable component (Shahoian’s “magnet head”). *Id.*; APPLE-1003, ¶¶130-135.

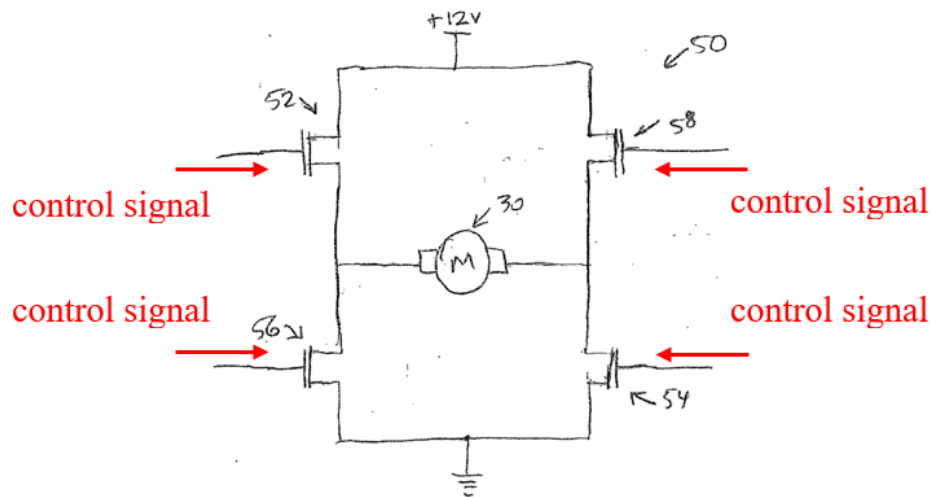


Fig. 5a

APPLE-1003, ¶129 (APPLE-1037, FIG. 5A (annotated)).

Each control signal input to each transistor (*e.g.*, the control signal input to input to transistor 52) is a directional signal d. APPLE-1003, ¶¶129-130. The

control signals control whether the transistors are open or closed, which affects the direction of voltage/current through the actuator load. *Id.*

When transistors 52 and 54 are open and transistors 56 and 58 are closed, the current flows through the coil in a first direction. *Id.* Similarly, when transistors 56 and 58 are open and transistors 52 and 54 are closed, the current flows through the coil in a second direction. *Id.*

The switch receives the control signals (*e.g.*, the control signal input to transistor 52) from the microprocessor. For example, the H-bridge switch is included as part of the “actuator interface,” which is “connected between actuators 30 and microprocessor 26 to convert signals from microprocessor 26 into signals appropriate to drive actuators 30,” and Shahoian expressly describes that the “microprocessor” functions to “provide signals to actuators 30,” confirming the switch receives the transistor control signals from the “microprocessor.” APPLE-1004, 4:31-39; *see also* 4:19 (“output signals”); 5:4-10 (“signals received from microprocessor 26”); APPLE-1003, ¶¶130-132.

A POSITA also would have found it obvious, based on Shahoian’s description, to control the switch using the control signal from the microprocessor. APPLE-1003, ¶131. Indeed, Shahoian describes that the microprocessor outputs control signals to control the actuator, and that the microprocessor provides these signals as input to the H-bridge. APPLE-1004, 4:19-39; 5:4-10 (“signals received

from microprocessor 26”). A POSITA would have been motivated to control Shahoian’s H-bridge switch using control signals from the microprocessor to efficiently control the drive direction. APPLE-1003, ¶¶131-134. Doing so would have effectively utilized Shahoian’s existing microprocessor to carry out the task of outputting control signals received by the switch. Moreover, a POSITA would have had a reasonable expectation of success given that the “local microprocessor” outputs control signals for device operation, and generating appropriate control signals by the microprocessor would have been achieved largely through software implementation. *Id.*

[1.6] the control component receiving output signals from sensors within the linear resonant vibration module during operation of the linear resonant vibration module and adjusting one or more operational control outputs of the control component according to the received output signals from the sensors in order that subsequent operation of linear resonant vibration module produces desired outputs³ from the one or more sensors⁴ corresponding to one or more operational control parameters.

³ The term “desired” is ambiguous and renders claim 1 indefinite. Yet, unpatentability of claim 1 can be determined here, because the prior art expressly describes such features in its feedback control system. APPLE-1003,

¶137.

⁴ The term “the one or more sensors” lacks antecedent basis. Petitioner has

The “microprocessor” of the combination’s control component receives output signals from multiple sensors (*e.g.*, sensors that detect “position” and “velocity,” in accordance with Cosper) within the LRVM during operation of the LRVM. APPLE-1009, [0050]. The “microprocessor” adjusts one or more operational control outputs (including H-bridge transistor control signals and power supply control signals) of the control component according to the received sensor output signals from the sensors in order that subsequent operation of the LRVM produces desired outputs (position and/or velocity measurements) from the one or more sensors corresponding to one or more operational control parameters, such as amplitude and/or frequency (“desired amplitude set-point” and/or “desired frequency set-point”). APPLE-1003, ¶¶136-137; APPLE-1009, Abstract; [0009]-[0010]; [0011] (“maintains the amplitude of oscillation of the subassembly at a desired amplitude set-point” and “desired frequency set-point”); [0055] (“desired amplitude set-point” and “desired frequency set-point”); [0050]; *supra*, §V.A.3 (Shahoian-Cosper combination). Control signals to the H-bridge’s transistors are

made a best effort to interpret the claim for the present proceeding, but reserves the right to raise the issue of indefiniteness in other proceedings involving the ’767 patent.

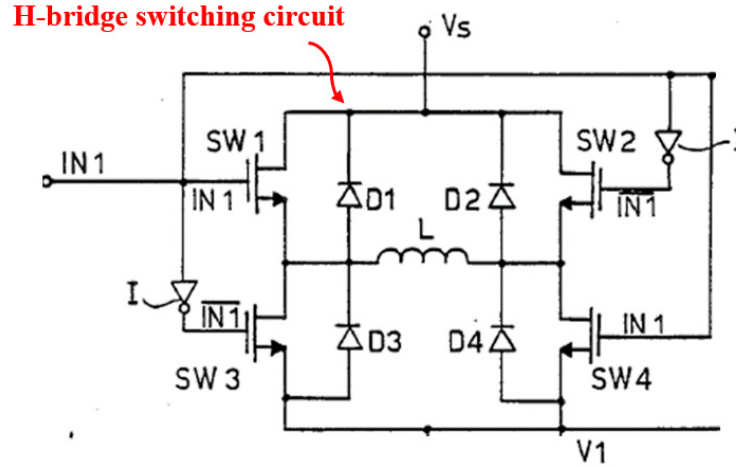
adjusted to change the driving frequency over time to maintain oscillation “at or near a resonant frequency.” *Id.*; APPLE-1009, Abstract; [0057]-[0058].

B. GROUND 1B: Shahoian-Cosper-Rossi renders obvious claims 1-4 (plain and ordinary meaning)

Under the plain and ordinary meaning of “control component,” and Resonant’s means-plus-function interpretation, claims 1-4 are obvious based on the Shahoian-Cosper-Rossi combination. APPLE-1003, ¶¶138-160. Claim 1 is yet again addressed in Ground 1B, as Rossi further informs Element [1.5.3], as discussed below.

1. Rossi

Rossi describes an H-bridge switching circuit that includes “two pairs of analog switches arranged in a bridge configuration.” APPLE-1020, Abstract; 1:65-3:55; APPLE, ¶¶89-92. The H-bridge switch includes a “driving signal IN1” input. *Id.*; *see also*, 1:8-47; 2:50-3:55. The “driving signal IN1” is split, and a portion passed through an “inverter I” to generate an internal “driving signal IN1” and an “inverted signal thereof $\overline{\text{IN1}}$.” *Id.*, 1:65-2:11; 3:43-55; FIGS. 4, 6; cls. 1, 3, 4.



APPLE-1003, ¶91 (APPLE-1020, FIG. 6. (partial, annotated)).

2. Predictable Shahoian-Cosper-Rossi Combination

Shahoian teaches use of a “well-known H-bridge circuit” to supply a drive signal to the actuator. APPLE-1004, 7:47-50; APPLE-1037⁵, 4:1-11; 12:29-14:18;

⁵ The contents of App. No. 09/608,125 (APPLE-1037) is “effectively part of [Shahoian] as if [it] were explicitly contained therein.” *Arbutus Biopharma Corp. v. ModernaTX*, 65 F.4th 656, 662-63 (Fed. Cir. 2023) (internal quotations and citation omitted). *Advanced Display Sys., v. Kent State Univ.*, 212 F.3d 1272, 1282 (Fed. Cir. 2000) (“effectively part of the host document as if [they] were explicitly contained therein.”). The ’125 application is the parent of App. No. 10/949,467, which published as U.S. Patent Publication No. 2005/0219206 (APPLE-1022).

FIG. 5A. APPLE-1003, ¶80. Rossi demonstrates the conventional knowledge of implementing an H-bridge switch to provide oscillating force. *See, e.g.* APPLE-1020, 1:65-2:11, 3:43-55, FIGS. 4, 6; APPLE-1003, ¶68.

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, that receives the control signal from the microprocessor, in accordance with Shahoian-Cosper's feedback control. APPLE-1003, ¶¶139-140. Such a configuration would have yielded the predictable result of oscillating the Shahoian actuator's magnet by switching the polarity of drive signals generated based on Cosper's feedback control suggestions. *Id.*

Multiple reasons would have prompted a POSITA to implement an H-bridge circuit, in accordance with Rossi's suggestions, in the Shahoian-Cosper system. APPLE-1003, ¶¶141-144.

First, a POSITA would have predictably looked toward other references, such as Rossi, for implementation details of an H-bridge switch, to further Shahoian's stated objectives. APPLE-1004, 7:47-50 (describing use of "a well-known H-bridge circuit"); APPLE-1037, 13:26-35; APPLE-1003, ¶142. Rossi plainly demonstrates a well-known H-bridge that receives as input a drive signal ("IN1"), which is then split and one branch inverted to generate complementary

internal signals. APPLE-1020, Abstract, 1:65-2:49; 2:56-3:54; FIGS. 4, 6. A POSITA would have recognized the benefits from Rossi's straightforward teachings of providing complementary drive signals via a splitter/inverter configuration for respective sets of the four H-bridge transistors, such that current/voltage is applied in one of two opposite directions through the coil. APPLE-1003, ¶142. Rossi expressly indicates the predictable benefit of a configuration that is effective to "functionally switch the load L between the supply node V_s , and virtual ground nodes" using splitters/inverters in hardware to provide complementary internal drive signals, thereby reliably driving the movable magnet head of the actuator. APPLE-1020, 2:4-12. Rossi thus provided an example of a suitable switch technique that a POSITA would have readily implemented in Shahoian's system. APPLE-1003, ¶142. Moreover, a POSITA would have recognized from Rossi the conventional use of diodes (D1-D4) across each transistor, further enhancing reliability by protecting the transistors from potential high voltage transients arising from the coil. *Id.*

Second, a POSITA would have been motivated to combine Shahoian-Cosper and Rossi to avail the system of a simple and reliable circuit design. APPLE-1003, ¶143. A POSITA would have recognized, from Rossi's description, the benefits of controlling the four transistors of the H-bridge using a control signal from the microprocessor that is split and inverted by hardware (the H-bridge switch circuit).

Id. Doing so reliably results in complementary internal signals (IN1 and $\overline{\text{IN1}}$), which would have promoted simplicity in the control signal generation and the circuit to deliver the drive signal to the coil. *Id.* For example, using a control signal from the microprocessor that is split and inverted by hardware reliably results in complementary internal signals (e.g., IN1 and $\overline{\text{IN1}}$) such that the corresponding transistors of the respective pairs reliably have complementary (e.g., inverse) signals to one another to facilitate current/voltage through the coil in one of the two opposed directions. *Id.* Such a configuration would have facilitated simplicity in the control signal generation, because a single control signal from the microprocessor can be input to the H-bridge switch circuit to control all four transistors in unison. *Id.* The H-bridge switch circuit in accordance with Rossi thus facilitates control of power to the wire coil, and oscillation of the movable magnet, using few output signals. *Id.*

Third, a POSITA would have been prompted to combine Rossi and Shahoian-Cosper because doing so was the application of a known technique (Rossi's implementation of an H-bridge switch circuit) to a known device (the primary Shahoian system that utilizes an H-bridge switch circuit) ready for improvement to yield predictable results (benefits articulated above). *KSR*, 550 U.S. at 417 (2007). Indeed, the modifications would have amounted to a simple substitution of one known H-bridge switch circuit for another. *Id.*; *see also Intel*

Corporation v. PACT XPP Schweiz AG, 61 F.4th 1373, 1381 (Fed. Cir. March 13, 2023) (reversing Board and finding that Petitioner “just had to show that [secondary reference’s feature] was a ‘suitable option’ to replace [primary reference’s feature],” and not that it was an “‘improvement’ in the categorical sense”).

A POSITA would have had a reasonable expectation of success in making the proposed modifications based on the similarity of the function of the H-Bridge switch circuit in Rossi and Shahoian-Cosper, and because the modifications would have been implemented largely through routine circuit design considerations and software instructions for generating the control signal. APPLE-1003, ¶144.

3. Application to Challenged Claims

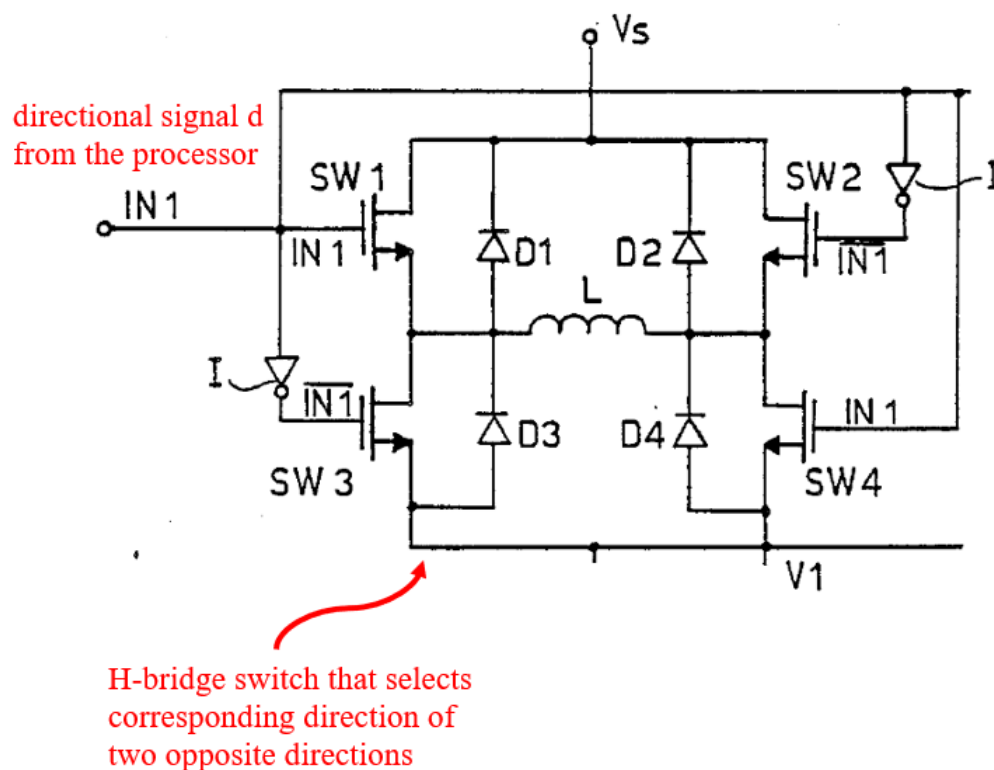
[1.P]-[1.5.2], [1.6]

See, supra, Ground 1A, Analysis of Elements [1.P]-[1.5.2], [1.6]; APPLE-1003, ¶¶117-137, ¶145.

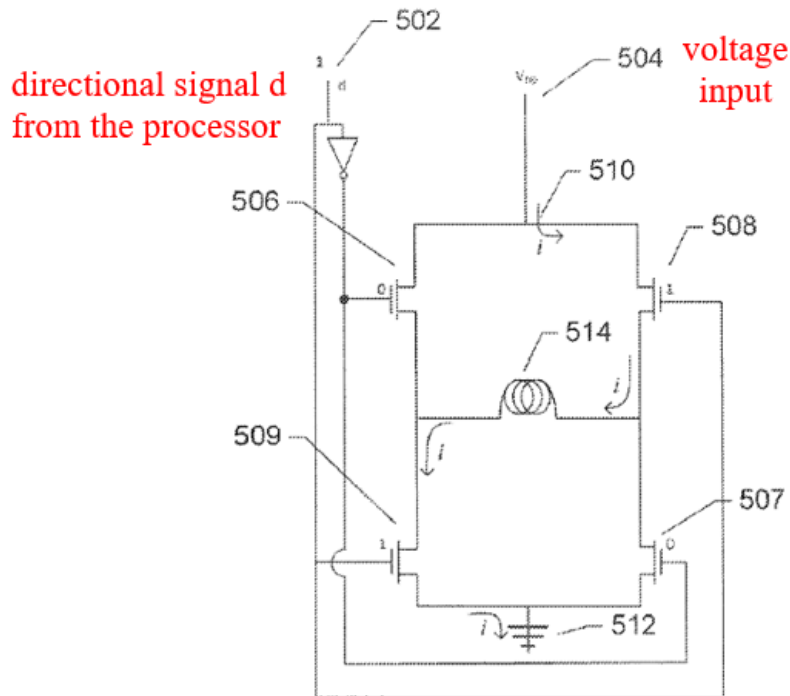
[1.5.3] a switch that receives a directional signal d from the processor and that selects a corresponding direction of the two opposite directions in which the driving component drives the moveable component;

The combination includes an H-bridge switch, in accordance with Rossi. *Supra*, §V.B.2 (Shahoian-Cosper-Rossi combination). The H-bridge switch receives a directional signal d (“IN1”) and selects a corresponding direction of the two opposite directions in which the driving component drives the moveable

component. APPLE-1020, 1:65-2:15; 3:44-55; *see also, infra*, Analysis of Element [2.3]; APPLE-1003, ¶¶146-148, ¶151. Rossi describes that the “two pairs of switches (namely SW1, SW4 and SW2, SW3) arranged in a bridge configuration functionally switch the load L between the supply node Vs, and virtual ground nodes,” dependent on the directions signal d received by the switch at “IN1.” *Id.*



APPLE-1003, ¶146 (APPLE-1020, FIG. 6 (partial, annotated)). The switch of the combined system, including a single directional signal d input and splitter/inverter features, in accordance with Rossi, is nearly identical to the H-bridge switch shown in the '767 patent:



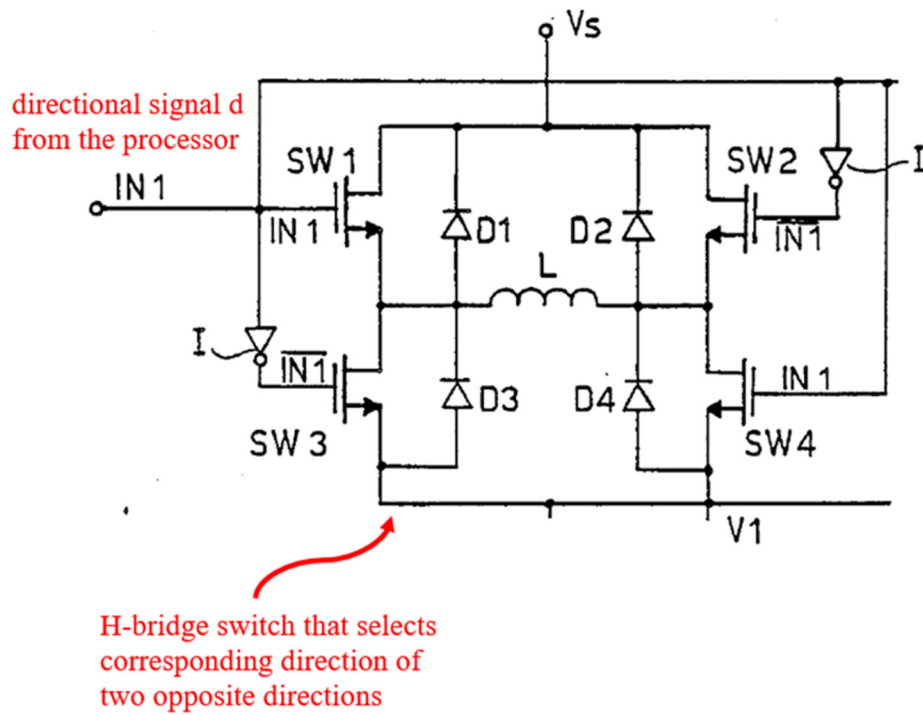
H-bridge switch that selects
corresponding direction of
two opposite directions

FIGURE 5A

APPLE-1003, ¶147 (APPLE-1001, FIG. 5A (annotated)).

[2.1] The linear resonant vibration module of claim 1 wherein the switch comprises: a directional-signal *d* input;

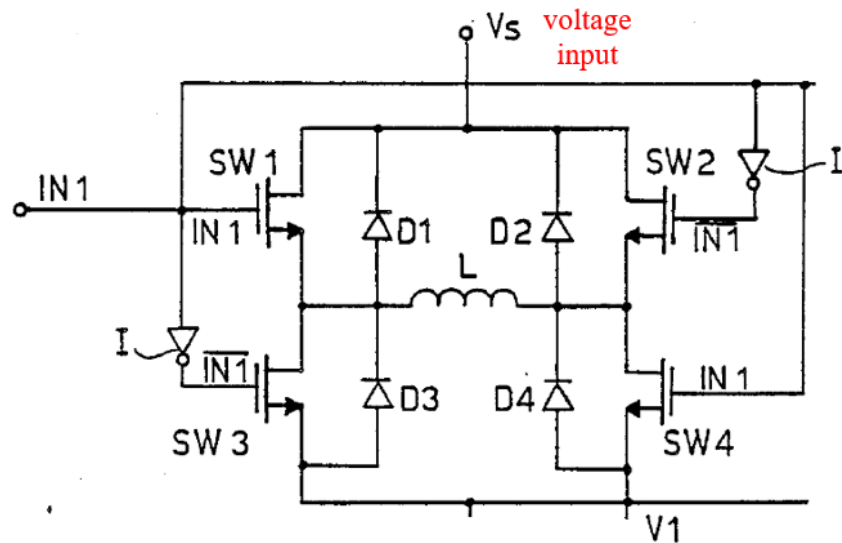
The Shahoian-Cosper-Rossi combination's switch includes a directional-signal *d* input ("driving signal IN1" node). APPLE-1003, ¶149; *supra*, §V.B.2 (Shahoian-Cosper-Rossi combination).



APPLE-1003, ¶149 (APPLE-1020, FIG. 6 (partial, annotated)).

[2.2] a voltage input;

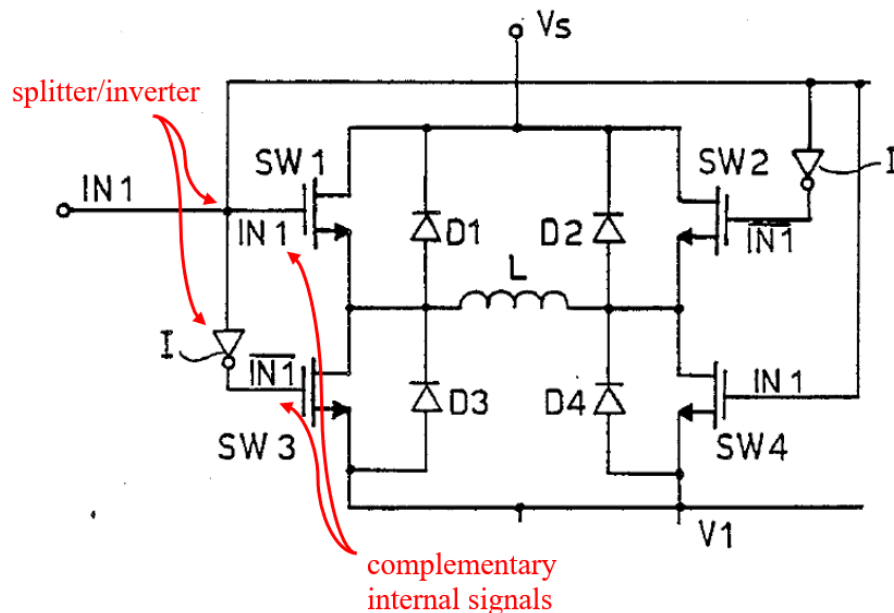
The Shahoian-Cosper-Rossi combination's switch includes a voltage input (voltage supply node " V_s " in accordance with Rossi). APPLE-1020, Abstract, 1:65-2:12; cls. 1, 3, FIGS. 4, 6.



APPLE-1003, ¶150 (APPLE-1020, FIG. 6 (annotated)).

[2.3] a directional-signal splitter/inverter that generates two complementary internal signals, d and $\bar{d}$, corresponding to directional-signal d ; and

The Shahoian-Cosper-Rossi combination's switch includes a directional-signal splitter (shown below)/inverter ("I") that generates two complementary internal signals, d ("driving signal IN1" after the splitter) and $\bar{d}$ ("driving signal $\overline{\text{IN1}}$."), corresponding to direction-signal d ("driving signal IN1" before the splitter). APPLE-1003, ¶151; *supra*, §V.B.2 (Shahoian-Cosper-Rossi combination). As described in Rossi, the "inverter I" inverts each split of the driving signal IN1 to generate the complementary internal signals. APPLE-1020, 1:65-2:2.



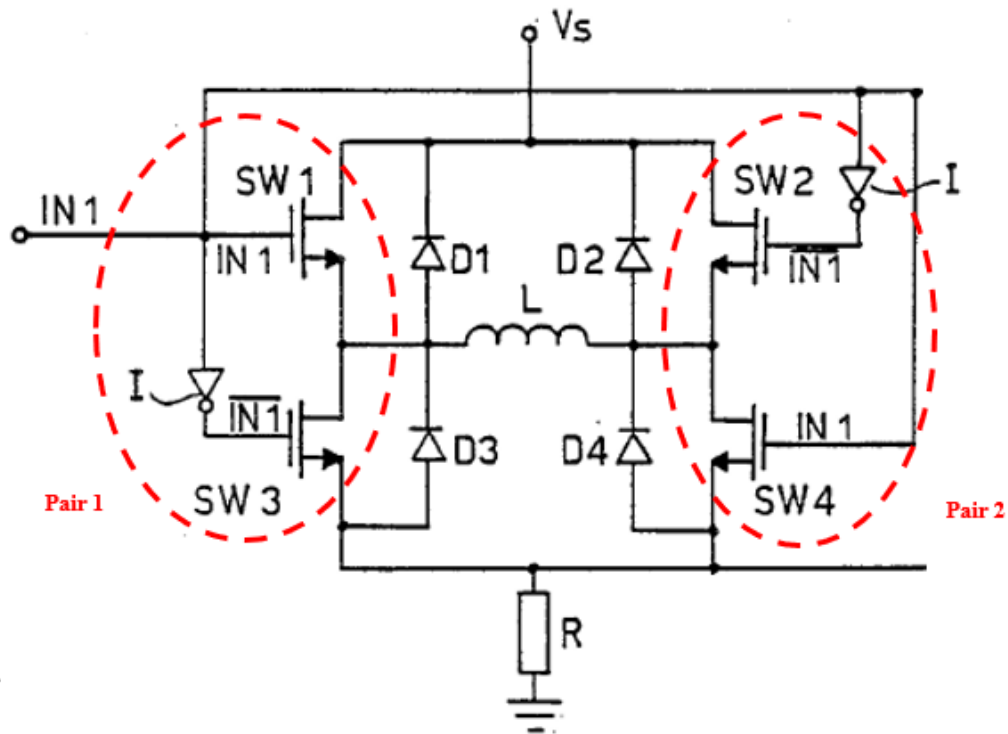
APPLE-1003, ¶151 (Rossi, FIG. 6 (partial, annotated)); *see also* 1:65-2:5 (switches “driven, respectively, by a driving signal IN1 and by the inverted signal thereof $\overline{IN1}$, the latter being obtained by means of an inverter I.”).

[2.4] two pairs of solid-state switches, a first switch of each pair controlled by internal signal d and a second switch of the pair controlled by internal signal $\bar{d}$, that apply the input voltage in a first direction to the driving component when the d^6 is in a first voltage state and that apply the input voltage in a second direction to the driving component when the d is in a second voltage state.

⁶ This term (“the d ”) is indefinite. Antecedent basis is unclear because the claims recites two d ’s (“directional-signal d ” and “internal signal d ”). Petitioner has made a best effort to interpret the claim for the present proceeding, but reserves the right to raise the issue of indefiniteness in other proceedings involving the ’767 patent.

The Shahoian-Cosper-Rossi combination's switch includes two pairs of solid-state switches (transistors "SW1," "SW2," "SW3," "SW4"). *Supra*, §V.B.2 (Shahoian-Cosper-Rossi combination); APPLE-1004, 4:46-53; APPLE-1037, FIG. 5A; APPLE-1020, 3:43-55; APPLE-1003, ¶¶152-157 (explaining transistors described by Rossi are solid-state switches). The first pair of switches is SW1 and SW3. *Id.* The second pair of switches is SW2 and SW4. *Id.*

A first switch ("SW1 and SW4") of each pair is controlled by internal signal $\bar{d}$ ("input signal IN1" after the splitter) and a second switch ("SW2 and SW3") of each pair is controlled by internal signal $\bar{d}$ ("inverted signal $\overline{IN1}$ "). APPLE-1020, 1:65- 2:2 ("four switches: SW1, SW4 and SW2, SW3; driven, respectively, by a driving signal INI and by the inverted signal thereof $\overline{INI}$ ").



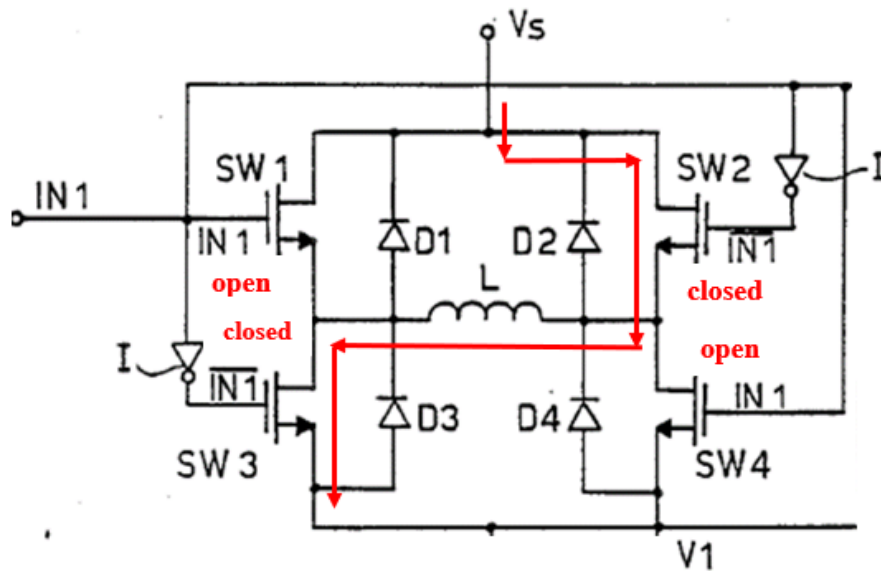
APPLE-1003, ¶153 (APPLE-1020, FIG. 6 (partial, annotated)).

The switches apply the input voltage (supply voltage “ V_s ”) in a first direction to the driving component (Shahoian’s electromagnet coil) when the directional-signal d (signal IN1 before the splitter) is in a first voltage state.

APPLE-1003, ¶154; APPLE-1020, 2:2-49; 2:50-3:55; FIG. 5 (“IN1”). The same is true when the internal signal d (driving signal IN1 after the splitter) is in the first voltage state. *Id.* Similarly, the switches apply the input voltage in a second direction to the driving component when the directional-signal d and the internal signal d are in a second voltage state. *Id.*

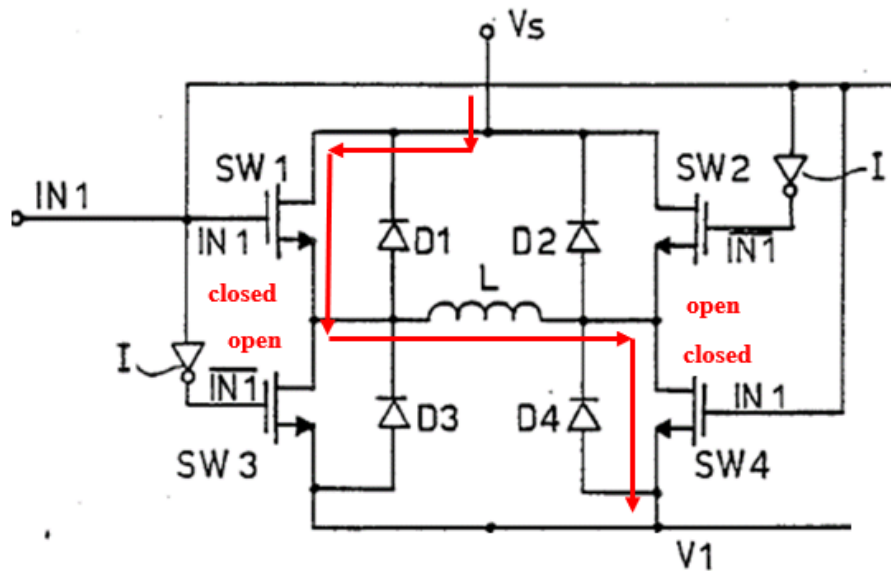
For example, the voltage state of the directional-signal d (“driving signal

IN1” before the splitter) controls whether the switches are open or closed. When the “IN1” is in a first voltage state, SW1 and SW4 are open while SW2 and SW3 are closed. APPLE-1020, 1:65-2:45; FIGS. 1, 4, 6; APPLE-1003, ¶155. The supply voltage is thus applied to the electromagnet (“L”) in a first direction.



APPLE-1003, ¶155 (APPLE-1020, FIG. 6 (partial, annotated)).

When the “IN1” is in a second voltage state, SW1 and SW4 are closed while SW2 and SW3 are open. The supply voltage is thus applied to the electromagnet (“L”) in a second direction.



APPLE-1003, ¶156 (APPLE-1020, FIG. 6 (partial, annotated)).

[3.1] The linear resonant vibration module of claim 2 wherein the linear resonant vibration module further includes a vibration sensor; and

The Shahoian-Cosper-Rossi combination's LRVM includes a vibration sensor (accelerometer) in addition to the sensors associated with "position" and "velocity" that are used as part of the feedback control. *Supra*, ¶V.A.3 (Shahoian-Cosper combination); Ground 1A, Analysis of Element [1.6]); APPLE-1003, ¶158. Like the accelerometer in the '767 patent, the accelerometer in the Shahoian-Cosper-Rossi LRVM provides information about vibration strength. APPLE-1001, 6:7-14 ("accelerometers.").

[3.2] wherein the control program continuously monitors output from the vibration sensor in order to adjust the frequency at which the control program changes the voltage state of the directional signal d.

The Shahoian-Cosper-Rossi combination's 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. *Supra*, Ground 1A, Analysis of Element [1.5.1]-[1.5.2], [1.6]; APPLE-1004, 5:21-53; APPLE-1003, ¶159. Like the control loop described in the '767 patent, the continuous control loop provided by the combined system “uses continuous feedback control to optimize the vibrational force produced by the LRVM by continuously seeking to operate the LRVM at a frequency as close as possible to the resonant frequency for the LRVM.” APPLE-1001, 7:9-14; APPLE-1009, [0010].

[4] The linear resonant vibration module of claim 2 wherein the control program receives user input from one or more input features, including one or more of buttons, dials, switches, and other user-input features.

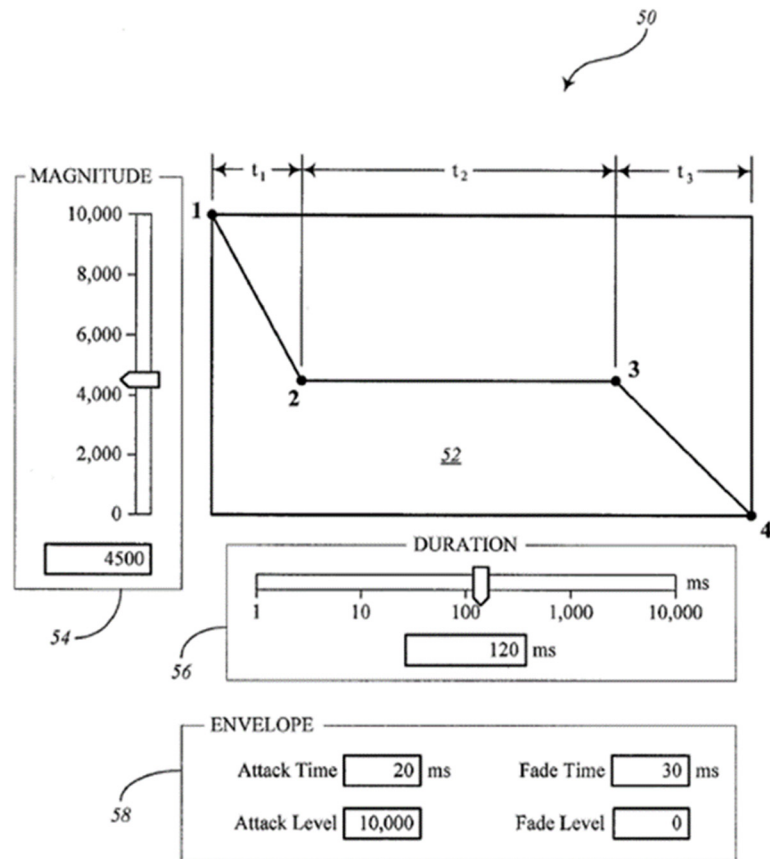
The Shahoian-Cosper-Rossi combination’s control program receives user input (commands) from one or more input features (Shahoian’s input device 39, which includes buttons and/or an on/off switch in accordance with Cosper). APPLE-1003, ¶160. For example, Shahoian’s microprocessor 26 “receive[s] commands from any other input devices 39 included on interface apparatus 14, such as buttons.” APPLE-1004, 4:44-49; 5:26-33. Cosper describes example user input features, including an “on/off switch,” which would have been advantageously implemented in the combined system. *Supra*, Ground 1A, Analysis of Element [1.5.2]; §V.A.3 (Shahoian-Cosper combination).

C. GROUND 1C: Shahoian-Cosper-Rossi-Ramsay renders obvious claim 5 (plain and ordinary meaning)

Under the plain and ordinary meaning of “control component,” and Resonant’s means-plus-function interpretation, claim 5 is obvious based on the Shahoian-Cosper-Rossi-Ramsay combination. APPLE-1003, ¶¶161-174.

1. Ramsay

Ramsay provides techniques for “enabling a regular user of an end user device, such as a cellular telephone, to customize parameters associated with haptic effects applied to the user by the end user device.” APPLE-1006, Abstract; APPLE-1003, ¶¶97-98. For example, “the user may access programmable haptic design software 30 via GUI 24.” APPLE-1006, [0032]. “[P]arameters or characteristics of a haptic output or haptic track” that are modifiable “include a frequency of vibration and amplitude of vibration. Also, the frequency and amplitude can be set to change over time.” APPLE-1006, [0030], [0033], [0035], [0046]; APPLE-1003, ¶¶99-101. By way of example, Figure 4 illustrates a “graphical user interface (GUI) 50” that includes a magnitude adjusting mechanism 54, duration adjusting mechanism 56, and an envelope adjusting mechanism 58.” APPLE-1006, [0053]. In addition, Ramsay can “enable[] the user to enter one or more frequencies for the haptic track or even continually changing frequencies to be played along the length of the haptic track.” *Id.*, [0046].



APPLE-1006, FIG. 4.

With Ramsay's system, users can have “the power to create customized haptic effects,” “similar to those available to a professional haptic designer.” APPLE-1006, [0015]. For example, users can not only create and modify haptic parameters such as “a frequency of vibration and amplitude of vibration” in each haptic track, but also “combine or mix different haptic tracks together if desired to provide a fuller haptic experience.” *Id.*, [0030]; APPLE-1003, ¶98. Ramsay can “allow[] the user to combine haptic tracks to play simultaneously, to overlap in time for a portion of the time, to play end-to-end, or even to start a subsequent

track after a short pause at the end of a first track.” APPLE-1006, [0047]. Further, users are enabled “to enter one or more frequencies for the haptic track or even continually changing frequencies to be played along the length of the haptic track.” APPLE-1006, [0037]; APPLE-1003, ¶101.

2. Predictable Shahoian-Cosper-Rossi-Ramsay Combination

A POSITA would have been motivated to combine user input/customization, in accordance with Ramsay, with Shahoian-Cosper-Rossi’s LRVM features, to avail the system of user input to modify vibration control parameters. APPLE-1003, ¶¶161-168. In the resulting system, the control software receives user input that allows a user to customize haptic feedback preferences (e.g., via a graphical user interface (GUI) or other input at the system, such as “display screen 20”), in accordance with Ramsay. APPLE-1006, [0015] (“allow a user to create and/or modify the parameters associated with haptic feedback on the target device itself through on-device means”). The memory in the Shahoian-Cosper-Rossi-Ramsay combination would store “a software program for enabling an end user to create and/or modify haptic effects, the software program of which can be executed by processor.” APPLE-1006, [0025], [0027]-[0028]; [0037]; APPLE-1003, ¶162.

Multiple reasons would have prompted a POSITA to implement user-selectable force feedback parameters, in accordance with Ramsay, into the Shahoian-Cosper-Rossi actuator system. APPLE-1003, ¶¶163-168.

First, a POSITA would have been motivated to combine Ramsay with Shahoian-Cosper-Rossi to enhance user interaction with a device by facilitating selection of vibration output according to a user's preferences. APPLE-1003, ¶164; APPLE-1004, 3:65-4:3. User input to customize force feedback would result in personalized settings preferred by a particular user or for a particular scenario. APPLE-1006, [0015], [0016]; [0020]; [0023]; [0030] ("For example, the modifiable parameters include a frequency of vibration and amplitude of vibration. Also the frequency and amplitude can be set to change over time"); APPLE-1003, ¶164 (describing scenarios that a user might select vibration output having a particular amplitude, frequency, etc.). Indeed, doing so would have expanded the functionalities of the Shahoian-Cosper-Rossi system, allowing the end user to freely create and customize haptic effects to their liking. APPLE-1003, ¶164; APPLE-1006, [0014]-[0015]. Ramsay's technique allows users to conveniently "create or modify the haptic effect files directly on the device." APPLE-1006, [0014]; APPLE-1003, ¶164. A POSITA would have recognized that the resulting system can benefit from Ramsay's GUI that displays haptic tracks and offers

various, easy-to-use mechanisms for adjusting haptic parameters. APPLE-1003, ¶164; APPLE-1006, [0053]-[0057].

Second, a POSITA would have been motivated to combine Ramsay with Shahoian-Cosper-Rossi so that the software receives user input that selects a strength of vibration and/or frequency that can be used to produce a wide range of user-distinguishable force feedback outputs. APPLE-1003, ¶165; APPLE-1004, 3:65-4:3, 5:4-11, 6:26-40. User inputs to set parameters for one or more different force feedback outputs would have facilitated generation of vibration outputs that are readily distinguishable to the user, enhancing the haptic function by effectively communicating a scenario/condition to the user. APPLE-1006, [0030] (“the user is able to combine or mix different haptic tracks together if desired to provide a fuller haptic experience. In this way, a user is capable of programming or customizing a haptic track or track mix to one’s liking.”), [0020], [0029].

Third, a POSITA would have been prompted to combine Shahoian-Cosper-Rossi with Ramsay because doing so was the application of known techniques (Ramsay’s user customization of parameters associated with haptic effects) to improve a similar system. *KSR*, 550 U.S. 417. A POSITA would have had a reasonable expectation of success in making the proposed modifications based on the similarity of the resonant systems described by Ramsay and the Shahoian-Cosper-Rossi system, and because the modifications would have been

implemented largely through routine software. APPLE-1003, ¶¶166-168. The combination would modify the Shahoian-Cosper-Rossi system only to the extent that it is necessary to implement Ramsay’s software tools, and the system would otherwise remain unchanged and perform its intended operations. APPLE-1003, ¶¶167-168. In fact, Shahoian and Ramsay were originally assigned to the same company, and share similar structures and operations that are compatible. APPLE-1003, ¶97.

3. Application to Challenged Claims

[5.1] The linear resonant vibration module of claim 4 wherein, when the control program receives user input directing a change in vibration strength, the control program changes the current provided from a power supply to the driving component; and

The Shahoian-Cosper-Rossi-Ramsay combination’s control program receives user input through an “input/output device” (e.g., GUI) directing a change in vibration strength (magnitude/amplitude of vibration). APPLE-1006, [0022]-[0026]), [0030]-[0033], [0038]-[0039], [0046], [0053] (“magnitude adjusting mechanism”); [0054]-[0055]; APPLE-1004, 3:26-64. In the combined system, the software executed by the microprocessor receives user input adjusting the magnitude of the waveform via a user interface, in accordance with Ramsay, thereby directing a change in vibration strength. *Id.*; *supra*, §V.C.2 (Shahoian-Cosper-Rossi-Ramsay combination); APPLE-1003, ¶¶169-171; APPLE-1006,

[0030] (“the modifiable parameters may include a . . . amplitude of vibration.”); *see also* FIG. 4 (“magnitude”).

When the control program receives the user input directing a change in vibration strength (magnitude/amplitude), the control program changes the current provided from a power supply to the driving component. APPLE-1003, ¶172. Indeed, the current applied to the coil directly impacts the magnitude of the oscillations, implementing the user input directing a change in vibration strength. APPLE-1003, ¶¶172-173 (citing APPLE-1023, 9:65-10:3 (“The magnitude or strength of the force is dependent on the magnitude of the current that is applied to the coil.”), 17:32-51 (“the gain 332 (or magnitude) of the force” and “gain of 100”).

[5.2] wherein, when the control program receives user input directing a change in vibration frequency, the control program changes the frequency at which the control program changes the voltage state of the directional signal d.

The Shahoian-Cosper-Rossi-Ramsay combination’s control program receives user input through an “input/output device” (e.g., GUI) directing a change in vibration frequency. APPLE-1006, [0030] (“frequency of vibration”); *see also*, [0033], [0035], [0039], [0051]; *supra*, Analysis of [5.1]. In response to such user input, the control program changes the frequency at which the control program changes the voltage state of the directional signal d. APPLE-1003, ¶174; *supra*, §V.C.2 (Shahoian-Cosper-Rossi-Ramsay combination). Indeed, in the combined

system, the vibration frequency is controlled by the frequency at which the microprocessor changes the voltage state of the directional signal d output to the H-bridge switch circuit, and thus the frequency of the control signal is changed to implement the received user input. APPLE-1003, ¶174 (describing known operation of frequency control using H-bridge switch); APPLE-1004, 7:34-36 (“A drive waveform that changes between positive and negative signs can be provided to the actuator to cause the oscillations.”); APPLE-1037, 14:24-35 (“provide voltage or current in one of two directions”).

D. GROUND 2A: Shahoian-Cosper-Ramsay-Aldrich renders obvious claim 1 (means-plus-function construction)

If the Board applies the means-plus-function construction of “control component” described above (*supra*, §IV.A), claim 1 is obvious based on the Shahoian-Cosper-Ramsay-Aldrich combination⁷. A POSITA would have found it obvious to combine Shahoian, Cosper, and Ramsay (without Rossi) for the reasons described above. *Supra*, §V.A.3 (Shahoian-Cosper combination), §V.C.2 (Shahoian-Cosper-Rossi-Ramsay combination). A POSITA would have further

⁷ To be clear, Ground 2B likewise demonstrates unpatentability of claim 1 based on the construction proposed by patent owner in the district court. *Supra*, IV.A.2; APPLE-1033.

found it obvious to implement the combination in accordance with Aldrich's suggestions of a "hill-climbing" control algorithm to maintain oscillation at a resonant frequency. APPLE-1003, ¶175-177.

Ultimately, the '767 patent's claims are directed to control of known linear resonant vibration modules using known control components and circuitry. Shahoian and Cosper provide a linear resonant vibration module having most features recited by the '767 claims. APPLE-1003, ¶¶175-186. Ramsay and Aldrich provide additional known implementation details, to the extent not considered expressly recited by Shahoian and Cosper. *Id.*

1. Aldrich

Aldrich describes a feedback control algorithm to drive an actuator to "one of the resonance peaks and eventually to oscillate about the peak." APPLE-1021, 2; APPLE-1003, ¶¶93-94. The drive frequency is incremented or decremented. *Id.* If the increment or decrement results in an increased output (e.g., in the current/voltage ratio), then the direction of change (increase or decrease, respectively) of frequency is accepted and another such change (increment or decrement, respectively) is made during the following sampling period. APPLE-1021, 2; APPLE-1003, ¶¶95-96. If, on the other hand, the increment or decrement results in a decrease in output, then the direction of change of frequency during the following sampling period is reversed. This process is repeated during oscillation

to maintain oscillation about a resonant frequency. *Id.*

2. Predictable Combination of Shahoian-Cosper-Ramsay-Aldrich

A POSITA would have been motivated to implement a hill-climb feedback control algorithm, in accordance with Aldrich, in Shahoian-Cosper-Ramsay's system that utilizes sensor feedback to control an H-bridge switch that changes directionality of voltage/drive signals to generate a vibration output. APPLE-1003, ¶¶175-186.

In the combined system, sensor outputs would have been received and processed by Shahoian's microprocessor using at least a "hill-climbing control algorithm . . . to find and remain within the vicinity of the resonance," in accordance with Aldrich's suggestions. APPLE-1021, 2. The control program would have been included with the "software instructions . . . provided with" Shahoian's microprocessor that implement feedback control in accordance with Cosper. APPLE-1004, 4:16-17. Implementing Aldrich's algorithm as a control program for applying continuous feedback control about a resonant frequency would have been a routine application of known software coding techniques. APPLE-1003, ¶¶178-181.

To generate control signals that maintain oscillation at resonance, the drive frequency would have been incremented or decremented, and a currently measured

vibration strength parameter (based on the acceleration sensor signal, for example, in accordance with Cosper) compared with a previously measured vibration strength parameter. APPLE-1003, ¶179; APPLE-1021, 2. In accordance with Aldrich's suggestions, if the increment or decrement results in an increased vibration strength (determined based on comparison of the currently measured strength compared to the previously measured strength), then the direction of change (increase or decrease, respectively) of frequency is accepted and another such change (increment or decrement, respectively) is made during the following sampling period. *Id.* If the increment or decrement results in a decrease in vibration strength, then the direction of change of frequency during the following sampling period is reversed because the frequency was incremented/decremented past the resonant peak. *Id.*

A POSITA would have implemented Aldrich's hill-climb technique using a Boolean value to indicate whether the frequency was being increased. APPLE-1003, ¶180. The use of Boolean values to track such a parameter was conventional, and would have been selected as a matter of routine implementation based on Aldrich's suggestions for switching between incrementing and decrementing frequency. APPLE-1003, ¶180 (describing conventional use of Boolean variables) (citing APPLE-1026, 29). Indeed, based on Aldrich's description of reversing the direction of change of frequency, a POSITA would

have predictably utilized a Boolean variable to track the direction of change of frequency. APPLE-1021, 2 (“direction of change of frequency during the following sampling period is reversed.”); APPLE-1003, ¶180.

Additionally, a POSITA would have implemented Aldrich’s hill-climb technique in a feedback control loop in which local variables are set to default variables. A POSITA would have recognized, and found it obvious, to set local variables to default values so that the control signal is generated to produce oscillation, which is then adjusted as appropriate through feedback control. *Id.*; APPLE-1003, ¶¶102-103, 181, 183-186. A POSITA would have been motivated to set default values for these specific local variables to facilitate initiation of the actuator close to expected and/or user-selected operating parameters. *Id.*

To be clear, a POSITA would have been prompted to utilize integer values when processing sensor signals. In the combined system, the sensor signals from the accelerometer are an integer value, which facilitates digitally processing the signals, and efficient computation and processing of the force values represented by the sensor signals. APPLE-1003, ¶182; APPLE-1021, 2. The use of integer values amounted to a mere design choice (between integer or non-integer values). *Id.* Moreover, a POSITA would have readily recognized the efficiency and effectiveness of utilizing an integer value associated with the sensor signals. APPLE-1003, ¶182.

Multiple reasons would have prompted a POSITA to implement a “hill-climbing” control algorithm, in accordance with Aldrich’s suggestions, in the Shahoian-Cosper-Ramsay system. APPLE-1003, ¶¶183-186.

First, a POSITA would have combined Shahoian-Cosper-Ramsay and Aldrich to avail the system of a known feedback algorithm for targeting a resonant frequency. APPLE-1003, ¶184. Cosper describes monitoring sensor outputs and adjusting the control signal to automatically maintain oscillation at resonance. APPLE-1009, [0008]-[0011]. A POSITA would have predictably looked to teachings such as Aldrich for implementation details, especially where Aldrich describes an algorithm for driving an actuator at resonance using vibration strength feedback, and where Cosper describes “various algorithms for analyzing feedback signals and driving the resonant subassembly as described are contemplated.” APPLE-1009, [0056].

Second, a POSITA would have combined Shahoian-Cosper-Ramsay and Aldrich to implement feedback control according to a known technique that continuously updates the control outputs throughout operation of the system. APPLE-1003, ¶185. The algorithm facilitates comparison of current and previous parameters throughout device operation so that the frequency at which the voltage state of the directional signal d can be adjusted to maintain oscillation at the

resonance frequency, furthering the explicit objectives of Cosper. *Id. Intel Corp.*, 61 F.4th at 1381.

Third, here again, this combination was the application of known techniques (Aldrich’s “hill-climbing” feedback control algorithm) to improve similar systems in the same way. *KSR*, 550 U.S. at 417. Moreover, a POSITA would have had a reasonable expectation of success in making the proposed modifications, which would have been implemented largely via software executed by the microprocessor. APPLE-1003, ¶186.

3. Application to Challenged Claims

[1.P]-[1.3]

See, supra, Ground 1A, Analysis of Elements [1.P]-[1.3]; APPLE-1003, ¶187, ¶¶117-121.

[1.4] a driving component that drives the moveable component in each of two opposite directions;

The combination’s LRVM includes a driving component (Shahoian’s “wire coil” with oscillating current) that drives the moveable component (Shahoian’s movable “magnet head”) in each of two opposite directions. *Supra*, Ground 1A, Analysis of Element [1.4]. APPLE-1003, ¶188-189.

[1.5.1] a control component that includes a microprocessor and that controls supply of power from the power supply to the driving component to cause the moveable component to linearly oscillate, the control component including, in addition to the microprocessor,

The Shahoian-Cosper-Ramsay-Aldrich combination includes the claimed control component under the means-plus-function construction (*supra*, IV.A.2).⁸ APPLE-1003, ¶¶190-197. The control component performs the following functions: controlling supply of power from the power supply to the driving component to cause the movable component to linearly oscillate; controlling operation of the linear resonant vibration module; receiving output signals from sensors within the linear resonant vibration module during operation of the linear resonant vibration module; and adjusting one or more operational control outputs of the control component according to the received output signals from the sensors in order that subsequent operation of linear resonant vibration module produces desired outputs from the one or more sensors corresponding to one or more operational control parameters.

The structure for performing those functions is the combination of: a microprocessor; a switch that receives a directional signal d from the processor and that selects a corresponding direction of the two opposite directions in which the driving component drives the moveable component; a control program, stored in

⁸ The functions and corresponding structure of “control component” are addressed throughout the Analysis of Elements [1.5.1]-[1.6] below.

one of a separated electronic memory or within the processor, that is executed by the microprocessor wherein the control program performs the algorithm shown in Figs. 7A–C and described at 6:15–8:3 of the '767 patent; and equivalents thereof.

Shahoian describes that the “microprocessor” (local microprocessor 26) is provided with “software instructions” and controls “input and output signals.” APPLE-1004, 4:16-20, 7:46-53; 4:20-30; 4:56-61; 5:4-6; APPLE-1003, ¶¶191-192. In the combination, that microprocessor is programmed to provide a control output to the H-bridge switch for controlling the direction of the drive signal through the coil (e.g., directional signal d). *Supra*, Ground 1A, Analysis of Element [1.5.1]; APPLE-1003, ¶124.

The microprocessor also controls supply of power from the power supply to the H-bridge switch using a control output to the power supply (“actuator interface 38”). The supply of power from the power supply to the H-bridge switch is transferred to the electromagnet coil, which causes the moveable component to move back and forth and affects the magnitude of vibration strength, which is beneficially adjusted by modulating the power supply input to the H-bridge switch. APPLE-1003, ¶¶192-197; APPLE-1004, 5:26-34; 5:35-40; FIG. 1 (“power supply”). Indeed, Shahoian explicitly illustrates control flow from the “local microprocessor” to “actuator interface” in FIG. 1. APPLE-1004, FIG. 1; *see also*, *supra*, Ground 1C, Analysis of [5.1] (describing vibration “magnitude”); APPLE-

1003, ¶193, ¶¶194-197 (citing APPLE-1023, 9:46-57 (“microprocessor 26 can control the direction and/or magnitude of the current in wire coil 84a”); 9:65-10:5 (“The magnitude or strength of the force is dependent on the magnitude of the current that is applied to the coil.”); APPLE-1025, 6:19-47 (“increasing a period of time T during which the current is supplied and/or by increasing the maximum current”)); APPLE-1003, ¶¶104-106.

Moreover, Shahoian describes control of the power supply to selectively control the magnitude of power supplied to the H-bridge switch, including whether the power supply delivers ‘0’ volts or ‘12’ volts, by cycling between ‘on’ and ‘off’ states. APPLE-1004, 5:35-37 (“Power supply 40 can optionally be coupled to actuator interface 38 and/or actuators to provide electrical power”); 7:38-45 (describing independent adjustment of “magnitude” and “frequency” of vibration output); APPLE-1003, ¶¶194-197 (citing APPLE-1037, 10:26-27 (“an actuator interface can provide the desired voltage value to the motor 100”); 10:34-35 (“the vibration increases in magnitude proportionally with the magnitude of voltage used to control the motor”).

Under the means-plus-function construction, the microprocessor executes an algorithm to control supply of power from the power supply to the driving component to cause the moveable component to linearly oscillate, as described in more detail immediately below with respect to the claimed control program. *Infra*,

Ground 2A, Analysis of [1.5.2] (“control program”).

[1.5.2] a control program, stored in one of a separated electronic memory or within the processor, that is executed by the microprocessor to control operation of the linear resonant vibration module,

In the combined system, the “microprocessor” of the control component executes a control program provided by “software instructions,” which are stored in memory, that control operation of the linear resonant vibration module.

APPLE-1004, 4:10-24, 7:46-53; 4:20-30; 4:49-54; 4:56-61; 5:4-6; APPLE-1003, ¶¶198-200; *see also* Ground 1A, Analysis of [1.5.2].

The recited “control component” functions are carried out by the algorithm described with reference to FIGS. 7A-7C of the ’767 patent, according to the means-plus-function construction of “control component” recited in Element [1.5.2] (*supra*, IV.A.2). In “step 702” of FIG. 7A, the software instructions of the “microprocessor” begin execution upon a power-on event invoked by a user through a power switch or other user control and sets seven local variable to default values. APPLE-1003, ¶¶200-205.

For example, like initial “step 702” of FIG. 7A, the software instructions of the “microprocessor” in the combination begin execution upon a power-on event invoked by a user through a power button or other user control. APPLE-1003, ¶200. Shahoian describes that the “microprocessor” receives input from “input devices 39,” and Cosper describes an “on/off” switch for “controlling the power to

the control logic/control circuit 12.” APPLE-1004, 4:44-49; APPLE-1009, [0053]; *supra*, §V.A.3 (Shahoian-Cosper combination).

The software of the microprocessor of the combined system sets the same local variables to default values. *Supra*, §V.D.2 (Shahoian-Cosper-Ramsay-Aldrich combination); APPLE-1003, ¶¶201-211.

Moreover, in the combined system, the set-point values include variables consistent with the seven variables recited by the '767 patent, according to the means-plus-function construction. For example, in accordance with Shahoian, Cosper, and Ramsay, the combined system includes multiple different “haptic effects”/ “haptic tracks” that specify a current operational *mode* of the device. APPLE-1003, ¶206. The modes include operation in which feedback control maintains oscillation at the mechanical resonant frequency of the system. APPLE-1004, 7:29-34; APPLE-1009, [0010]; APPLE-1003, ¶¶206-207 (describing predictable benefits of a variable to indicate to the control program the operational mode the device is currently operating in). The combined system operates based on stored pre-defined haptic effects (*default operational mode*), such as an effect in which feedback control maintains oscillation at the mechanical resonant frequency, when initialized. Additionally, the combined system includes one or more alternative or complex modes of operation that systematically and/or periodically alter the frequency or produce various complex, multi-component

vibrational modes. APPLE-1003, ¶207 (describing example multi-component vibrational techniques that “combine haptic tracks” and/or that systematically/periodically alter the output over time); APPLE-1006, [0035]-[0039], [0047], [0057]-[0059]. Indeed, Ramsay describes “ROM 28 may be configured to store a library of preset haptic tracks” having such parameters, and/or that are combined. APPLE-1006, [0028].

The combination includes a **strength** variable corresponding to user-selected strength of operation (“gain” or “magnitude”). APPLE-1003, ¶208. Indeed, in accordance with Ramsay’s suggestions, the system includes a strength variable (“gain” or “magnitude”) that provides the strength of vibration output, and that can be adjusted based on user input. *Supra*, Ground 1C, Analysis of [5.1] (describing vibration “magnitude” and associated user inputs). A strength variable determines the magnitude or strength of the vibration force, which is dependent on the current applied to the coil. *Supra*, Ground 2A, Analysis of Element [1.5.1] (citing APPLE-1023, 9:65-10:3 (“The magnitude or strength of the force is dependent on the magnitude of the current that is applied to the coil.”); APPLE-1023, 17:32-51 (“the gain 332 (or magnitude) of the force” and “gain of 100”); FIG. 6; APPLE-1025, 6:19-47)); APPLE-1037, 10:34-35; APPLE-1003, ¶¶104-106, 208.

The combination also includes **sensed values** that include previous and currently-sensed vibrational strength values, in accordance with Cosper and

Aldrich. The combined system includes a currently sensed vibration strength value and a previously sensed vibration strength value that are compared in carrying out the control algorithm. APPLE-1003, ¶209; APPLE-1021, 2 (describing evaluation of frequency change results in increase or decrease of vibration output). The variables are initialized with default values that provide a starting point for operation (e.g., zero). *Id.*

The combination includes a **frequency** at which current is changed in the coil and a **directional signal d** from the microprocessor. *See, e.g.,* APPLE-1004, 4:41-44 (“frequency of the drive waveform”); APPLE-1009, [0010] (“drive signals that are processed to maintain mechanical oscillation at the mechanical resonant frequency”); APPLE-1021 (“excitation frequency”); *see also, supra*, Ground 1A, [1.5.3] (directional signal d). The frequency variable is initialized with default values in order to provide a starting point for operation (e.g., based on the stored “haptic effect” or “haptic track,” or an assumed resonant frequency). APPLE-1003, ¶¶210 (citing APPLE-1007). The directional signal d, for example, is initialized with a default value (e.g., high or low), which is then reversed during operation to induce oscillation according to the feedback control program. APPLE-1003, ¶¶199-220 (describing obvious design choice of initialize direction signal d as high or low); APPLE-1004, FIG. 5.

A **Boolean value** indicates the frequency is being increased. APPLE-1003,

¶¶199-220. The Boolean value variable tracks the status of frequency increase/decrease to implement the comparison in accordance with Aldrich's control algorithm, as a matter of routine implementation. APPLE-1003, ¶211 (describing conventional use of Boolean variables) (citing APPLE-1026, 29).

At "step 704, the control program waits for the next event." APPLE-1001, 6:33-36. In the combined system, the software executing on the microprocessor waits for the next event, such as sensor input to be used in determining the control signal, or a user input to power down the device. APPLE-1003, ¶212; *infra*, Analysis of Element [1.6]; APPLE-1009, [0106] ("power switch" to "turn the device 'on' or 'off'," and input to adjust "mode" of operation); [0125] ("feedback loops"). Indeed, consistent with Shahoian and Cosper, which describe operation responsive to received events (sensor and user inputs), the system waits for the next event in order to operate accordingly when an event is received. *Id.* To be clear, use of a loop or event handler in a feedback control system were known and a conventional technique readily implemented by a POSITA in order to operate in accordance with the respective event. APPLE-1003, ¶¶212-213 (describing conventional techniques of timers, loops, and event handlers) (citing APPLE-1026, 6-11)

At "step 712," the '767 control program algorithm calls a "monitor" routine," illustrated in FIG. 7B. APPLE-1001, 6:57-59; APPLE-1003, ¶¶214-218.

The “monitor” routine recited by the ’767 patent was a conventional routine for implementing a feedback loop to maintain operation of a linear actuator at or near resonance. APPLE-1003, ¶214; APPLE-1009, Abstract, [0008]-[0011]; APPLE-1021, 2. In the combined system, the control program compares vibration parameters while incrementing or decrementing the drive frequency, in accordance with Aldrich. *Supra*, §V.D.2 (Shahoian-Cosper-Ramsay-Aldrich combination). The combined system includes multiple sensors, including a sensor for acceleration (e.g., accelerometer). *Infra*, Analysis of Element [1.6]. The software executed by the microprocessor in the combined system receives signals from the sensors, including sensor signals from the accelerometer indicative of vibrational strength, and compares a current sensed vibration strength value and a previous sense vibration strength value to adjust the input frequency about a resonant frequency, consistent with steps 736-750 of FIG. 7B of the ’767 patent. APPLE-1003, ¶¶214-218.

For example, in accordance with Aldrich’s suggestions, a currently sensed vibration strength value at an incrementally increased control signal frequency is compared with a previous sensed vibration strength value. APPLE-1003, ¶215. When the vibration strength has increased with increased frequency input, “then the direction of change . . . of frequency is accepted and another such change . . . is made during the following sampling period.” APPLE-1021, 2. This is the same as

steps 738-740 of FIG. 7B of the '767 patent.

Similarly, when the vibration strength has not increased with increased frequency input, the control program determines that the resonant frequency has been exceeded. APPLE-1003, ¶216; APPLE-1021, 2. The “direction of change of frequency during the following sampling period is reversed,” such that the frequency is decremented, and the process continues. APPLE-1021, 2. This is the same as steps 742-744 of FIG. 7B of the '767 patent.

The combined system proceeds in a similar manner when decrementing the input frequency, following the same algorithm of FIG. 7B at steps 746-752, for example. APPLE-1003, ¶¶217.

In the combined system, the currently and previously sensed sensor signals are processed and stored as integer values. APPLE-1003, ¶218; *supra*, §V.D.2 (Shahoian-Cosper-Ramsay-Aldrich combination).

At “step 714,” the '767 patent's control program calls a “control” routine, illustrated in FIG. 7C, “when the event corresponds to a change in the user input through the user interface.” APPLE-1001, 6:59-62. In the combined system, the user input provides a change in vibration strength, and the user input is received during a monitoring period so that the input is processed and implemented. APPLE-1003, ¶219. In particular, the software executing on the microprocessor outputs a corresponding control signal in accordance with the user unput. *Id.*; *infra*,

Ground 2B, Analysis of Elements [5.1]-[5.2]; *see also, supra*, Ground 1C, Analysis of Elements [5.1]-[5.2]. The routine continues according to the user-selected settings (e.g., until further input is received).⁹ *Id.*

The '767 patent's control program algorithm of FIG. 7A further recites that, when the event is a power-down event, as determined in step 718, then the control program appropriately powers down the device, in step 720. APPLE-1001, 6:62-66. The combined system executes a power-down event in response to user input that turns the device "off." *See* APPLE-1009, [0053]; APPLE-1003, ¶220.

[1.5.3] a switch that receives a directional signal d from the processor and that selects a corresponding direction of the two opposite directions in which the driving component drives the moveable component;

The combination renders obvious Element [1.5.3]. *Supra*, Ground 1A, Analysis of [1.5.3]; APPLE-1003, ¶¶129, 221. As discussed above, Shahoian's "H-bridge" switch circuit provides a switch as recited by Element [1.5.3]. *Id.*

[1.6] the control component receiving output signals from sensors within the linear resonant vibration module during operation of the linear resonant vibration module and adjusting one or more operational control outputs of the control component according to the received output signals from the sensors in order that subsequent operation of linear resonant vibration module produces

⁹ The '767 patent expressly enumerates "loops" or "other simple programming techniques" to implement the frequency timer and monitoring interval. APPLE-1001, 6:45-48.

desired outputs from the one or more sensors corresponding to one or more operational control parameters.

The Shahoian-Cosper-Ramsay-Aldrich combination renders obvious Element [1.6]. The combined system controls oscillation based on feedback from multiple sensors within the LRVM during operation of the LRVM, in accordance with Cosper. *Supra*, §V.A.3 (Shahoian-Cosper combination), §V.D.2 (Shahoian-Cosper-Ramsay-Aldrich combination). For example, the “microprocessor” receives output signals from multiple sensors (e.g., “position,” “velocity,” “acceleration” sensors) associated with movement of the moving magnet head and positioned within the LRVM. APPLE-1009, [0050] (“detect position, velocity, acceleration, etc.” or “a sensor 14 is connected to a driver associated with force transducer 20, and senses the load or driving force applied to the subassembly.”); APPLE-1003, ¶223.

The microprocessor implements feedback control by adjusting one or more operational control outputs (e.g., frequency of the control signal input to the H-bridge switch) according to the received output signals from each of the sensors received during operation corresponding to one or more operation control parameters (e.g., vibration strength, velocity, etc.), in accordance with Cosper and Aldrich, as discussed above; rendering obvious Element [1.5.3] according to the

means-plus-function construction. *Supra*, Ground 2A, Analysis of Elements [1.5.1]-[1.5.2]; APPLE-1003, ¶¶222-223.

E. GROUND 2B: Shahoian-Cosper-Ramsay-Aldrich-Rossi renders obvious claims 1-5 (means-plus-function construction)

If the Board applies the means-plus-function construction of “control component” described above (*supra*, §IV.A.2), claims 1-5 are obvious based on the Shahoian-Cosper-Ramsay-Aldrich-Rossi combination. A POSITA would have found it obvious to combine Rossi with Shahoian-Cosper-Ramsay-Aldrich for the reasons described above regarding combination of Rossi with Shahoian-Cosper. *Supra*, §V.B.2 (Shahoian-Cosper-Rossi combination); APPLE-1003, ¶¶224-225.

1. Application to Challenged Claims

[1.P]-[1.4]

See, supra, Ground 1A, Analysis of Elements [1.P]-[1.4]; APPLE-1003, ¶¶117-123, APPLE-1003, ¶226.

[1.5.1]

See, supra, Ground 2A, Analysis of Element [1.5.1]; APPLE-1003, ¶¶190-197, ¶227.

[1.5.2] a control program, stored in one of a separated electronic memory or within the processor, that is executed by the microprocessor to control operation of the linear resonant vibration module,

The combination renders obvious Element [1.5.2] for the reasons discussed

above with respect to Shahoian-Cosper-Ramsay-Aldrich. *Supra*, Ground 2A, Analysis of Element [1.5.2]. Element [1.5.2] is also rendered obvious based on further combination with Rossi. APPLE-1003, ¶¶228-229.

For example, the POSITA would have found it obvious, based on Rossi, that the control component, including the microprocessor, is programmed with an algorithm to provide an output to the power supply (e.g., power supply control) and an output to the H-bridge switch (e.g., directional signal d). APPLE-1005, [0009]; APPLE-1003, ¶229. The H-bridge circuit of the combined system includes two inputs—“IN1” and “Vs”—in accordance with Rossi, which are controlled, directly or indirectly, by the microprocessor control algorithm. APPLE-1003, ¶229. A control signal is output from the microprocessor to “IN1” of the H-bridge circuit, providing a direction signal. *Supra*, Ground 1B, Analysis of Element [2.1]. Additionally, a POSITA would have found it obvious that the microprocessor controls supply of power to the driving component by a control output to the power supply, based on Rossi’s explicit teaching of a voltage input (“Vs”). The supply of power to the coil causes the moveable component to move back and forth and affects the magnitude of vibration strength, and is beneficially adjusted to alter the strength of the vibration output (e.g., according to received user input, etc.). APPLE-1003, ¶229; APPLE-1004, 5:26-40; FIG. 1 (“power supply”). Such control of the current magnitude was well known. APPLE-1003, ¶229 (citing

APPLE-1023, 9:46-57 (“microprocessor 26 can control the direction and/or magnitude of the current in wire coil 84a), 8:23-52; 9:65-10:5; APPLE-1025, 6:19-47 (“increasing a period of time T during which the current is supplied and/or by increasing the maximum current”); APPLE-1003, ¶¶104-106.

[1.5.3] a switch that receives a directional signal d from the processor and that selects a corresponding direction of the two opposite directions in which the driving component drives the moveable component;

The combination renders obvious Element [1.5.3]. APPLE-1003, ¶230. For example, the combined system includes an “H-bridge” switch, in accordance with Rossi, as recited by Element [1.5.3]. *Supra*, Ground 1B, Analysis of 1.5.3.

[1.6]

See, supra, Ground 1A, Analysis of Element [1.6]; Ground 2A, Analysis of Element [1.6]; APPLE-1003, ¶231, ¶¶136-137, ¶¶222-223.

[2.1]-[2.4]

See, supra, Ground 1B, Analysis of Elements [2.1]-[2.4]; APPLE-1003, ¶232, ¶¶149-157.

[3.1]

See, supra, Ground 1B, Analysis of Element [3.1]; APPLE-1003, ¶233, ¶158.

[3.2]

The Shahoian-Cosper-Ramsay-Aldrich-Rossi combination renders obvious

Element [3.2]. *See, supra*, Ground 1B, Analysis of Element [3.2]; APPLE-1003, ¶¶234-235, ¶159.

To be clear, the combined system discloses Element [3.2] according to the means-plus-function construction. The software executed by the microprocessor in the combined system continuously monitors the output of the vibration sensor so as to continuously adjust the control outputs to maintain oscillation at resonant frequency, and this continuous control loop is the same as the control loop described in the '767 patent. APPLE-1001, 7:9-14. Indeed, the combined system monitors output of the vibration sensor in the same manner as described above with respect to other sensors used in the feedback control system (*supra*, Ground 2A, Analysis of Element [1.5.2]), carrying-out the same algorithm shown in FIG. 7B of the '767 patent.

[4]

See, supra, Ground 1B, Analysis of Claim [4]; APPLE-1003, ¶236, ¶160.

[5.1] The linear resonant vibration module of claim 4 wherein, when the control program receives user input directing a change in vibration strength, the control program changes the current provided from a power supply to the driving component; and

The Shahoian-Cosper-Ramsay-Aldrich-Rossi combination renders obvious Element [5.1]. In the combined system, the software executed by the microprocessor receives user input adjusting the magnitude (e.g., height,

frequency, etc.) of the waveform via a user interface, in accordance with Ramsay, thereby directing a change in vibration strength, and the control program changes the current provided from a power supply to the driving component. APPLE-1006, [0022]-[0026], [0030]-[0033], [0046], [0053]-[0055]; *supra*, Ground 1C, Analysis of Element [5.1]; APPLE-1003, ¶¶237-238, ¶¶171-173.

[5.2] wherein, when the control program receives user input directing a change in vibration frequency, the control program changes the frequency at which the control program changes the voltage state of the directional signal d.

The Shahoian-Cosper-Ramsay-Aldrich-Rossi combination renders Element [5.2] obvious. For example, Ramsay describes that a user can customize characteristics of a haptic output including frequency of vibration. APPLE-1006, [0030]; *supra*, Ground 1C, Analysis of Elements [5.1]-[5.2]; APPLE-1003, ¶¶239-240, ¶¶171-174.

VI. DISCRETIONARY DENIAL IS NOT WARRANTED

A. The *General Plastic* Factors Favor Institution

The '767 patent has not been the subject of IPR—by Apple or any petitioner—and thus the *General Plastic* factors weigh heavily against denial. *General Plastic Industrial Co. v. Canon Kabushiki Kaisha*, IPR2016-01357, Paper 19 at 16 (PTAB Sept. 6, 2017) (precedential as to section II.B.4.i).

To be clear, the existence of IPRs involving an unrelated petitioner and different patents (9,369,081; 9,941,830, 8,860,337), does not favor denial.

Petitioner is not an RPI or related party to those IPRs, or the associated litigation, which involve different accused products and different prior art. Moreover, those proceedings do not involve the '767 patent, which has different claims and different claim construction considerations. Petitioner has been diligent in preparing its Petition here, nearly three months before its statutory bar date. The lack of overlap mitigates against any play-booking concerns, of which there are none. Not only is the art of the Grounds herein different than the art of the unrelated IPRs, but the art here includes recently identified references, such as Rossi and Aldrich, uncovered in Dec., 2023 as particularly relevant to features recited by the '767 patent.

B. The *Advanced Bionics* Test Favors Institution—§325(d)

The references Grounds 1A-2B were not applied in a rejection during prosecution. This Petition thus does not involve the same or substantially the same art or arguments previously presented, ending the *Advanced Bionics* inquiry in favor of institution. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 at 8-9 (P.T.A.B. February 13, 2020) (precedential).

C. The *Fintiv* Factors Weigh in Favor of Institution - 35 U.S.C. § 314

This Petition's merits are compelling, and the evidence presented herein is

substantial, counseling against discretionary denial under *Fintiv*.

Factor 1 is neutral or favors institution. Apple has requested a stay pending resolution of a Motion to Transfer to the Northern District of California. While the PTAB does not infer how the district court would rule should a stay be requested, the pending motion at least increases the likelihood of a stay. *Hulu LLC v. SITO Mobile R&D IP, LLC*, IPR2021-00298, Paper 11 at 10-11 (May 19, 2021).

Factor 2 favors institution. The Board will likely issue its Final Written Decision by October/November 2025, within about two months of the currently scheduled trial date (August 4, 2025) and likely before the median time-to-trial in WDTX (October, 2025, based on median time of 28.3 months). The currently-scheduled trial date is uncertain and subject to change due to a number of factors. Indeed, the case was recently transferred from the docket of Judge Counts to the docket of Judge Albright, with the impact on the schedule not yet resolved. Moreover, a Motion to Transfer to the Northern District of California, and a Motion to Stay while the transfer motion is considered, both remain pending. APPLE-1036.

Factor 3 favors institution because Petitioner has diligently filed this Petition nearly two months ahead of the one-year time bar, while the litigation remains in its early stages. By the anticipated institution deadline in October 2024, the co-pending litigation will still be in early stages—expert and fact discovery

will be months away from concluding. *Id.* Moreover, a Motion to Transfer Venue is still pending. APPLE-1036.

Factors 4 and 5 are neutral. Resolution is expected around the time of a decision in the District Court, which mitigates against duplication of effort and serves efficiency and integrity goals. The same parties are in the co-pending litigation.

Factor 6 favors institution because this Petition's merits are compelling for the reasons described herein, demonstrating unpatentability based on multiple grounds and constructions. '767 claims have not previously been challenged in a PTAB proceeding. The strength of the merits alone outweigh any inefficiencies borne of parallel litigation.

VII. PAYMENT OF FEES – 37 C.F.R. § 42.103

Petitioner authorizes the Patent and Trademark Office to charge any fees to Deposit Account No. 06-1050.

VIII. CONCLUSION

Petitioner respectfully requests institution of IPR.

IX. MANDATORY NOTICES UNDER 37 C.F.R § 42.8(a)(1)

A. Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1)

Apple Inc. is the petitioner and real party in interest.

B. Related Matters Under 37 C.F.R. § 42.8(b)(2)

Petitioner is not aware of any disclaimers, reexamination certificates or petitions for *inter partes* review for the '767 Patent. The '767 Patent is the subject of *Resonant Systems, Inc. d/b/a RevelHMI v. Apple, Inc.*, 7-23-cv-00077 (WDTX) filed June 1, 2023. The '767 Patent was the subject of *Resonant Systems, Inc. v. Fun Factory USA, Inc.*, 2-15-cv-00054 (WDWA), filed January 14, 2015, now terminated.

C. Lead And Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)

Petitioner provides the following designation of counsel.

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E. Service Information

Please address all correspondence and service to the address listed above.

Petitioner consents to electronic service by email at IPR50095-0177IP1@fr.com.

Respectfully submitted,

Dated: April 12, 2024

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CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter Partes* Review totals 13,973 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated: April 12, 2024

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on March 15, 2024, a complete and entire copy of this Petition for *Inter Partes* Review and all supporting exhibits were provided via Federal Express, to the Patent Owner by serving the correspondence address of record as follows:

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