

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SONY INTERACTIVE ENTERTAINMENT INC. AND SONY GROUP
CORPORATION

Petitioners

v.

RESONANT SYSTEMS, INC.
Patent Owner

Case No. IPR2024-00570
Patent No. 9,941,830

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 9,941,830**

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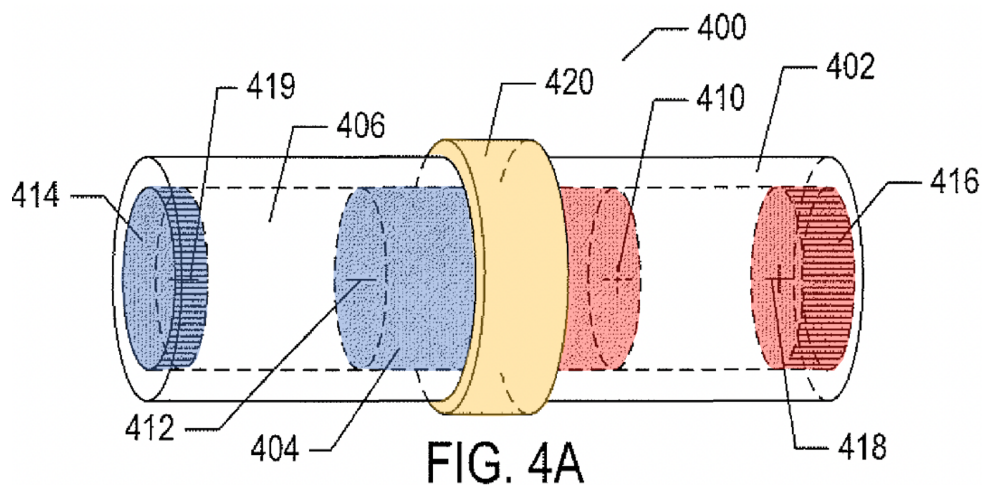
I. INTRODUCTION

Sony Interactive Entertainment Inc. and Sony Group Corporation (“Petitioners”) respectfully request *inter partes* review (“IPR”) of claims 1-8, 11, 15-17, and 20 (the “Challenged Claims”) of U.S. Patent No. 9,941,830 (the “’830 Patent”).

II. SUMMARY OF THE '830 PATENT

A. Description of the '830 Patent

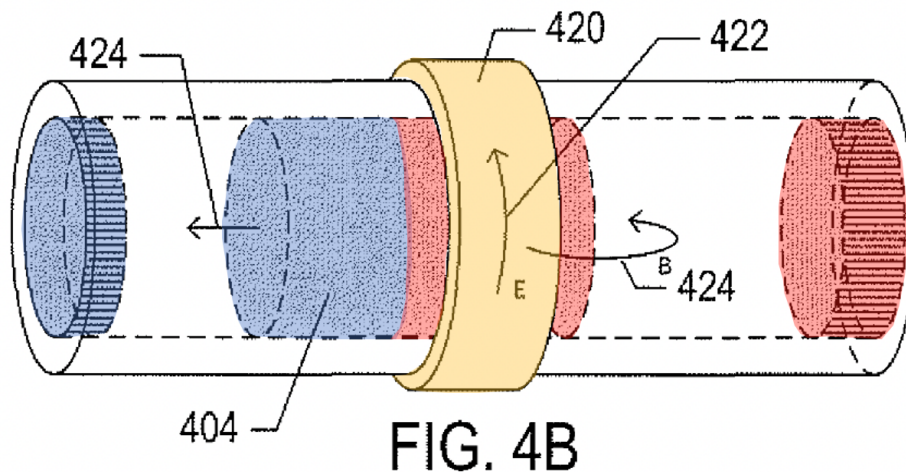
The '830 Patent describes “linear vibration modules...that can be used within a wide variety of different types of appliances, devices, and systems, to generate vibrational forces.” *'830 Patent* (Ex. 1001), 4:17-21. An exemplary module is depicted in Figure 4A and includes “a cylindrical housing 402 within which a solid, cylindrical mass 404, or weight, can move linearly along the inner, hollow, cylindrically shaped chamber 406 within the cylindrical housing or tube 402.” *Id.*, 4:54-57.



Id., Fig. 4A¹.

Mass 404 and disks 414 and 416 are magnets. *Id.*, 4:60-64. The magnets are oriented such that the left disk 414 and the left side of mass 412 are negative polarities (denoted in blue), and the right disk 416 and the right side of mass 410 are positive polarities (denoted in red). *Id.* A coil of conductive wire 420 (denoted in orange) encircles the housing “at approximately the mid-point of the cylindrical housing.” *Id.*, 5:7-10.

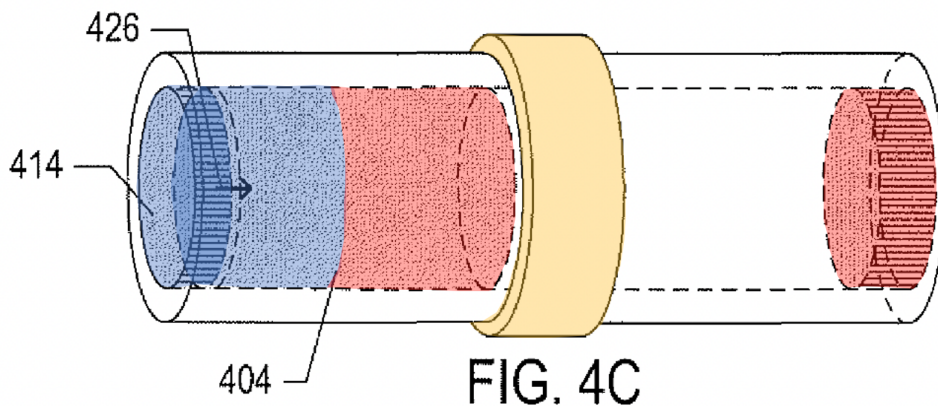
“When an electric current is applied to the coil 420 in a first direction 422, a corresponding magnetic force 424 is generated in a direction parallel to the axis of the cylindrical chamber, which accelerates the weight 404 in the direction of the magnetic force 424.” *Id.*, 5:12-16.



Id., Fig. 4B.

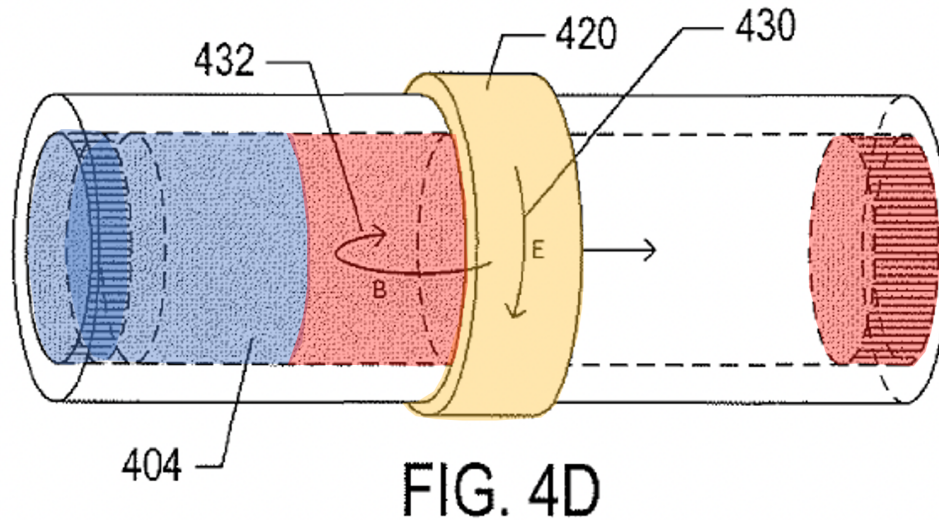
¹ All emphases added unless otherwise noted.

“When the weight reaches a point at or close to the corresponding disk-like magnet 414...a magnetic force due to the repulsion of the disk-like magnet 414 and the weight 404, 426, is generated in the opposite direction, decelerating the weight and reversing its direction.” *Id.*, 5:16-21.



Id., Fig. 4C.

“As the weight reverses direction...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.” *Id.*, 5:21-27.



Id., Fig. 4D.

“[B]y a combination of a magnetic field with rapidly reversing polarity, generated by alternating the direction of current applied to the coil, and by the repulsive forces between the weight magnet and the disk-like magnets at each end of the hollow, cylindrical chamber, the weight linearly oscillates back and forth within the cylindrical housing 402, imparting a directional force at the ends of the cylindrical chamber with each reversal in direction.” *Id.*, 5:34-41. “The frequency of the oscillation of the solid, cylindrical mass is determined by the frequency at which the direction of the current applied to the coil is changed.” *Id.*, 5:50-53.

“FIG. 6 provides a block diagram of the LRVM” and includes a CPU 602 that “receives inputs from the user controls 606 that together comprise a user interface.” *Id.*, 6:6-20, 6:25-27. User controls 606 “may include any of various dials, pushbuttons, switches, or other electromechanical-control devices.” *Id.*, 6:27-29. A

control routine executing on the CPU sets the “mode” and “strength” variables based on the state of the user controls. *Id.*, 8:14-19. The “mode” variable “indicates the current operational mode of the device,” and the “strength” variable is “a numerical value corresponding to the current user-selected strength of operation, corresponding to the electrical current applied to the coil.” *Id.*, 6:60-65. The amplitude of the vibrational forces generated by the LRVM is related to the current applied to the coil. *Id.*, 5:43-49. Thus, the “strength” variable allows the user to control the vibrational amplitude of the LRVM. *Declaration* (Ex. 1003), ¶42.

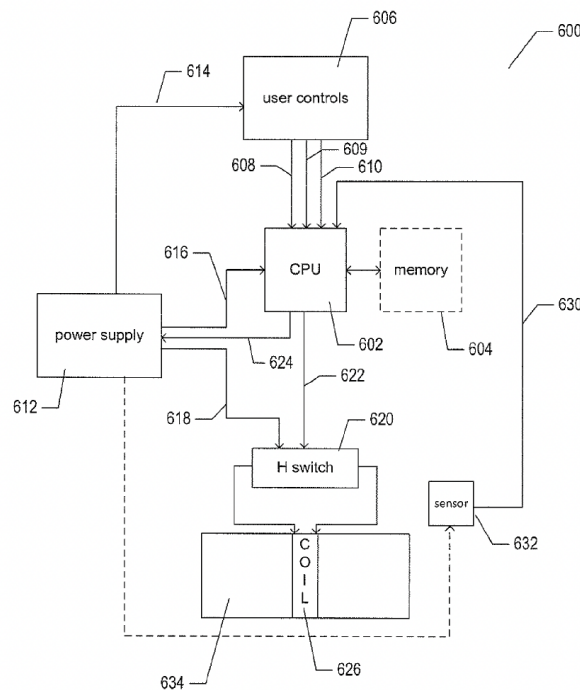


FIG. 6

'830 Patent, Fig. 6.

B. Field of Endeavor and Problem Solved by the Inventors

The '830 Patent describes vibration modules “within a wide variety of different types of appliances, devices, and systems, to generate vibrational forces.” *'830 Patent*, 4:17-21; *see also, id.*, 1:16-21 (defining the Technical Field as “related to vibration-generating devices”). The linear vibration module (LVM) is “linear in the sense that the vibrational forces are produced by a linear oscillation of a weight or component within the LVM or LRVM, rather than as a by-product of an unbalanced rotation, as in the case of currently employed unbalanced electric motors.” *Id.*, 4:21-27. However, the '830 Patent also describes an alternative embodiment where “an oscillating **rotational** force is generated to cause the movable weight to oscillate both in a plane perpendicular to the axis of the chamber as well as linearly oscillating the direction of the chamber.” *Id.*, 9:39-49, Fig. 12. Therefore, the field of endeavor of the '830 Patent at least includes vibration modules. *Declaration*, ¶51.

The '830 Patent also generally seeks to solve problems associated with using unbalanced electric motors to generate vibrations. *'830 Patent*, 2:14-67.

C. Summary of the Prosecution History

The '830 Patent claims priority to a provisional application filed on May 18, 2009. Because the '830 Patent claims the benefit of a filing date before March 16, 2013, Petitioner applies the pre-AIA versions of §§ 102 and 103. Since the prior art

cited in this Petition predates May 18, 2009, Petitioner adopts May 18, 2009, as the priority date for the Challenged Claims for purposes of this proceeding.

During the prosecution of the '830 Patent, as-filed claims 1-12 were rejected as being unpatentable over USPN 2011/0144426 to Blenk et al. ("Blenk") and USPN 2011/0248817 to Houston et al. ("Houston '817"). *'830 Patent File History* (Ex. 1002), 36. The Examiner found that Blenk teaches a "vibration module comprising housing, movable component, power supply driving component that drives movable component to oscillate within housing and control component that controls power from the power supply." *Id.* The Examiner further found that Houston '817 teaches "stored values with controller[.]" *Id.*

In response, Applicant successfully argued that "the controller of Houston ['817] resides in a computer, and is separate from the vibrating device; see e.g., Fig. 38....Thus, the stored values of Houston are not in the same module as the vibrating device." *Id.*, 24. However, this is plainly incorrect. As shown below, the vibration controller 632 resides in the haptic interface device 634 (i.e., the vibrating device) – not the system controller/computer 622. *Infra*; *Houston*, [0214], Fig. 38. Likewise, the combination of Houston and Goldenberg, which was not considered by the Examiner, renders obvious storing values in the same module as the vibrating device. *Infra*.

D. Claim Construction

In this proceeding, claims are interpreted under the same standard applied by Article III courts (i.e., the *Phillips* standard). 37 C.F.R. § 42.100(b); *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312 (Fed. Cir. 2005) (*en banc*). Words in a claim are given their plain meaning, which is the meaning understood by a person of ordinary skill in the art in view of the patent and file history. *Phillips*, 415 F.3d 1303, 1312-13. Petitioner applies the ordinary and customary meaning of the claim terms as understood by a POSITA for all terms not expressly construed below.²

For purposes of this proceeding only, Petitioners apply PO's construction in the parallel litigation for the following claim terms:³

Claim Term	PO's Construction
"a driving component that drives the moveable component to oscillate within the housing;" (Claims 1 and 20)	Subject to 35 U.S.C. § 112 ¶ 6. <u>Function</u> : "driving the moveable component to oscillate within the housing"

² Petitioners' application of prior art to the Challenged Claims is not a waiver of any argument in litigation that any claim term in the '830 Patent is indefinite or invalid. And Petitioner does not waive their rights to raise additional issues of claim construction in litigation.

³ The prior art mapped in this Petition renders the claim limitations unpatentable even if they are not construed under §112, ¶6.

	<u>Structure</u> : “One or more coils or electromagnets”
“a control component that controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by the one or more stored values.” (Claims 1 and 20)	Subject to 35 U.S.C. § 112 ¶ 6. <u>Function</u>: “controlling supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values” <u>Structure</u>: “oscillator circuit; microcontroller with internal or external memory; processor; CPU; microprocessor; and equivalents thereof”
“wherein the control component receives output signals from sensors within the vibration module during operation of the vibration module and adjusts one or more operational control outputs of the control component according to the received output signals from the sensors.” (Claim 3)	Subject to 35 U.S.C. § 112 ¶ 6. <u>Function</u>: “receiving output signals from sensors within the vibration module during operation of the vibration module and adjusts one or more operational control outputs of the control component according to the received output signals from the sensors.” <u>Structure</u>: “oscillator circuit; microcontroller with internal or external memory; processor; CPU;

	microprocessor; and equivalents thereof”
“The vibration module of claim 1” (Claim 4)	“The vibration module of claim 3”
“wherein the control component adjusts the 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 the vibration module produces desired outputs from the one or more sensors corresponding to one or more operational control parameters.” (Claim 4)	Subject to 35 U.S.C. § 112 ¶ 6. <u>Function</u>: “adjusting the 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 the vibration module produces desired outputs from the one or more sensors corresponding to one or more operational control parameters” <u>Structure</u>: “Same structure as described above with respect to claim 3.”
“wherein the one or more operational control parameters is a strength of vibration produced by the oscillation of the moveable component; and wherein the one or more operational control outputs is a frequency at which the control component drives the moveable component to oscillate, the control component dynamically adjusting the power supplied to the driving	Subject to 35 U.S.C. § 112 ¶ 6. <u>Function</u>: “dynamically adjusting the power supplied to the driving component to produce oscillation of the movable component at a resonant frequency for the vibration module” <u>Structure</u>: “oscillator circuit; microcontroller with internal or external memory; processor; CPU;

component to produce oscillation of the movable component at a resonant frequency for the vibration module.” (Claim 5)	microprocessor; and equivalents thereof”
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Resonant’s Opening Claim Construction Brief (Ex. 1004), 13-28; *Western Digital Corporation v. Spex Technologies, Inc.*, IPR2018-00084, Paper 14, at 11 (PTAB Apr. 25, 2018); *10X Genomics, Inc. v. Bio-Rad Laboratories, Inc.*, IPR2020-00086, Paper 8, at 19-20.

E. Level of Skill of a Person Having Ordinary Skill in the Art

A POSITA would have an engineering-related undergraduate degree such as electrical, mechanical, or computer engineering, with at least two years of experience with computer-controlled electrical or electronic systems, or equivalent academic experience (e.g., a master’s degree with a similar focus). *Declaration*, ¶125. The POSITA could have also obtained similar knowledge and experience through a combination of education and experience in the above. *Id.*

III. REQUIREMENTS UNDER 37 C.F.R. § 42.104

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

Petitioners certify the ’830 Patent is eligible for IPR.

B. Identification of Challenge Under 37 C.F.R. § 42.104(b)

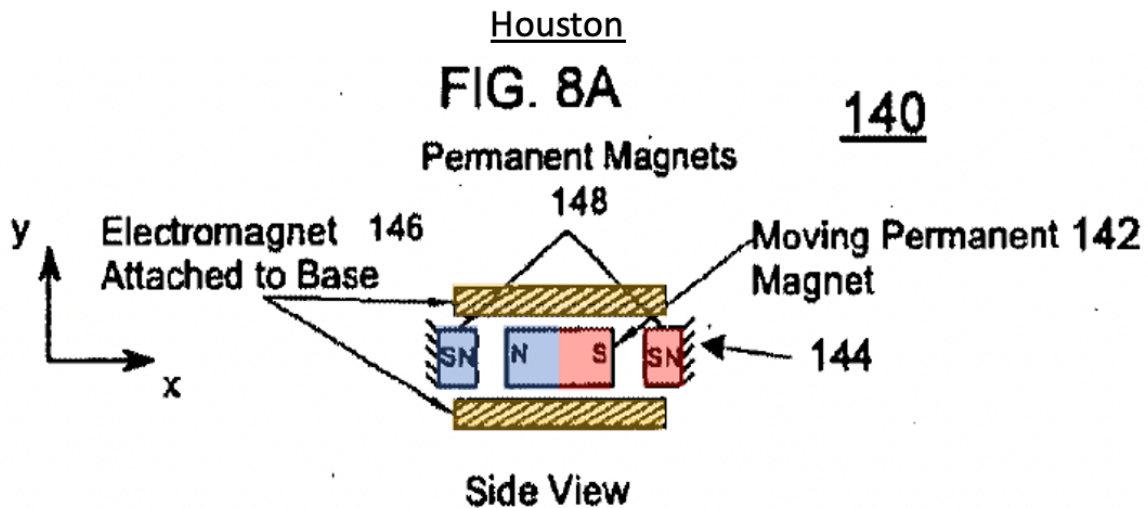
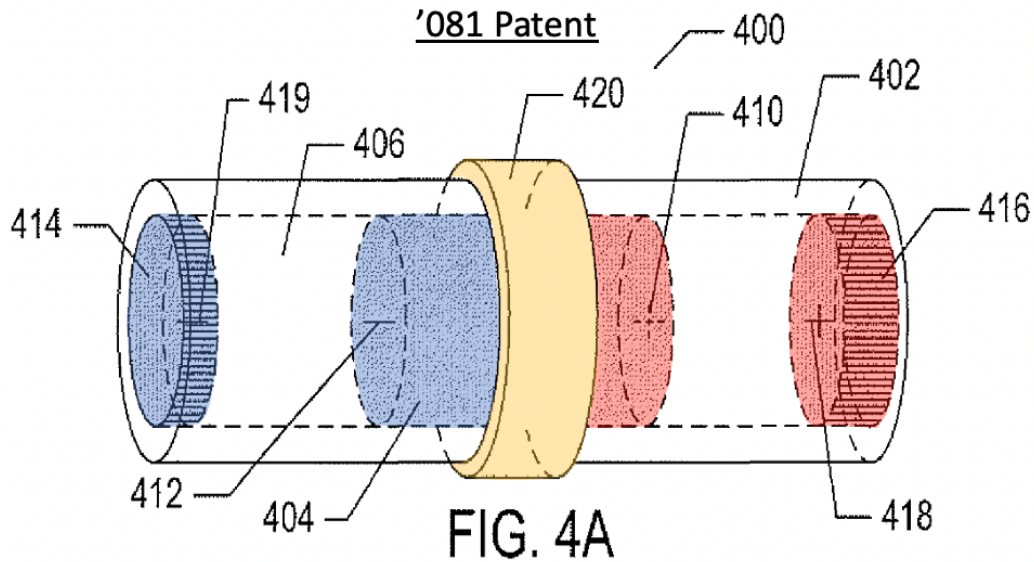
Petitioners request the Challenged Claims be found unpatentable on the following grounds:

Proposed Ground of Unpatentability
<u>Ground 1:</u> Claims 1, 2, 7, 8, and 17 are obvious under § 103(a) over Houston (Ex. 1005) and Goldenberg (Ex. 1006).
<u>Ground 2:</u> Claims 3-6 are obvious under § 103(a) over Houston, Goldenberg, and Ibuki (Ex. 1007).
<u>Ground 3:</u> Claim 11 is obvious under § 103(a) over Houston, Goldenberg, and Rosenberg (Ex. 1008).
<u>Ground 4:</u> Claims 15 and 20 are obvious under § 103(a) over Houston, Goldenberg, and Tierling (Ex. 1009).
<u>Ground 5:</u> Claim 16 is obvious under § 103(a) over Houston, Goldenberg, Tierling, and Fukumoto (Ex. 1010).

IV. SHOWING OF ANALOGOUS ART

A. Houston

Houston published on December 28, 2006, and qualifies as prior art under 35 U.S.C. §102(b). Houston teaches a vibration device that produces “haptic sensations to enhance the realism of a video game[.]” *Houston*, [0002]. Houston discloses the same linear actuator as the ’830 Patent. Specifically, each includes a magnet 142 that moves linearly in a cylindrical chamber to produce vibrations. *Compare ’830 Patent*, 4:54-62 *with Houston*, [0121], Fig. 8B (depicting magnet in a cylindrical chamber). Like the ’830 Patent, the poles of Houston’s moving magnet 142 are oriented such that moving magnet 142 is repelled by magnets 148 fixed at the ends of the chamber:



Like the '830 Patent, Houston also discloses that a fixed electromagnet 146 (i.e., a coil) is “coupled to the base 144 and at least partly surrounding the moving mass 142.” *Houston*, [0121]; *see also, id.*, [0010] (“[T]he linear motion vibration actuators each include a moving magnet and a stationary electromagnetic coil.”).

Houston is analogous to the claimed invention of the '830 Patent. Houston teaches the same linear actuator that produces vibrational forces as the '830 Patent

and is, therefore, in the same field of endeavor. *Declaration*, ¶94. Because Houston proposes using linear moving magnet actuators to generate vibrations, Houston is also reasonably pertinent to problems associated with using unbalanced electric motors to generate vibrations. *Id.*, ¶95.

B. Goldenberg

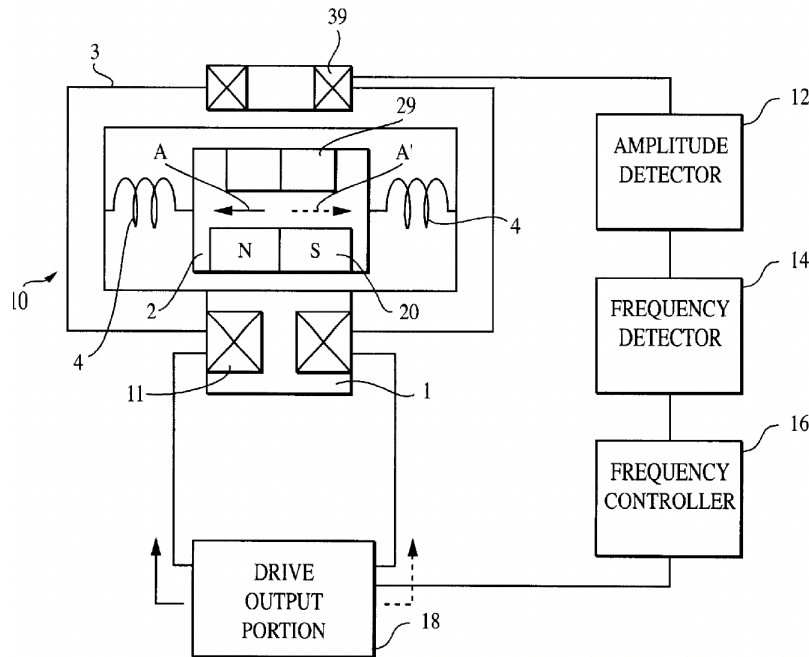
Goldenberg published on March 25, 2004, and qualifies as prior art under 35 U.S.C. §102(b). Goldenberg describes “techniques for controlling a vibrotactile interface controller, such as a haptic feedback gamepad, using more sophisticated force effects, as well as techniques for enhancing the vibrotactile feedback output by such vibrotactile controllers.” *Goldenberg*, [0016]. “[T]he term ‘vibrotactile device’ or ‘vibrotactile feedback device’ is intended to refer to any controller or interface device that outputs vibrations to the user of the device[.]” *Id.* Goldenberg’s control techniques are applied to linear actuators “including moving magnet motors, solenoids, voice coil actuators, etc.” *Id.*, [0059].

Goldenberg is analogous to the claimed invention of the ’830 Patent. Like the ’830 Patent, Goldenberg’s linear actuator produces vibrational forces via the linear oscillation of a moving magnet and is, therefore, in the same field of endeavor as the ’830 Patent. *Declaration*, ¶101. Because Goldenberg proposes using linear motion vibration actuators to generate vibrations, Goldenberg is also reasonably pertinent to problems associated with using unbalanced electric motors to generate vibrations.

Id., ¶102.

C. Ibuki

Ibuki issued on August 27, 2002, and qualifies as prior art under 35 U.S.C. §102(b). Ibuki describes a “vibrating linear actuator” including “a moving portion with a magnet and further having a spring configured to support the moving portion.” *Ibuki*, Abstract. The moving portion 2 “is supported by springs 4 that are each affixed to the frame [3].” *Id.*, 4:23-25. As shown in Figure 3, “moving portion 2 reciprocates in the direction of arrows A, A' by deforming the springs 4 and has a permanent magnet 20 that has magnetic poles N, S arranged at the side of the moving portion opposing the stator 1.” *Id.*, 4:25-29. “The actuator further includes an electromagnetic coil [11] configured to receive an electrical current, whereupon the coil moves the moving portion against a load supplied by the spring to reciprocally move the moving portion[.]” *Id.*, Abstract.



Id., Fig. 3.

Ibuki is analogous to the claimed invention of the '830 Patent. Like the '830 Patent, Ibuki describes a vibrating linear actuator and is, therefore, in the same field of endeavor as the '830 Patent. *Declaration*, ¶105. Because Ibuki proposes using a moving magnet actuator to generate vibrations, Ibuki is also reasonably pertinent to problems associated with using unbalanced electric motors to generate vibrations. *Id.*, ¶106.

D. Rosenberg

Rosenberg issued on September 8, 1998, and qualifies as prior art under 35 U.S.C. §102(b). Rosenberg describes a virtual reality system 10 including “a human/computer interface apparatus 12, an electronic interface 14, and a host computer 16.” *Rosenberg*, 8:15-18. “[T]he interface apparatus uses voice coil

actuators that produce forces in either **linear** or rotary degrees of freedom using currents applied in a magnetic fields.” *Id.*, Abstract. In the linear voice coil embodiment, magnets “form a linear channel through which a coil head ... translates.” *Id.*, 31:27-31.

Rosenberg is analogous to the claimed invention of the ’830 Patent. Like the ’830 Patent, Rosenberg discloses producing forces using linear voice coil actuators and is, therefore, in the same field of endeavor as the ’830 Patent. *Declaration*, ¶109.

E. Tierling

Tierling published on December 13, 2007, and qualifies as prior art under 35 U.S.C. §102(b). Tierling describes “computer interface devices that allow the user to provide input to computer systems and allow computer systems to provide tactile feedback to the user.” *Tierling*, [0002]. The interface device includes an actuator that outputs a “linear force ... using a linearly moving element, as in a voice coil actuator or a linear moving-magnet actuator[.]” *Id.*, [0042].

Tierling is analogous to the claimed invention of the ’830 Patent. Tierling discloses generating vibrations using a linear voice coil actuator or a linear moving-magnet actuator and is, therefore, in the same field of endeavor as the claimed invention of the ’830 Patent. *Declaration*, ¶115. Because Tierling proposes using a voice coil actuator or a linear moving-magnet actuator to generate vibrations, Tierling is also reasonably pertinent to problems associated with using unbalanced

electric motors to generate vibrations. *Id.*, ¶116.

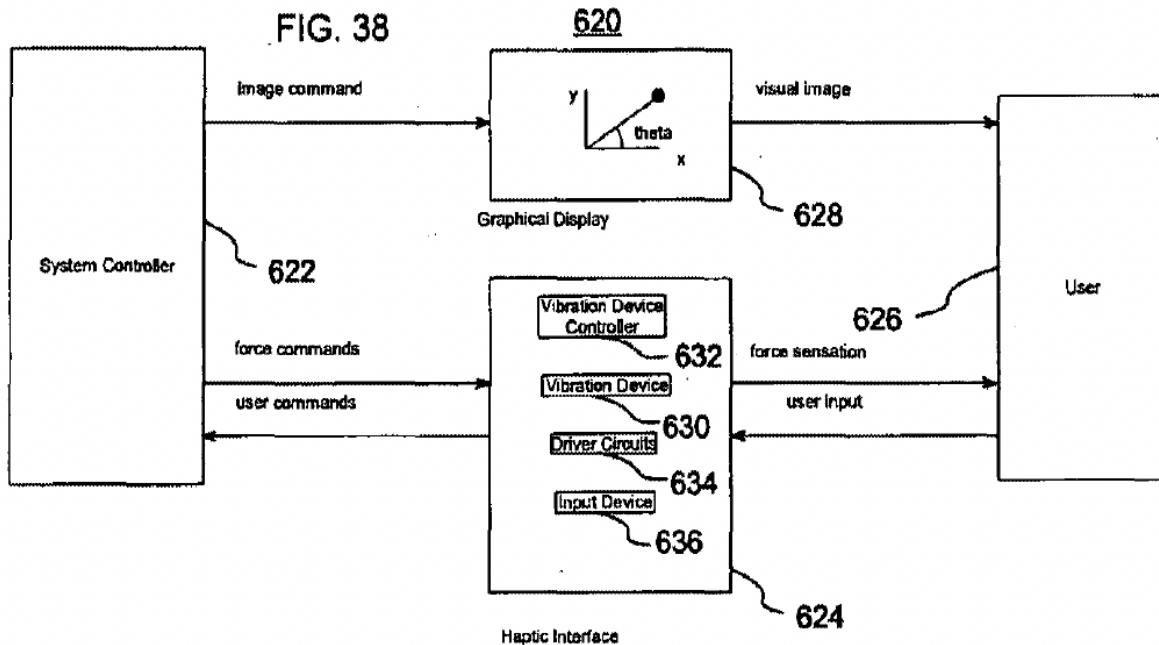
F. Fukumoto

Fukumoto published October 17, 2002, and qualifies as prior art under §102(b). Fukumoto describes an electronic device, such as a PDA, that “drives an oscillatory actuator to cause generation of vibration when it is detected that an operation input to a touch panel or operation key has been received.” *Fukumoto*, Abstract; [0146]-[0151]. “[T]he PDA 10 has a touch panel 102, a display unit 103, a key input unit 111, a memory 112, a CPU (central processing unit) 113, a drive signal generation circuit 114, and an oscillatory actuator 115.” *Id.*, [0147]; *see id.*, Figs. 1-2 and [0151] (“The oscillatory actuator 115 is a linear oscillatory actuator of a so-called moving permanent magnet type which uses a permanent magnet as a movable weight (weight) and causes the movable weight to linearly reciprocate by electromagnetic force to cause generation of vibration.”).

Fukumoto is analogous to the claimed invention of the ’830 Patent. Like the ’830 Patent, Fukumoto describes a linear actuator and is, therefore, in the same field of endeavor as the claimed invention of the ’830 Patent. *Declaration*, ¶122. Because Fukumoto proposes using a linear moving-magnet actuator to generate vibrations, Fukumoto is also reasonably pertinent to problems associated with using unbalanced electric motors to generate vibrations. *Id.*, ¶123.

V. OBVIOUS TO COMBINE EMBODIMENTS OF HOUSTON

The Grounds presented below rely on the computer system of Figure 38, which “includes a systems controller 622, which provides force commands to a haptic interface 624 that generates forces which result in force sensations being received by user 626.” *Houston*, [0213]. “A graphical display 628 is also provided for receiving image commands from the system controller 622 and for displaying a visual image to the user 626[,]” including images relating to simulations “of a user firing a gun,” “an impact between objects,” “driving a vehicle,” and “a car or spacecraft spinning out of control.” *Id.*, [0213], [00216]-[0219].



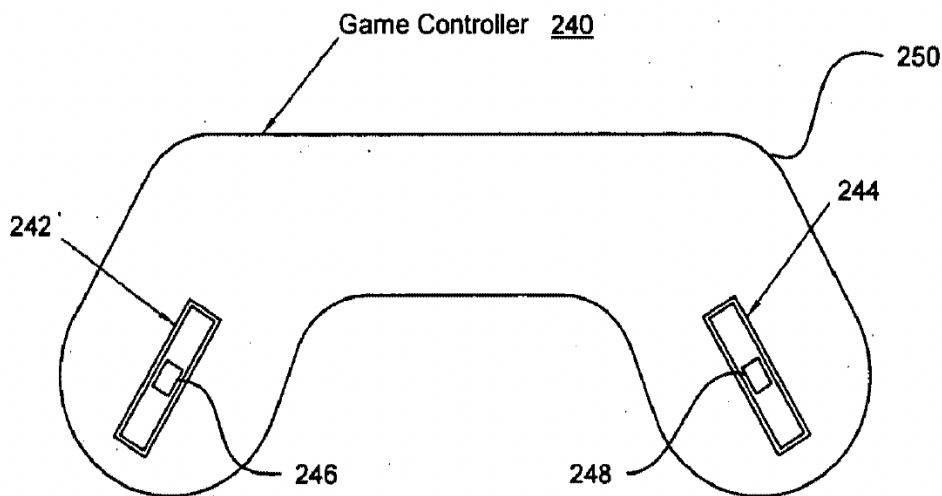
Id., Fig. 38.

The haptic interface 624 “includes a vibration device 630 having vibration

actuators (not shown), a vibration controller 632, driver circuits 634 which drive the vibration device actuators, and an input device 636, which can detect user input and which can include buttons, joysticks, and pressure sensors.” *Id.*, [0214]. “The components of the haptic interface 624 may be of **any of the configurations** described herein.” *Id.*

A. Obvious to Implement Haptic Interface 624 as the Game Controller of Figure 16

Figure 16 “illustrates a vibration device 240 having a pair of actuators 242 and 244.” *Id.*, [0157]. “In this embodiment, vibration device housing 250 is configured as a hand held game controller for computer or video games.” *Id.* “Linear motion vibration actuator 242 is shown as being located in the left handle and linear motion vibration actuator 244 is shown as being located in the right handle.” *Id.*



Id., Fig. 16.

It would have been obvious, and a POSITA would have been motivated to

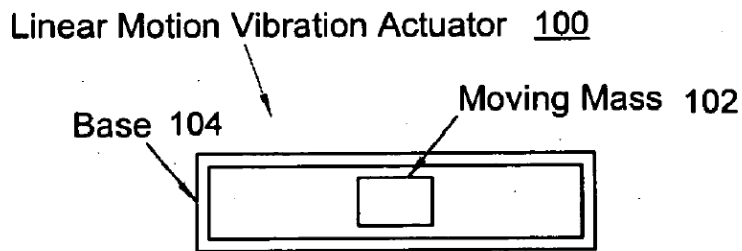
implement the haptic interface 624 of Figure 38 as the game controller 240 of Figure 16. *Declaration*, ¶132. A POSITA would have understood that the computer system of Fig. 38 directly corresponds to a computerized gaming system. *Id.*, ¶¶129-130, ¶132. Namely, user 626 provides inputs to the haptic interface 624 via input device 636, which “include[s] buttons, joysticks, and pressure sensors.” *Id.*, ¶132 (*citing Houston*, [0214], Fig. 38). A POSITA would have understood that buttons, joysticks, and pressure sensors were all input devices commonly included on video game controllers, such as depicted in Figure 16. *Id.* The user inputs are then sent to the system controller 622 as user commands, which are interpreted by the system controller and used to generate image commands for graphical display 628 and force commands for haptic interface 624. *Id.*, ¶133. Figure 38’s computer system simulates actions commonly included in video games, including firing a gun, driving a car or other vehicle, colliding with another object, etc. *Id.* Thus, a POSITA would have been motivated to combine the prior art elements of Figure 38’s computer system with Figure 16’s video game controller according to known methods to yield the predictable result of a video game system that receives user inputs and provides haptic feedback to the user. *Id.*, ¶134. Haptic interface 624 “includes a vibration device 630 having vibration actuators[.]” *Houston*, [0214]. Because game controller 240 includes linear motion vibration actuators 242, 244, it would have also been obvious to a POSITA to implement vibration device 630 using linear motion

vibration actuators 242, 244 for the same reasons. *Declaration*, ¶135.

Because video game systems including haptic game controllers were well known many years prior to the '830 Patent and because Houston teaches that “[t]he components of the haptic interface 624 may be of **any of the configurations** described herein,” there would have been a reasonable expectation of success implementing Figure 38’s haptic interface 624 using Figure 16’s game controller 240. *Id.*, ¶¶77-81, ¶136 (*citing Houston*, [0214]).

B. Obvious to Implement Vibration Device 630 Using the Linear Motion Vibration Actuator of Figure 4

It would have been obvious to implement Figure 38’s vibration device 630 using Figure 16’s linear motion vibration actuators 242, 244. *See* Section V.A. “The actuators 242 and 244 include moving masses 246 and 248, respectively.” *Houston*, [0157]. Figure 4 and its corresponding disclosure provide more details regarding linear motion vibration actuators, such as shown in Figure 16. *Declaration*, ¶¶137-138. Specifically, Figure 4 depicts a linear motion vibration actuator 100 that “contains a moving mass 102 and a base 104.” *Houston*, [0112].



Id., Fig. 4.

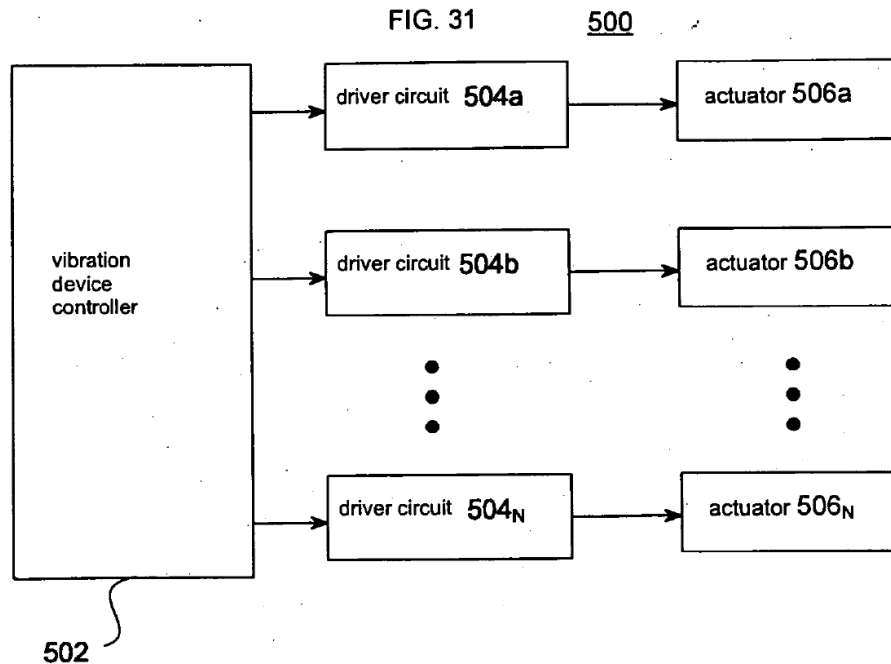
“The moving mass 102 moves relative to the base 104 in a back-and-forth linear motion.” *Id.*, [0112]. “The forces in the linear motion vibration actuator 100 may be magnetic forces, such as with a voice coil.” *Id.*, [0114]. “Magnetic forces may be generated between base 104 and the moving magnet that generate acceleration and motion of the moving mass 104.” *Id.*

It would have been obvious, and a POSITA would have been motivated to implement actuators 242 and 244, which are the actuators of vibration device 630 (see Section V.A), using Figure 4’s linear motion vibration actuator 100. *Declaration*, ¶139. A POSITA would have understood that the linear motion vibration actuators 242, 244 as they are depicted in Figure 16, are identical to the linear motion actuator 100 depicted in Figure 4 and include the same basic components, including a moving mass and a base. *Id.* Thus, a POSITA would have been motivated to look to the disclosures of Figure 4 to gain a more detailed understanding of the components of linear motion vibration actuators 242, 244. *Id.* Houston’s depiction of linear motion vibration actuators 242, 244 as identical to linear motion actuator 100 is an express teaching, suggestion, and motivation to implement linear motion vibration actuators 242, 244 using linear motion actuator 100. *Id.* Because linear motion vibration actuators 242, 244 are identical to linear motion actuator 100, there would have been a reasonable expectation of success modifying haptic interface 624 as described above. *Id.*

C. Obvious to Implement Vibration Controller 632 as a Microprocessor Per the Embodiment of Figure 31

Figure 38's haptic interface 624 also includes "a vibration controller 632" and "driver circuits 634 which drive the vibration device actuators[.]" *Houston*, [0214], Fig. 38. "The embodiment shown in FIG. 38 can be utilized so that the force sensations felt by the user 626 are **generated by the vibration device controller 632** specifically to correspond to the image on the graphical display 628." *Id.*, [0215]. "The vibration device controller 632 may specify one or more of the amplitude of vibration, $A_{combined}$, direction of force, theta, and frequency of vibration, $f[.]$ " *Id.*

Figure 31 depicts "system 500 having a controller for one or more vibration devices that use **linear motion vibration actuators[.]**" *Id.*, [0196]. "Vibration device controller 502 specifies the desired vibration effect and one or more driver circuit(s) 504_a, 504_b,...,504_N provide the necessary power to actuators 506_a, 506_b,...,506_N." *Id.*



Id., Fig. 31.

“The controller 502 may be,...a microprocessor and the driver circuit(s) 504 may be, for instance, one or more electrical amplifiers.” *Id.*, [0197]. For example, Houston teaches that the driver circuit/amplifier may be an “H bridge, such as the L298 manufactured by ST Microelectronics.” *Id.*, [0250]. Houston further teaches that “controller 502 and drive circuit 504 may be integrated into a single microprocessor[.]”*Id.*, [0197].

Houston expressly suggests using system 500 for vibration devices including linear motion vibration actuators. *Declaration*, ¶145 (*citing Houston*, [0196]). Because haptic interface 624, as modified in view of Figures 16 and 4, utilizes linear motion vibration actuators, it would have been obvious, and a POSITA would have

been motivated to implement vibration controller 632 as a microprocessor. *Id.* There would have been a reasonable expectation of success because system 500 directly applies to linear motion vibration actuators. *Id.*

**VI. THERE IS A REASONABLE LIKELIHOOD THAT THE
CHALLENGED CLAIMS ARE UNPATENTABLE**

**A. Ground 1: Houston and Goldenberg Render Claims 1, 2, 7, 8, and 17
Obvious**

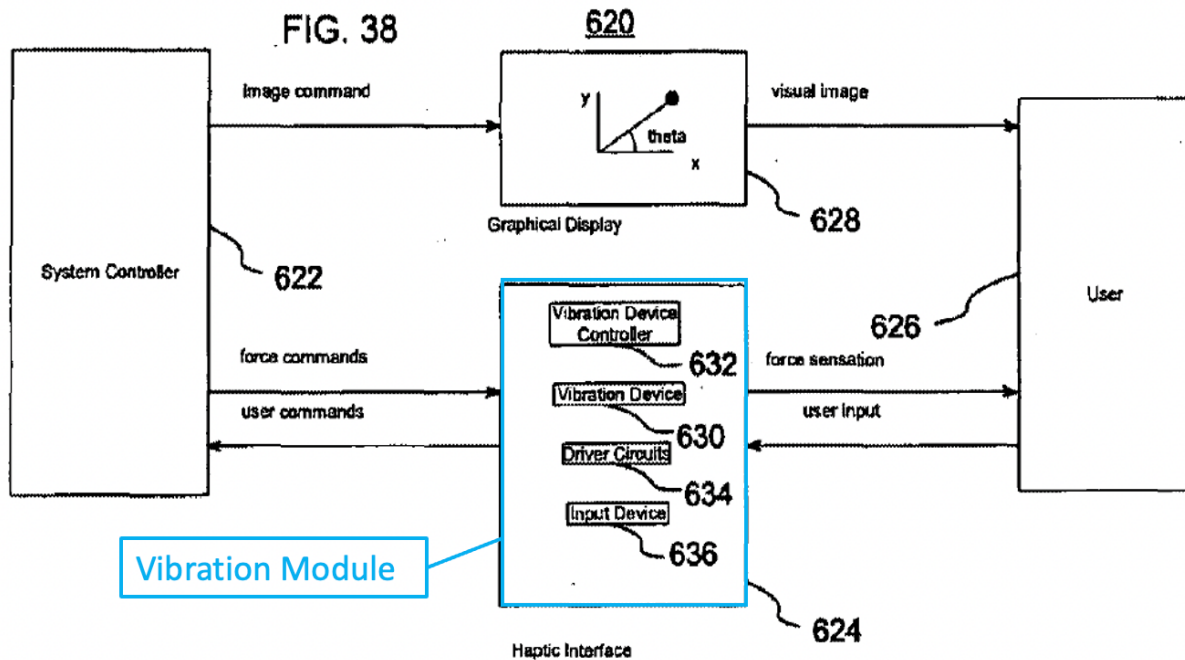
1. Claim 1

(a) Claim 1[P]

It would have been obvious to implement Houston's haptic interface 624 using Figure 16's game controller 240. *See* Section V.A. Game controller 240 includes "[l]inear motion **vibration actuator** 242...in the left handle and linear motion **vibration actuator** 244...in the right handle." *Houston*, [0157], [0018].

Since Houston's haptic interface 624 includes vibration actuators, it qualifies as the claimed vibration module.⁴

⁴ Claim language emphasized for clarity.



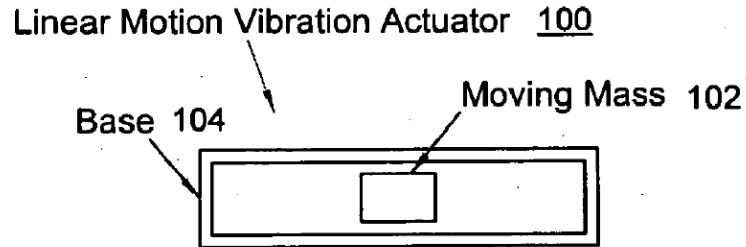
Declaration, ¶147(citing *Houston*, Fig. 38).

(b) Claim 1(a)

“FIG. 16 illustrates a vibration device 240 having a pair of actuators 242 and 244.” *Houston*, [0157]. “[V]ibration device **housing 250** is configured as a hand held game controller for computer or video games.” *Id.* It would have been obvious to implement *Houston*’s haptic interface 624 using Figure 16’s game controller 240. *See* Section V.A. Thus, housing 250 is a housing of haptic interface 624 (i.e., vibration module). *Declaration*, ¶148.

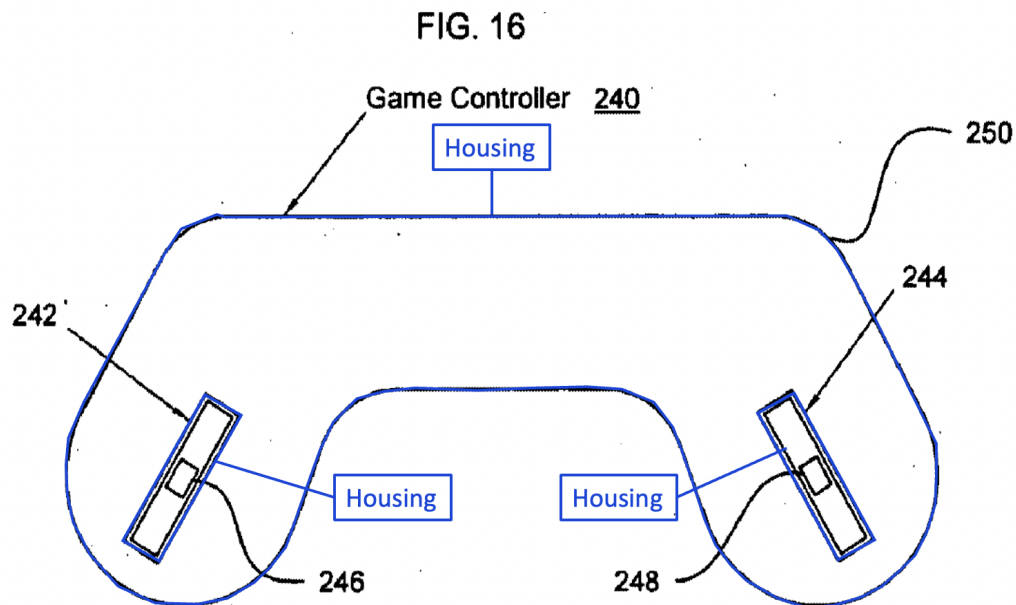
It would have also been obvious to implement each linear motion vibration actuator 242, 244, which are the actuators included in haptic interface 624’s vibration device 630, using the linear motion vibration actuator 100 of Figure 4. *See*

Section V.B. As shown in Figure 4, the linear motion vibration actuator 100 includes a base 104, which is a housing that encloses moving mass 102:



Houston, Fig. 4; *Declaration*, ¶149.

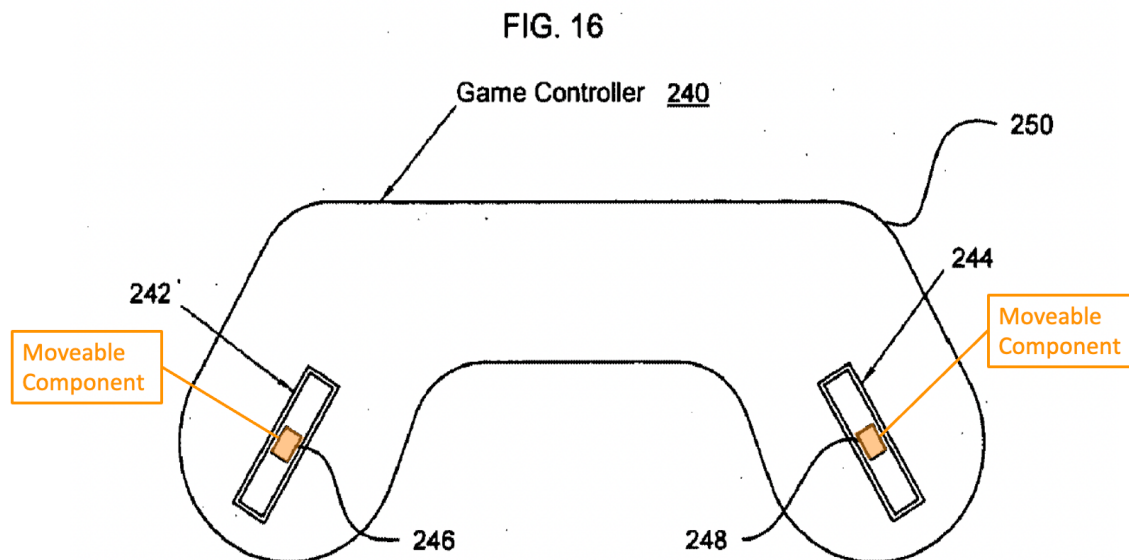
Thus, the vibration device housing 250 and the base of each linear motion vibration actuator 242, 244 each individually qualifies as a housing:



Declaration, ¶150 (citing *Houston*, Fig. 16).

(c) Claim 1(b)

It would have been obvious to implement Houston's haptic interface 624 using Figure 16's game controller 240. *See* Section V.A. Game controller 240 includes linear motion vibration actuators 242, 244, which “include moving masses 246 and 248, respectively.” *Houston*, [0157]. Each moving mass “**moves** relative to the base 104 in **a back-and-forth linear motion.**” *Id.*, [0112]; Section V.B. Each moving mass 246, 248 qualifies as a moveable component:



Declaration, ¶151 (citing *Houston*, Fig. 16).

(d) Claim 1(c)

1) *Houston Implicitly Teaches “a power supply”*

Houston's haptic interface 624 also includes “a vibration controller 632” and “driver circuits 634 which drive the vibration device actuators[.]” *Houston*, [0214], Fig. 38. It would have been obvious to a POSITA to implement vibration controller

632 and driver circuits 634 using the components described with respect to system 500 depicted in Figure 31. *See* Section V.C. With respect to Figure 31, Houston teaches that the vibration controller “specifies the desired vibration effect and one or more driver circuit(s) 504 a, 504 b,...,504 N **provide the necessary power** to actuators 506a, 506b,...,506N.” *Houston*, [0196], [0242] (“The driver circuit provides sufficient **current and voltage** to drive the Actuators with the **necessary electrical power.**”).

A POSITA would reasonably read Houston to understand that the haptic interface 624 implicitly includes a power supply to “provide the necessary power to actuators[.]” *Declaration*, ¶153; *see IXI IP, LLC v. Samsung Elecs. Co.*, 903 F.3d 1257, 1262–65 (Fed. Cir. 2018) (analyzing an implicit disclosure theory); *see also In re Burckel*, 592 F.2d 1175, 1179 (CCPA 1979) (“Under 35 U.S.C. § 103, a reference must be considered not only for what it expressly teaches, but also for what it fairly suggests.”).

2) *The Combination of Houston and Goldenberg Renders Obvious “a power supply”*

To the extent it is found that a power supply is not implicitly taught by Houston, the claimed power supply would have been obvious to a POSITA based on the teachings of Goldenberg. *Declaration*, ¶¶154-156. Goldenberg teaches “a vibrotactile interface controller,” which is an “interface device that outputs vibrations to the user of the device[.]” *Goldenberg*, [0016]. Goldenberg’s device

includes a power supply 120 “included in or coupled to device 104, and can be coupled to actuator interface 124 and/or actuators 120 and 122 to provide electrical power to the actuators.” *Id.*, [0034].

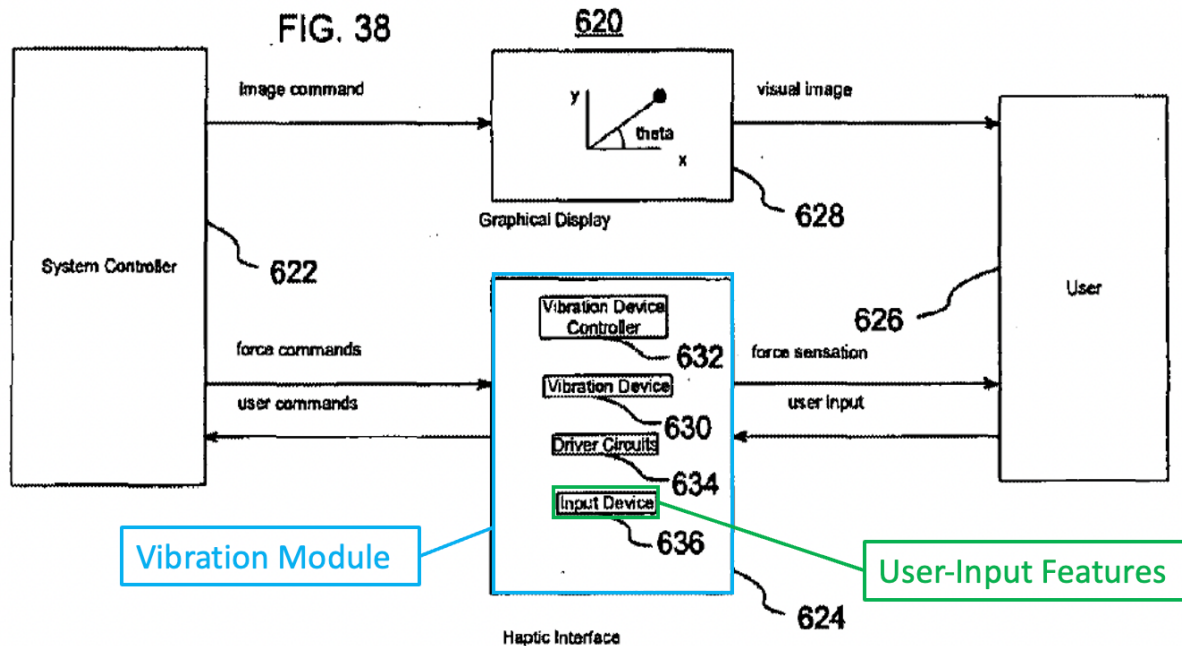
Houston teaches providing power to the actuators. Goldenberg teaches an interface device having a power supply that provides power to actuators. A POSITA would have understood that a power supply would be incorporated into Houston’s haptic interface according to the known methods taught by Goldenberg. *Declaration*, ¶155. A POSITA would have appreciated that incorporating Goldenberg’s power supply into Houston’s haptic interface would not have changed the haptic interface’s function in any way because each element would perform the same function as it does separately. *Id.* A POSITA would have understood that Houston’s haptic interface would have required a power supply to function as described. *Id.* Including a power supply in Houston’s haptic interface would have predictably enabled the driver circuits to supply power to the vibration actuators. *Id.* Thus, a POSITA would have been motivated to combine the prior art elements of Goldenberg’s power supply and Houston’s haptic interface according to known methods to yield the predictable result of a haptic interface device that is able to provide power to vibration actuators. *Id.*

A POSITA would have understood that power supplies were well-known components of user interface devices, such as Houston’s haptic interface, for

decades prior to the invention of the '830 Patent. *Id.*, ¶¶69-70, ¶156. Thus, there would have been a reasonable expectation of success incorporating a power supply into Houston's haptic interface. *Id.*, ¶156.

(e) Claim 1(d)

Houston's haptic interface includes "an input device 636, which can detect user input and which can include buttons, joysticks, and pressure sensors." *Houston*, [0214], [0030], [0210]. Per the '830 Patent, examples of "user-input features" include "buttons, sliders, and other types of user-input features." '830 Patent, 4:36-40. Therefore, Houston's input device 636 qualifies as the claimed user-input features since it also includes buttons and other types of user-input devices:



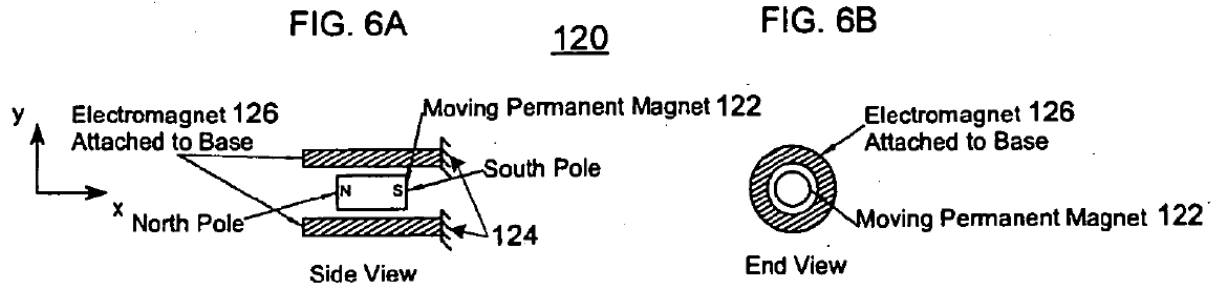
Declaration, ¶157 (citing *Houston*, Fig. 38).

(f) Claim 1(e)

Petitioners interpret this limitation under §112 ¶6 where “one or more coils or electromagnets” perform the function of “driving the moveable component to oscillate within the housing” under PO’s interpretation of the claim. *See* Section II.D.

Houston teaches that the linear motion vibration actuator’s “base 104 may contain...**an electromagnet**[.]” *Houston*, [0114]; *see* Section V.B. “Magnetic forces may be generated between base 104 and the moving magnet that **generate acceleration and motion of the moving mass 104.**” *Houston*, [0114]. “A force in the linear motion vibration actuator 100 generated with **an electromagnet** can be modulated by controlling the current flowing through the **electromagnet.**” *Id.*

Houston provides three example implementations of linear motion vibration actuator 100 where an electromagnet is attached to the base including Figs. 6-8. Figures 6A-B depict “embodiment of the linear motion vibration actuator 100” including “an **electromagnet** magnet 126 attached to base 124.” *Id.*, [0117]. “The **electromagnet 126 is preferably a coil** wound about the x axis.” *Id.* “As shown in the end view of FIG. 6B, in this embodiment the shape of the **electromagnet 124** is tubular and the shape of the permanent magnet is cylindrical.” *Id.*



Id., Figs. 6A-B.

Houston further teaches that controlling the current in the electromagnetic coil 126 drives the moving mass (i.e., moveable component) to oscillate within the base (i.e., housing):

The force in the actuator 120 can be modulated by controlling the current in the electromagnetic coil 124. When the current in the electromagnetic coil 124 flows in one direction, then the magnetic force will push the moving mass 122 towards one side of the actuator 120. Conversely when the current in the electromagnetic coil flows in the other direction, then the moving mass 122 will be pushed to the other side of the actuator 120. Increasing the amount of current in the electromagnetic coil will increase the amount of force applied onto the moving mass 122.

Id., [0118].

The implementations of linear motion vibration actuator 100 depicted in Figures 7A-B and 8A-B also include the same electromagnetic coil attached to the base as Figs. 6A-B. *Id.*, [0119], [0121], Figs. 7A-B, 8A-B; *Declaration*, ¶160.

Houston's electromagnetic coil is "one or more coils or electromagnets" and

meets the structural requirement of this means-plus-function limitation. *Declaration*, ¶¶159-161. Because reversing the current in the electromagnetic coil causes the moving mass to move in a back-and-forth linear motion within the actuator housing, the electromagnetic coil performs the function of “driving the moveable component to oscillate within the housing.” *Id.*, ¶¶162-163.

It would have been obvious, and a POSITA would have been motivated to implement the linear motion vibration actuator 100 using an electromagnetic coil wound about the base, as expressly suggested by Houston in the embodiments of Figs. 6-8. *Id.*, ¶164. As taught by Houston, a POSITA would have understood that this configuration would have predictably allowed the controller to control the force and direction of the moving mass by controlling the current applied to the electromagnetic coil. *Id.* Because electromagnetic coils were well understood by POSITAs and because an electromagnetic coil is expressly suggested by Houston, there would have been a reasonable expectation of success implementing the linear motion vibration actuator using an electromagnetic coil wound about the base. *Id.*, ¶¶62-68, ¶165.

(g) Claim 1(f)

Petitioners interpret this limitation under §112 ¶6 where an “oscillator circuit; microcontroller with internal or external memory; processor; CPU; microprocessor; and equivalents thereof” perform the function of “controlling supply of power from

the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values” under PO’s interpretation of the claim. *See* Section II.D.

Figure 38’s haptic interface 624 also includes “a vibration controller 632” and “driver circuits 634 which drive the vibration device actuators[.]” *Houston*, [0214], Fig. 38. It would have been obvious to implement the vibration controller 623 as a microprocessor. *See* Section V.C. Thus, *Houston* teaches that vibration controller 623 is a microprocessor thereby satisfying the structural requirement of this means-plus-function limitation. *Id.*; *Declaration*, ¶167.

The vibration controller/microprocessor also controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude. *Declaration*, ¶¶168-172. Specifically, *Houston* teaches that the vibration controller “specifies the desired vibration effect and one or more driver circuit(s) 504 a, 504 b,...,504 N **provide the necessary power to actuators** 506 a, 506 b,...,506 N.” *Houston*, [0196]. The vibration effects specified by the vibration controller include “one or more of the **amplitude of vibration**, $A_{combined}[.]$ direction of force, theta, and **frequency of vibration**, $f[.]$ ” *Id.*, [0215], Abstract (“A controller may send signals to one or more driver circuits for directing operation of the actuators. The controller may provide direction and **amplitude** control, vibration control, and **frequency** control to direct the haptic

experience.”), [0198] (“Here the controller 502 specifies the desired **vibration amplitude, A, frequency, f**, and phase, p, for each actuator 506.”), Fig. 32.

Controlling the direction of the current in the actuator’s electromagnetic coil (i.e., *the driving component*) drives the moving mass to oscillate within the base. *See* Claim 1(e); *Declaration*, ¶169. A POSITA would have understood that the frequency at which the current is switched in the electromagnetic coil corresponds to the frequency of oscillation of the moving mass. *Declaration*, ¶169. Houston also teaches that “[i]ncreasing the amount of current in the electromagnet will increase the amount of force applied onto the moving mass 122.” *Houston*, [0118]; Claim 1(e). A POSITA would have understood that, like the ’081 Patent, Houston teaches controlling the current to control the amount of force applied to the moving mass, thereby controlling the amplitude of vibration in the same way as described in the ’830 Patent. *Declaration*, ¶170. Thus, both the frequency and amplitude of the moving mass’s oscillation are directly controlled by the current applied to the electromagnetic coil, which is, in turn, controlled by the vibration controller/microprocessor. *Id.*, ¶171.

Because Houston teaches that (1) the vibration controller/microprocessor specifies the desired vibration effect (i.e., the frequency and amplitude) so that the driver circuits can provide the necessary power to actuators and (2) the vibration controller/microprocessor controls the current applied to the actuators’

electromagnetic coils to produce the desired vibration effect, a POSITA would understand that the vibration controller/microprocessor controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude. *Id.*, ¶172.

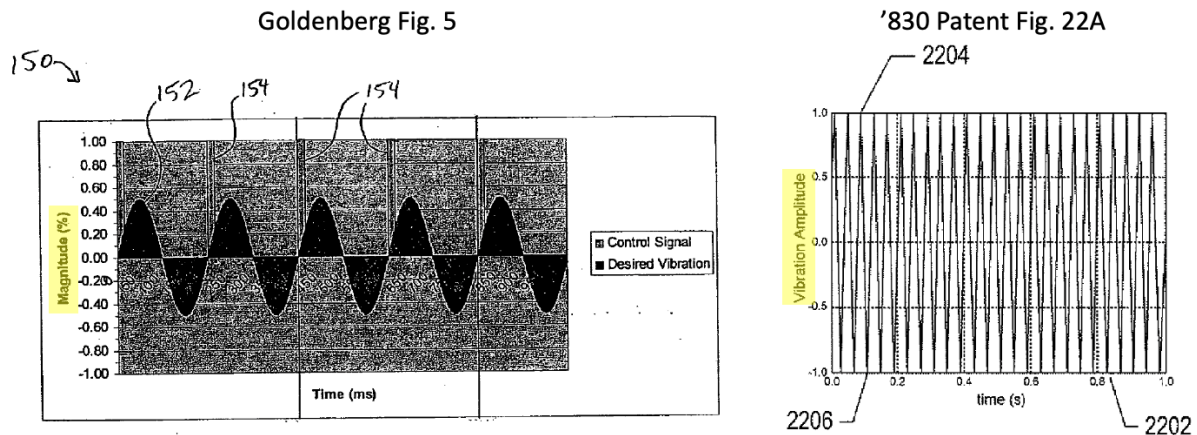
In related art, Goldenberg teaches a vibrotactile device 104 that includes a local microprocessor and memory for storing force profiles that dictate the frequency and amplitude of vibration. *Declaration*, ¶¶173-178. Specifically, Goldenberg’s system “includes a host computer 102 and a vibrotactile device 104.” *Goldenberg*, [0017]. “Vibrotactile interface device 104 is coupled to host computer 102 by a bi-directional bus 108.” *Id.*, [0022]. Vibrotactile device 104 includes a local microprocessor 110 that is “included within the housing of device 104” and is “a separate microprocessor from any processors in host computer 102.” *Id.*, [0023]. Local microprocessor 110 “allow[s] efficient communication with other components of the device” and is “dedicated to haptic feedback and sensor I/O of device 104.” *Id.* Thus, a POSITA would have understood that Goldenberg’s local microprocessor 110 is similar to Houston’s vibration controller/microprocessor in that they are both located within a haptic device (e.g., video game controller) and control the vibrations output by the actuators. *Declaration*, ¶174.

“[P]rocessor 110 can **operate independently** of host computer 102 by reading sensor signals and **calculating appropriate forces** from those sensor signals, time

signals, and **stored** or relayed **instructions** selected in accordance with a high level host command.” *Goldenberg*, [0023]. “The microprocessor 110 can process inputted sensor signals to determine appropriate output actuator control signals by following **stored instructions**.” *Id.*, [0025]. To accomplish this, vibrotactile device 104 also includes “[l]ocal memory, such as RAM and/or ROM” that is “coupled to microprocessor 110 in device 104 to store instructions for microprocessor 110 and store temporary and other data.” *Id.*, [0029]. “For example, **force profiles can be stored in memory**, such as a **sequence of stored force values** that can be output by the microprocessor, or a **look-up table of force values** to be output based on current events in the application program or other conditions.” *Id.* Houston further teaches that “the local microprocessor can include a **look-up table or other data to map certain kinesthetic force effects** to vibrotactile effects and control the motors appropriately.” *Id.*, [0046].

“Kinesthetic force effects can be organized into periodic and non-periodic effects.” *Id.*, [0045]. “Periodic effects are those force feedback effects, which are based on time and controlled with a periodic waveform.” *Id.*, [0057]. “For example, a vibration is a basic periodic effect in which a waveform type, such as a sine wave or square wave, is commanded to output the vibration at a particular **frequency (period) and magnitude**.” *Id.* An exemplary periodic effect “is illustrated in the graph 150 shown in FIG. 5” and includes “[a] sine wave 152 of **frequency 5 Hz and**

50% magnitude[.]” *Id.*, [0061]. As shown in the following comparison of Goldenberg’s Fig. 5 and the ’830 Patent’s Fig. 22A, Goldenberg’s “magnitude” is the same as the ’830 Patent’s “vibrational amplitude.”



Declaration, ¶177.

Thus, Goldenberg teaches caus[ing] the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values. *Declaration, ¶178.*

Based on the teachings of Goldenberg, it would have been obvious, and a POSITA would have been motivated to configure Houston’s vibration controller to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values. *Id.*, ¶179. First, a POSITA would have recognized that Houston and Goldenberg are combinable because both are directed to providing vibration effects in devices, such as game controllers, using linear actuators having moving magnets. *Houston*, [0002], [0007], [0112]-[0114], [0430], Figs. 4-8B, 16;

Goldenberg, [0016], [0059], Figs. 1-3; *Declaration*, ¶179. Houston teaches that the vibration controller/microprocessor outputs the desired amplitudes and frequencies to the driver circuits to direct the operation of the actuators. *Declaration*, ¶180 (*citing Houston*, [0215]). *Goldenberg* teaches a local microprocessor that controls the frequency and amplitude of vibration of the actuators based on stored values. *Id.* A POSITA would have appreciated that incorporating *Goldenberg*'s stored values for vibration effects would not have changed *Houston*'s device's function in any way because each element is still performing the same function. *Id.* Thus, a POSITA would have been motivated to combine the prior art elements of *Houston*'s vibration controller/microprocessor and *Goldenberg*'s stored values to yield the predictable result of a haptic interface that controls the actuators independently of the system controller. *Id.*

A POSITA would have understood that allowing the vibration controller/microprocessor to control the vibrations independently of the system controller would have predictably reduced the amount of communication required between the system controller and haptic device. *Id.*, ¶181. For example, instead of transmitting low level force commands dictating the specific frequencies and amplitudes, the system controller instead would send high level commands that are then converted by the vibration controller/microprocessor into specific frequencies and amplitudes based on the locally stored values as taught by *Goldenberg*. *Id.* This

would have predictably reduced the computational load of the system controller by removing the need for it to generate specific haptic waveforms in response to user input. *Id.* A POSITA would have appreciated that this modification would have only required minor software changes to Houston’s system controller 622 and haptic interface 624. *Id.* Given the predictability of computer programming, there would have been a reasonable expectation of success configuring Houston’s haptic interface cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values. *Id.*, ¶182.

2. Claim 2⁵

Goldenberg teaches a vibrotactile device 104 that includes “a local microprocessor 110” that is “dedicated to haptic feedback and sensor I/O of device 104.” *Goldenberg*, [0023]. “Microprocessor 110 can be provided with **software instructions** to wait for commands or requests from host 102, decode or parse the command or request, and handle/control input and output signals according to the command or request.” *Id.* “Microprocessor 110 can...provide signals to actuators 120 and 122 in accordance with instructions provided by host computer 102 over

⁵ Given the alternative language, Petitioners interpret this limitation as being “met either by a ‘variable oscillator circuit...’ or by ‘a control component that includes a microprocessor....’”

bus 108.” *Id.*, [0024]. “[H]ost computer 102 provides high level supervisory commands to microprocessor 110 over bus 108, and microprocessor 110 decodes the commands and manages low level force control loops to sensors and the actuator in accordance with the high level commands and independently of the host computer 102.” *Id.*, [0025]. “Local **memory**, such as RAM and/or ROM, can be **coupled to microprocessor 110** in device 104 to store instructions for microprocessor 110[.]” *Id.*, [0029]. Thus, Goldenberg teaches a microprocessor coupled to a memory that stores software instructions (i.e., *a control program*) for the microprocessor. *Declaration*, ¶185. Because the memory is coupled to the microprocessor, it is *an electronic memory within, or separate from, the microprocessor*. *Id.*, ¶186.

Based on the teachings of Goldenberg, it would have been obvious, and a POSITA would have been motivated to couple a memory storing a control program to Houston’s vibration controller/microprocessor. *Id.*, ¶187. As discussed above, Houston in view of Goldenberg teaches that vibration controller 632 is *a microprocessor that control[s] supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by the one or more stored values*. See Claim 1(f). A POSITA would have understood that Houston’s vibration controller/microprocessor would need to execute a control program to perform the described functions. *Declaration*, ¶187. A POSITA would have also understood that the control program would need

to be stored in an electronic memory so that it could be loaded and executed by the microprocessor. *Id.* Goldenberg teaches a microprocessor coupled to a memory that stores software instructions for the microprocessor. *Id.*, ¶185; *Goldenberg*, [0023]-[0025], [0029].

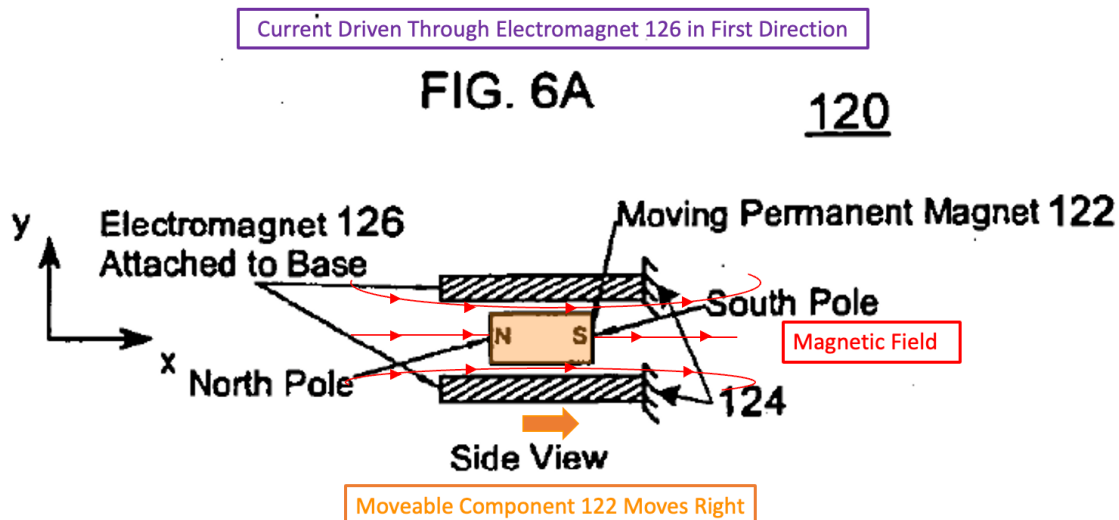
The claim requires the well-known elements of a microprocessor, a control program that is executed by the microprocessor, and an electronic memory for storing the control program. *Declaration*, ¶188. Houston teaches a microprocessor but is silent regarding a memory and control program. *Id.* Goldenberg teaches a microprocessor that executes software instructions, which are stored in an electronic memory. *Id.* The only difference between the claim and the prior art is the combination of the known prior art elements into a single device by coupling Goldenberg's electronic memory storing a control program to Houston's microprocessor without a change to the respective functions of either Houston's microprocessor or Goldenberg's memory. *Id.* Given the predictability and ubiquity of coupling microprocessors to memories storing control programs, there would have been a reasonable expectation of success modifying Houston in this way. *Id.*, ¶189.

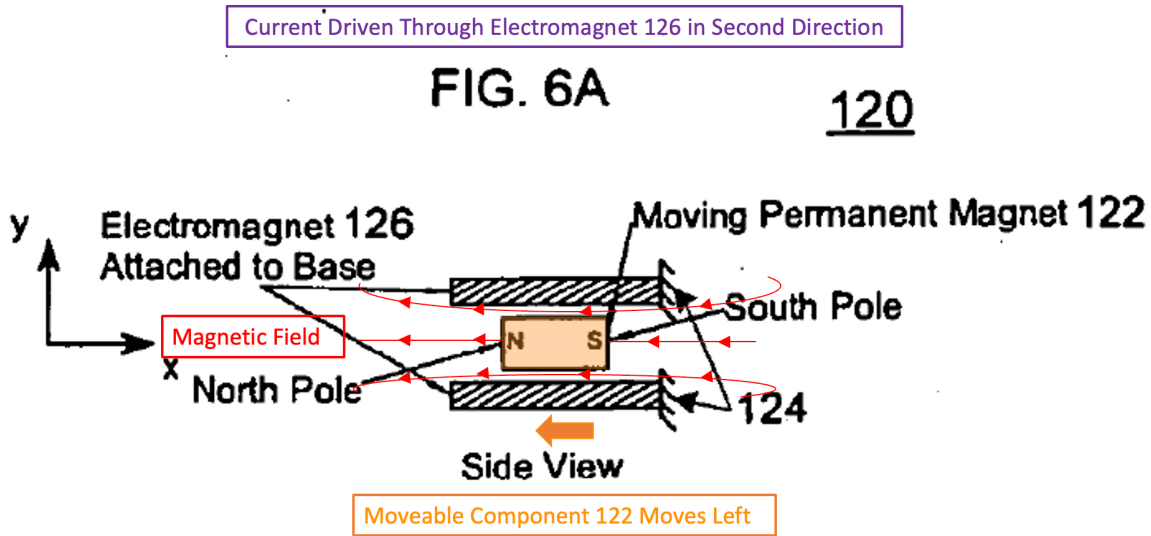
3. Claim 7

Houston's driving component comprises one or more electromagnetic coils. See Claim 1(e). Houston further teaches that “[t]he force in the actuator 120 can be

modulated by controlling the current in the electromagnet 124.” *Houston*, [0118].

“When the current in the electromagnet 124 flows in one direction, then the **magnetic force** will push the moving mass 122 towards one side of the actuator 120.” *Id.* “Conversely when the current in the electromagnet flows in the other direction, then the moving mass 122 will be pushed to the other side of the actuator 120.” *Id.* A POSITA would have understood that when the current is moving in one direction in the electromagnetic coil, a magnetic field is generated that causes the mass to move in a first direction (e.g., left), and when the current is reversed, a magnetic field is generated that causes the mass to move in the opposite direction (e.g., right). *Declaration*, ¶¶190-194. As shown in the annotated figures below, the magnetic fields inside electromagnetic coil 126 are parallel to the directions in which the moveable component is driven by the driving component:





Id., ¶194 (citing *Houston*, Fig. 6A).

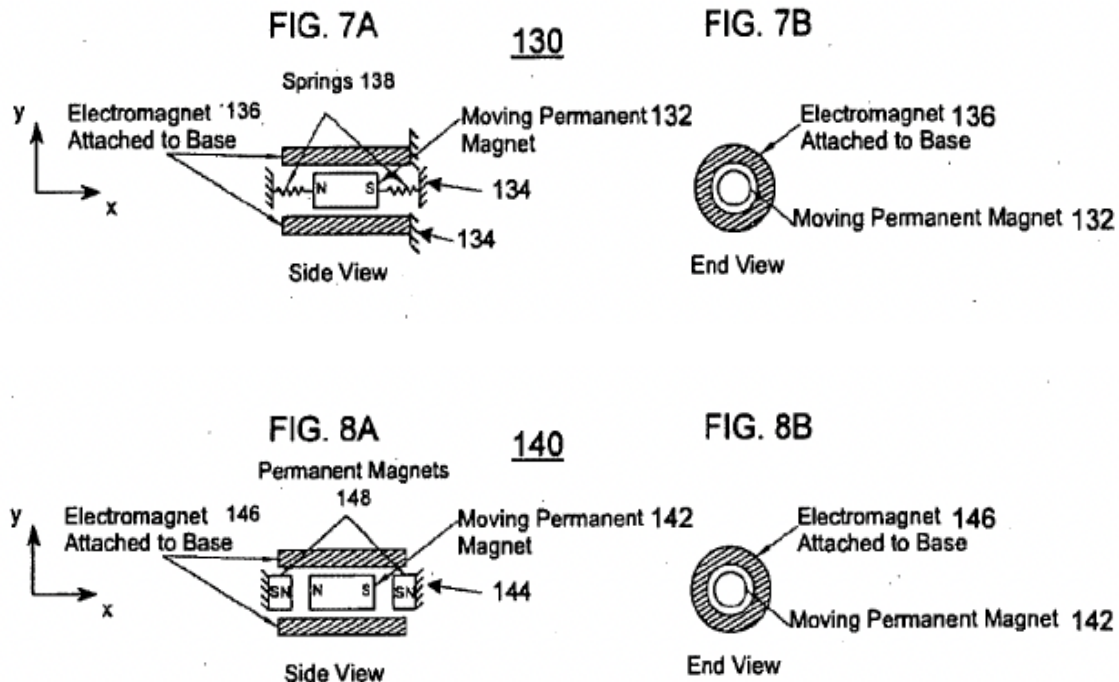
A limitation is inherent if it is the “natural result flowing from” the prior art’s explicit disclosure. *Schering Corp. v. Geneva Pharms.*, 339 F.3d 1379 (Fed. Cir. 2003). As explained by Dr. Welch, the fact that the magnetic fields inside electromagnetic coil 126 are parallel to the directions in which the moveable component is driven by the driving component is a direct result of Ampère’s law, which governs the direction of the magnetic field inside an electromagnetic coil. *Declaration*, ¶60, ¶94. Thus, this limitation is invalid based on inherency because it is “not an additional requirement imposed by the claims...but rather a property necessarily present.” *In re Kubin*, 561 F.3d 1351, 1357 (Fed. Cir. 2009).

4. Claim 8

(a) Claim 8(a)

Houston teaches several possible configurations of a vibration actuator. For

example, Houston teaches embodiments of the vibration actuator where *the housing is a tube, capped at both ends by movable-component-repelling components, including mechanical springs and magnets*. As shown in Figures 7B and 8B, the base 134/144 (i.e., *the housing*) *is a tube* containing a moving magnet 132/142:



Houston, Figs. 7-8; Declaration, ¶196.

In the embodiment of Figure 7, the linear tube is capped at both ends by *mechanical springs* 138. *Houston, Fig. 7A, [0119]* (“[T]he actuator 130 in this embodiment preferably includes one or more **springs 138 that are attached to the base 134** and to the moving magnet 132 at either end, as shown in the side view of FIG. 7A.”) “The springs 138 are operable to generate forces in a direction that returns the moving mass 132 to a center position, for instance midway between either

end of the electromagnet 136.” *Id.*, [0119]. Thus, springs 138 repel moving mass 132 towards the center of the linear tube. *Declaration*, ¶197.

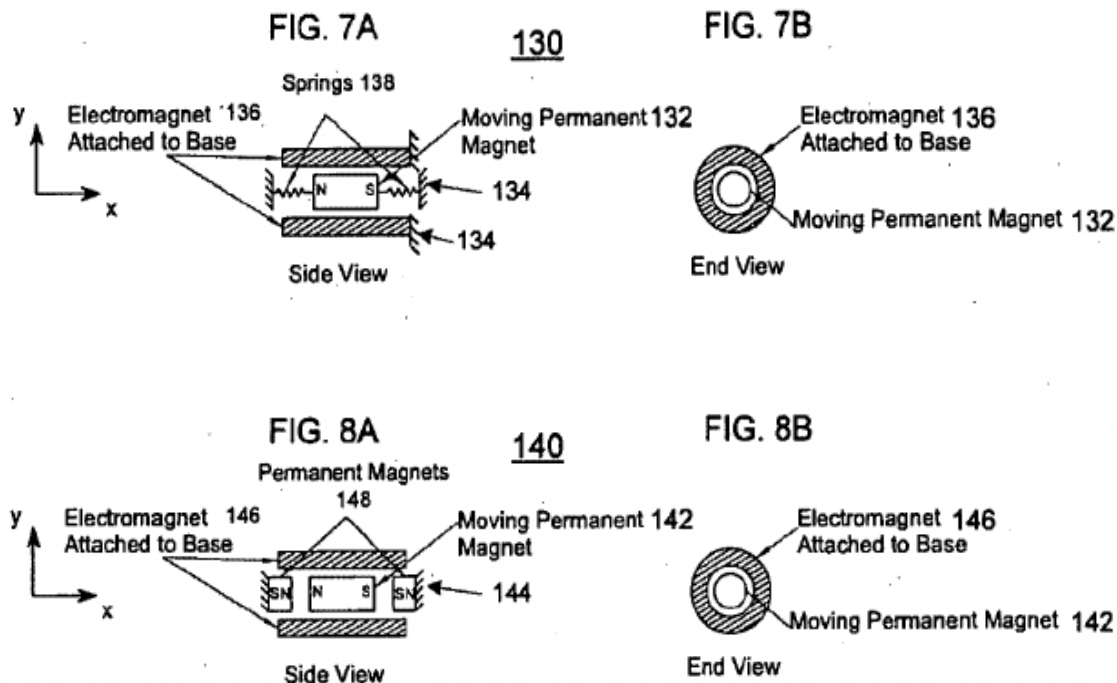
Alternatively, the embodiment of Figure 8 teaches capping both ends of the linear tube with magnets 148. *Houston*, Fig. 8A, [0121] (“[A] pair of permanent magnets 148 is attached to the base and are in operative relation to the moving magnet 142 at either end as shown in the side view of FIG. 8A.”). “The permanent magnets 148 have poles, as shown by the N and S in FIG. 8A, which are configured to repel the moving mass 142 and to generate forces in a direction that returns the moving mass 142 to a center position.” *Id.*, [0121]. Thus, magnets 148 repel moving mass 142 towards the center of the linear tube. *Declaration*, ¶198.

It would have been obvious to a POSITA to implement Houston’s actuator using either of the implementations shown in Figures 7 and 8. *Declaration*, ¶199. For example, a POSITA would have understood that using springs, per Figure 7, would have been advantageous in situations where the design goal is to minimize costs. *Id.* Likewise, a POSITA would have understood that using magnets, per Figure 8, would have been advantageous in situations where the design goal is to create an actuator with increased efficiency and smoothness. *Id.*, ¶200. Houston teaches that “the components of the haptic interface 624 may be of **any of the configurations** described herein.” *Houston*, [0214]. A POSITA would have been motivated to implement the vibration device 630 as either of the embodiments of Figures 7 and 8

as expressly suggested by Houston. *Declaration*, ¶200. Springs and magnets were well-understood at the time of the '830 Patent. *Id.*, ¶201. Thus, there would have been a reasonable expectation of success configuring Houston's haptic interface 624 to include either of these actuators. *Id.*

(b) Claim 8(b)

In both the embodiments of Figures 7 and 8, the movable component is a magnet 132/142 shaped to slide within the tube:



Houston, Figs. 7-8, [0117] (“As shown in the end view of FIG. 6B, in this embodiment the shape of the electromagnet 124 is tubular and the **shape of the permanent magnet is cylindrical.**”), [0119] (“[I]n accordance with aspects of the present invention is shown in FIGS. 7A-B, which is similar to the embodiment

shown in FIGS. 6A-B...The moving mass 132 preferably comprises a permanent magnet.”), [0121] (“This embodiment is similar to the embodiments shown in FIGS. 6A-B and 7-B in that actuator 140 includes a moving mass 142 including a permanent magnet...”); *Declaration*, ¶202.

It would have been obvious to a POSITA to implement Houston’s actuator using either of the implementations shown in Figures 7 and 8 for the same reasons as the previous limitation. *See* Claim 8(a); *Declaration*, ¶203.

(c) Claim 8(c)

See Claim 1(e).

5. Claim 17

Goldenberg teaches that “a magnitude and frequency of the vibration can be adjusted **independently** of each other by adjusting the control signal.” *Goldenberg*, Abstract; [0059] (“The present inventive method of control allows independent variation of magnitude and frequency of ... [an] actuator.”); *Declaration*, ¶177 (opining that the magnitude of vibration corresponds to amplitude). Goldenberg teaches that its system “can play a range of **frequencies** at any **amplitude**” and that its “control methods ... can be applied not only to rotational motors ... but other types of 1 DOF actuators, rotational and **linear, including moving magnet motors**[.]” *Goldenberg*, [0059]. In its control method, a frequency command, a magnitude command, and a function ... are supplied as parameters or inputs[.]” *Id.*

Mappings of vibrotactile effects to kinesthetic effects are provided in Goldenberg's system, which are "tailored for the most realism in a particular application." *Id.*, [0043]-[0044]. "A set of mappings may [] include settings for overall magnitudes provided in 'control panel'" that "allow the user to **adjust the overall magnitudes of particular force sensations** (or an overall gain of all force sensations) to a desired level." *Id.*, [0050]; *see id.*, [0090] ("If condition forces are played ... the user should preferably be given the opportunity to ... alter them per situation, perhaps in a profiler program presented at the application layer or other software layer on the host computer."), [0095] ("Customers are further able to choose how much haptic feedback functionality and sophistication that want[.]"). The set of mappings can also include settings for "force sensations to maximize the effectiveness of the vibrotactile effects for that type of application program[,] such as spring forces for a driving game being set to lower magnitude while increasing the amplitude of vibration forces. *Id.*, [0050]. Non-periodic effects, such as the "vibration frequency" for vector forces "can also be user selectable[.]" *Id.*, [0081]. Spring forces are also of a "user-selectable frequency." *Id.*, [0089]. Accordingly, a POSITA would have understood that Goldenberg teaches a user programming mappings for vibrotactile effects, including independently specifying amplitude and frequency. *Declaration*, ¶¶205-207.

Based on the teachings of Goldenberg, it would have been obvious to a

POSITA to use Goldenberg's user-programmed mappings in Houston's device. *Id.*,

¶208. First, a POSITA would have recognized that Houston and Goldenberg are combinable because both are directed to providing vibration effects in devices, such as game controllers, using linear actuators having moving magnets. *Id.* A POSITA would have appreciated that incorporating Goldenberg's user-selected frequency and amplitudes for vibration effects would not have changed Houston's device's function in any way because each element is still performing the same function. *Id.*,

¶209. A POSITA would have been motivated to use Goldenberg's user-programmed vibration patterns in Houston's device to allow user-selected customization of vibration effects to increase realism and user satisfaction in a particular program, such as a game. *Id.* Such a modification would have amounted to the application of known programming steps and hardware (Goldenberg's user-selected amplitude and frequency) to a known device ready for improvement (Houston's game controller with user-input features and linear motion vibrator) to obtain a predictable result (increased user control of vibrotactile effects for a particular event in a game). *Id.* Given the predictability of computer programming and the teachings of Houston, there would have been a reasonable expectation of success utilizing Goldenberg's vibration customization to enhance the user experience of Houston's game controller. *Id.*, ¶210.

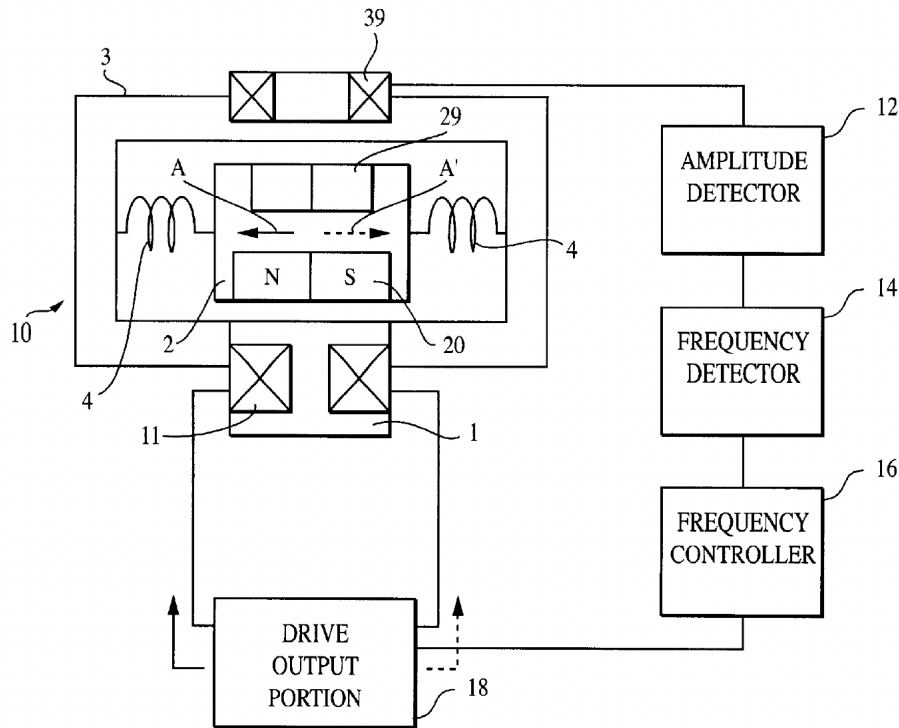
B. Ground 2: Houston, Goldenberg, and Ibuki render Claims 3-6 Obvious

1. Claim 3

Petitioners interpret this limitation under §112 ¶6 where “oscillator circuit; microcontroller with internal or external memory; processor; CPU; microprocessor; and equivalents thereof” perform the function of “receiving output signals from sensors within the vibration module during operation of the vibration module and adjusts one or more operational control outputs of the control component according to the received output signals from the sensors” under PO’s interpretation of the claim. *See* Section II.D. Houston teaches that vibration controller 623 is a microprocessor, thereby satisfying the structural requirement of this means-plus-function limitation. *See* Claim 1(f). Houston also teaches that the vibration controller/microprocessor outputs one or more operational control outputs including “one or more of the amplitude of vibration, $A_{combined}[,]$ direction of force, theta, and frequency of vibration, $f[.]$ ” *Houston*, [0215]; Claim 1(f). Houston also teaches an embodiment where “both the first actuator and the second actuator are preferably operated at substantially a natural frequency of the respective actuator.” *Houston*, [0036], [0120].

In related art, Ibuki teaches a vibrating linear actuator that includes sensors for detecting the amplitude and frequency of a moving portion 2. Specifically, “moving portion 2 is equipped with a sensing magnet 29, and the frame 3 is equipped

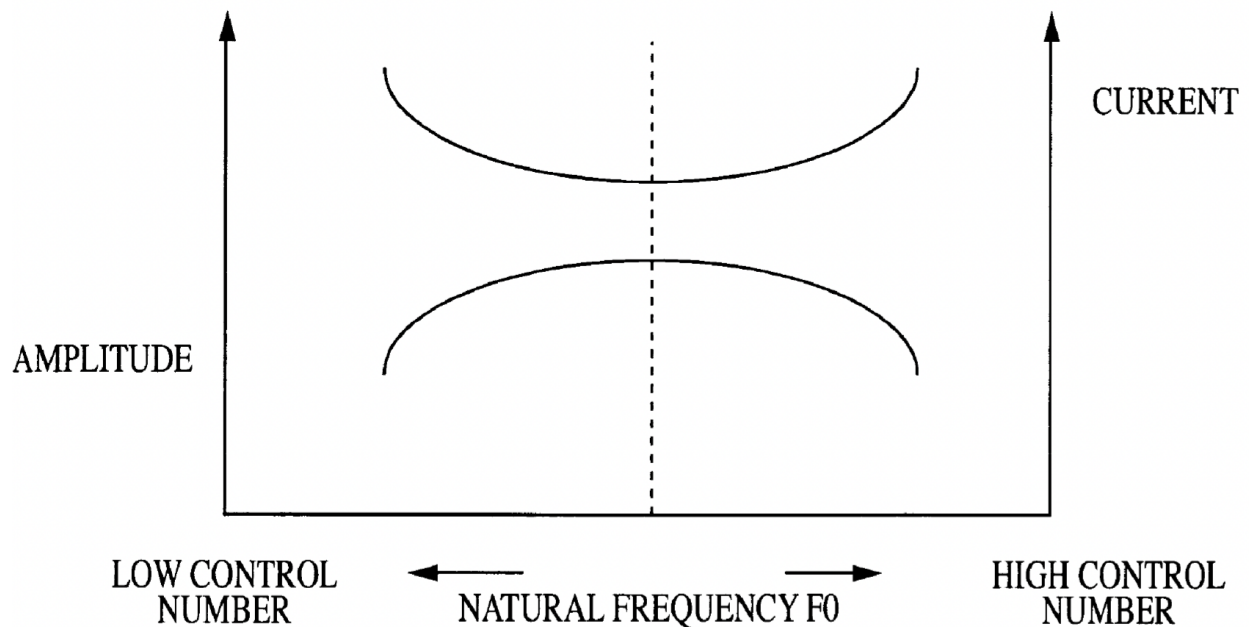
with a sensor coil 39 in which voltage is induced by movement of the sensing magnet 29.” *Ibuki*, 4:29-32. The output signal from the sensor coil 39 feeds into an amplitude detector 12 and a frequency detector 14:



Id., Fig. 3; *see also, id.*, 4:62-65 (“[A]s shown in FIG. 3, the natural frequency f_0 is detected by detecting the amplitude using an amplitude detector 12, and detecting the frequency from the output of the sensor 39, using a frequency detector 14.”).

The amplitude detector 12 is a sensor that “detects a signal corresponding to an amplitude of the moving portion 2” and “is operably connected to the frequency detector 14 and the frequency controller 16.” *Id.*, 8:5-9. Frequency detector 14 is also a sensor that “detect[s] a natural frequency of a spring vibration system made of the spring and the moving portion 2[.]” *Id.*, 7:60-63. Per *Ibuki*, “If the drive

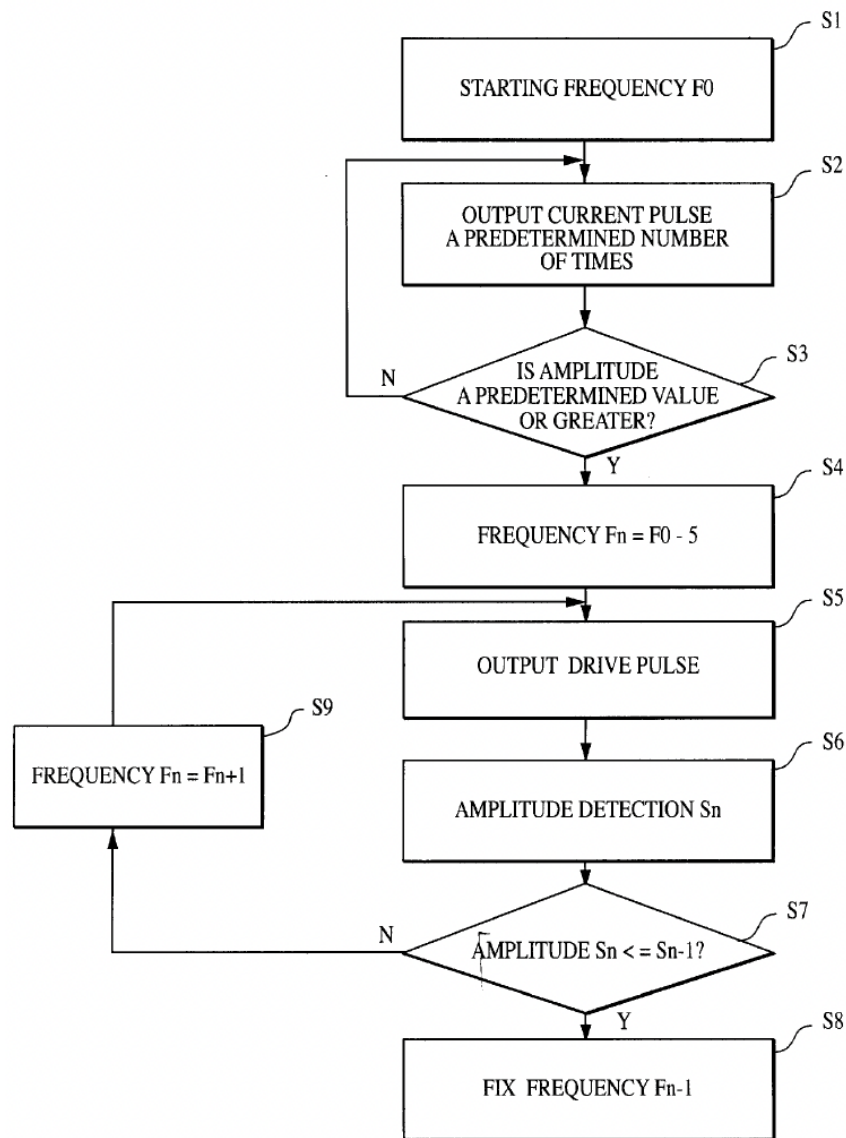
frequency f is identical to the natural frequency f_0 , the amplitude reaches maximum, and the current reaches a minimum value, as shown in FIG. 5.” *Id.*, 5:8-10.
“However, when the drive frequency f is higher or lower than the natural frequency f_0 , the amplitude decreases, and the drive current increases.” *Id.*, 5:10-13.



Id., Fig. 5.

Ibuki teaches the control component receives output signals from sensors within the vibration module during operation of the vibration module. Declaration, ¶¶213-215. Frequency controller 16 is connected to the frequency detector 14, and “amplitude detector 12 is operably connected to the frequency detector 14 and the frequency controller 16.” *Ibuki*, Fig. 5, 8:7-8. Based on the output signals received from the frequency and amplitude sensors, “the frequency controller is further configured to determine (i.e., set) a drive frequency by deriving the natural

frequency from a variation of an amplitude value while incrementally altering the frequency of the current pulse to be supplied to the coil.” *Id.*, 2:19-23. As shown in the processing steps of Figure 1, the frequency controller decrements (S4) or increments (S9) the drive frequency F_n based on measured amplitude values and outputs a corresponding drive pulse (S5):



Id., Fig. 1; *see also, id.*, 5:29-53.

The controller incrementally adjusts the drive frequency/output drive pulse until “the amplitude value reaches its maximum,” which signifies that the drive frequency has reached the natural frequency. *Id.*, 2:18-24; *see also, id.*, 5:8-9 (“If the drive frequency f is identical to the natural frequency f_0 , the amplitude reaches maximum...”). In other words, the controller adjusts the output drive pulse according to the received output signals from the amplitude and frequency sensors until the moving component reaches the natural frequency. *Declaration*, ¶216. Ibuki teaches that this allows the actuator to “vibrate the spring vibration system at its natural frequency without being affected by a variation of the spring vibration system” and “has a high drive efficiency and low cost.” *Ibuki*, 7:66-8:4.

It would have been obvious to a POSITA to modify Houston’s haptic interface to utilize Ibuki’s feedback control technique to ensure that the frequency of vibration, f (i.e., operational control output) corresponds to the actuator’s natural frequency. *Declaration*, ¶218. Ibuki teaches that vibrating the system at its natural frequency increases drive efficiency and lowers power consumption. *Id.* (citing *Ibuki*, 1:49-54). Like Ibuki’s actuator, Houston also teaches an implementation where the actuator includes “springs 138 [that] are operable to generate forces in a direction that returns the moving mass 132 to a center position[.]” *Houston*, [0119], 7A. A POSITA would recognize that, as taught by Ibuki, springs 138 would introduce variations into the system that would affect the natural frequency.

Declaration, ¶218. Thus, it would have been obvious to modify Houston's vibration controller/microprocessor to receive output signals from amplitude and frequency sensors within the actuator during the operation of the linear vibration module and configure software instructions executing on the microprocessor to adjust the frequency of vibration, f (i.e., one or more operational control outputs of the control component) until the amplitude value reaches its maximum thereby ensuring that the drive signal frequency corresponds to the actuator's natural frequency. *Id.* Ibuki teaches that vibrating the actuator at the natural frequency increases drive efficiency by imparting larger vibration to the user using less drive power. *Id.*, ¶219. Thus, a POSITA would have been motivated to improve similar actuators in the same way by utilizing Ibuki's feedback control technique to yield the predictable result of ensuring that Houston's microprocessor outputs a frequency of vibration that corresponds to the natural frequency despite any variations in the system. *Id.*

A POSITA would have understood that feedback control systems were conventional in electronic circuit design for decades prior to the invention of the '830 Patent. *Id.*, ¶220. Thus, there would have been a reasonable expectation of success configuring Houston's haptic interface to perform Ibuki's feedback control technique. *Id.*

2. Claim 4

In accordance with PO's proposed constructions, Petitioners interpret Claim 4 as depending from Claim 3 and under §112 ¶6 where the "same structure as described above with respect to claim 3" performs the function of "adjusting the 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 the vibration module produces desired outputs from the one or more sensors corresponding to one or more operational control parameters."

For the same reasons discussed with regard to Claim 3, Houston modified in view of Ibuki teaches that the microprocessor adjusts the vibration frequency, f (i.e., *the one or more operational control outputs of the control component*) according to the received output signals from the amplitude and frequency sensors in order that subsequent operation of the vibration module produces desired outputs from amplitude and frequency sensors corresponding to the actuator's natural frequency value (i.e., *one or more operational control parameters*). See Claim 3; Declaration, ¶222.

3. Claim 5

Petitioners interpret this limitation under §112 ¶6 where "oscillator circuit; microcontroller with internal or external memory; processor; CPU; microprocessor; and equivalents thereof" perform the function of "dynamically adjusting the power

supplied to the driving component to produce oscillation of the movable component at a resonant frequency for the vibration module” under PO’s interpretation of the claim. *See* Section II.D.

Regarding a strength of vibration produced by the oscillation of the moveable component, the ’830 Patent discloses “a strength of vibration...corresponds to the current applied to the coil[.]” ’830 Patent, 6:29-33. The ’830 Patent also discloses that “the amplitude of the vibration and vibrational forces produced are related to,” among other things, “the current applied to the coil[.]” *Id.*, 5:42-47. If a strength of vibration corresponds to the current applied to the coil and the amplitude of vibration also corresponds to the current applied to the coil, then the strength of vibration corresponds to the amplitude of vibration. *Declaration*, ¶224. Therefore, Petitioners interpret a strength of vibration produced by the oscillation of the moveable component as at least including the amplitude of vibration.

Houston teaches that the vibration controller/microprocessor outputs one or more operational control outputs, including “one or more of the **amplitude of vibration**, **A_{combined}**[,] direction of force, theta, and **frequency of vibration**, **f**[.]” *Houston*, [0215]; Claim 1(f). Houston further teaches that “[i]ncreasing the amount of current in the electromagnet will increase the amount of force applied onto the moving mass 112.” *Houston*, [0116]. Thus, Houston teaches the one or more operational control parameters is a strength of vibration produced by the oscillation

of the moveable component. Declaration, ¶225.

Houston also teaches *the one or more operational control outputs is a frequency at which the control component drives the moveable component to oscillate*. Houston, [0215] (describing vibration controller outputting “frequency of vibration, f ”). Houston also teaches an embodiment where “both the first actuator and the second actuator are preferably operated at substantially a natural frequency of the respective actuator.” *Id.*, [0036]. Ibuki confirms that the natural frequency is “a resonance frequency.” *Ibuki*, 1:20-24.

For the same reasons as discussed with regard to Claim 3, the combination of Houston and Ibuki teaches the microprocessor (i.e., *the control component*) dynamically adjusts the current (i.e., *power*) supplied to the electromagnetic coil (i.e., *the driving component*) to produce linear oscillation of the moving mass (i.e., *the movable component*) at a natural/resonant frequency for the haptic interface (i.e., *the vibration module*). See Claim 3; Declaration, ¶227.

4. Claim 6

(a) *Claim 6(a)*

Houston teaches an embodiment where the user inputs “various **input parameters** include[ing] input of **pattern number, amplitude**, duration and start-time for the vibration device using compound vibrations.” Houston, [0208], Fig. 36B. These input parameters “produce an extremely broad and rich set of haptic

sensations for the end user.” *Id.* The amplitude corresponds to a strength of vibration. See Claim 5. Thus, Houston’s amplitude input parameter corresponds to a strength of vibration operational control parameter. Declaration, ¶¶228-229.

Regarding the pattern number input parameter, Houston teaches “generating precise patterns of vibrations from simple parameters,” including “circles, ellipses and straight lines.” *Houston*, [0207]. Thus, Houston’s pattern number input parameter corresponds to a current operational mode operational control parameter. Declaration, ¶230.

It would have been obvious, and a POSITA would have been motivated to configure Houston’s haptic interface to allow the user to directly input operational control parameters, including a pattern number and amplitude, as expressly suggested by Houston. *Id.*, ¶231. A POSITA would have understood that allowing the user to enter their desired pattern and amplitude parameters for a game or simulation would have predictably enhanced realism and increased user satisfaction by allowing them to configure haptic feedback to their personal tastes. *Id.* Allowing the user to input these parameters would have predictably “produce[d] an extremely broad and rich set of haptic sensations for the end user.” *Id.* (citing *Houston*, [0208]). A POSITA would have appreciated that this modification to system controller 622 would have required only minor software changes to allow the user to provide the desired pattern number and amplitude parameters. *Id.* Thus, there would have been

a reasonable expectation of success configuring system controller 622 to accept user inputs for the configuration of the pattern number and amplitude parameters. *Id.*

(b) Claim 6(b)

Houston teaches that the vibration controller outputs one or more operational control outputs including “one or more of the **amplitude of vibration, $A_{combined}$** [,] direction of force, theta, and **frequency of vibration, f** [.]” *Houston*, [0215]; Claims 1(f), 3. The frequency of vibration, f , is a frequency at which the control component drives the moveable component to oscillate. See Claim 1(f); *Declaration*, ¶232.

Houston also teaches that “[i]ncreasing the amount of current in the electromagnet will increase the amount of force applied onto the moving mass 122.” *Houston*, [0118]; Claim 1(e). The ’830 Patent discloses that “the amplitude of the vibration and vibrational forces produced are related to ... the current applied to the coil[.]” ’830 *Patent* at 5:42-47. Additionally, the ’830 Patent discloses controlling “the current...used to drive the linear vibration module and to thus increase and decrease the amplitude of vibration produced by the linear vibration module.” *Id.* at 12:13-18. Thus, a POSITA would have understood that Houston’s amplitude of vibration, $A_{combined}$, is a control output that determines a current supplied by the power supply to the driving component. *Declaration*, ¶233.

C. Ground 3: Houston, Goldenberg, and Rosenberg render Claim 11 Obvious

1. Claim 11

Rosenberg teaches a voice coil actuator where “the wire coil includes multiple sub-coils that each include a different number of loops.” *Rosenberg*, 5:57-58. “[F]or example, the four different sub-coils shown in FIGS. 20b-20e, different magnetic fields can be induced for the pendulum head 244' and thus different torques can be applied to the pendulum.” *Id.*, 31:53-56; Figs. 20b-20e. Thus, each sub-coil qualifies as a driving component meaning that Rosenberg teaches four (i.e., two or more) driving components. *Declaration*, ¶¶234-236. Per Rosenberg, this arrangement is advantageous because “the current magnitudes need not be varied, allowing for less complex electronics[.]” *Rosenberg*, 32:10-12.

It would have been obvious to a POSITA to modify Houston’s haptic interface to include two or more driving components as taught by Rosenberg. *Declaration*, ¶237. As noted by Rosenberg, this arrangement would have predictably allowed Houston’s haptic interface to drive the moveable component to linearly oscillate with an amplitude/magnitude particular to the activated driving component using less complex electronics. *Id.* And a POSITA would have been motivated to improve similar actuators in the same way. *Id.* Since electromagnetic coils were well understood at the time of the ’830 Patent, there would have been a reasonable expectation of success incorporating Rosenberg’s two or more driving components

into Houston's haptic interface. *Id.*

D. Ground 4: Houston, Goldenberg, and Tierling render Claims 15 and 20 Obvious

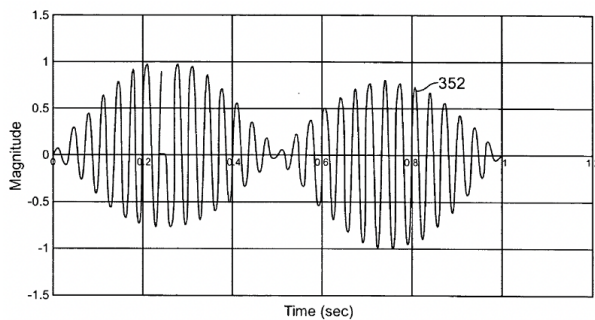
1. Claim 15

Houston teaches that “a single actuator can impart forces at **multiple frequencies at the same time.**” *Houston*, [0102]. In related art, Tierling teaches a similar haptic interface device, including an actuator that outputs a “linear force ... using a linearly moving element, as in a voice coil actuator or a linear moving-magnet actuator[.]” *Tierling*, [0042]. Tierling teaches that “when driving the inertial mass at a low frequency, the sensation to the user is weak” because of “the limited range of motion of the inertial mass in assembly 100[.]” *Id.*, [0062]. “This limited range of motion may be desirable in other aspects of the assembly design, e.g. a low profile so it will fit in small devices, but it detracts from the strength of the low frequency tactile sensations.” *Id.*

To solve this problem, Tierling teaches “methods for enhancing the feel of tactile sensations,” including a method where a “high frequency waveform is modified or modulated according to the desired low frequency so as to convey the sense of the low frequency in the tactile sensation perceived by the user.” *Id.*, [0060], [0080]. In one example, a 1 Hz waveform is used to modulate a 30 Hz waveform and then normalized to produce the combined waveform depicted in Figure 12. *Id.*, [0092]-[0106]. As shown in the side-by-side comparison below, Tierling's

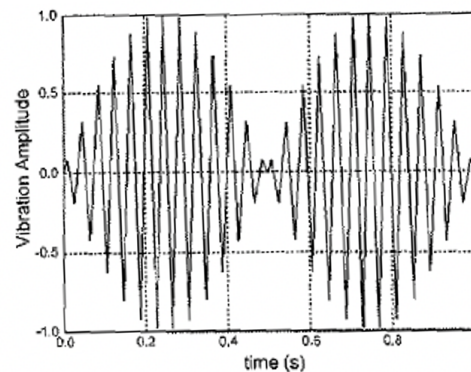
normalized waveform is nearly identical to the waveform shown in Figure 22B of the '830 Patent, which illustrates a complex vibration mode “driven at a **primary operational frequency of 25 Hz** with an added **modulating 1 Hz operational frequency.**” '830 Patent, 13:41-44.

Tierling Fig. 12



30 Hz primary oscillation frequency modulated by a
1 Hz modulating oscillation frequency

'830 Fig. 22B



25 Hz primary oscillation frequency modulated by a
1 Hz modulating oscillation frequency

Declaration, ¶239 (citing Tierling, Fig. 12; '830 Patent, Fig. 22B).

Thus, Tierling teaches enhancing the feel of tactile sensations by driv[ing] simultaneous oscillation of the moveable component at two or more frequencies to generate complex vibration modes. *Id.*, ¶240.

Based on the teachings of Tierling, it would have been obvious, and a POSITA would have been motivated to configure Houston's vibration controller/microprocessor to drive simultaneous oscillation of the moveable component at two or more frequencies to generate complex vibration modes. *Id.*, ¶241. A POSITA would have understood that Houston's linear actuators would have

had a limited range of motion to have a low enough profile to fit in a handheld controller, such as Houston's haptic interface. *Id.* Thus, a POSITA would have understood that Houston's linear actuators would have also produced "weak" low-frequency sensations. *Id.* A POSITA would have been motivated to configure Houston's vibration controller/microprocessor to modulate a lower frequency waveform with a higher frequency waveform to predictably enhance the sensation of low-frequency vibrations, thereby improving similar haptic feedback devices in the same way. *Id.* Techniques for combining signals of different frequencies were well-known for many years prior to the '830 Patent. *Id.* Thus, there would have been a reasonable expectation of success configuring Houston's vibration controller to modulate a lower frequency waveform with a higher frequency waveform, as taught by Tierling. *Id.*

2. Claim 20

(a) Claim 20[P]

See Claim 1[P].

(b) Claim 20(a)

See Claim 1(a).

(c) Claim 20(b)

See Claim 1(b).

(d) Claim 20(c)

See Claim 1(c).

(e) Claim 20(d)

See Claim 1(d).

(f) Claim 20(e)

See Claim 1(e).

(g) Claim 20(f)

See Claim 1(f).

(h) Claim 20(g)

See Claim 15.

E. Ground 5: Houston, Goldenberg, and Tierling render Claim 16 Obvious

1. Claim 16

(a) Claim 16(a)

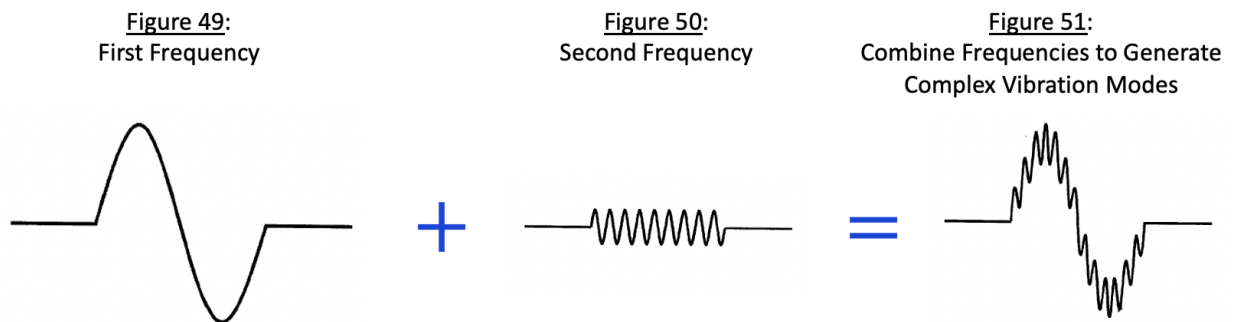
The '830 Patent discloses, “FIG. 22B illustrates a vibration mode of the linear vibration module driven at a **primary operational frequency** of 25 Hz with an added **modulating 1 Hz operational frequency**.” ’830 Patent, 13:41-44. Houston and Tierling teaches modulating a primary oscillation frequency by a modulating oscillation frequency, such as described in the '830 Patent. See Claim 15.

(b) Claim 16(b)

Regarding the claimed beat frequency, the '830 Patent discloses that Figure 23 “illustrates a different complex vibrational mode in which two driving frequencies combine to produce a **lower-frequency beat-wave form**.” ’830 Patent,

13:44-49, Fig. 23.⁶

Fukumoto teaches a vibration control processing program executed by the CPU that combines two driving frequencies to “caus[e] the oscillatory actuator 115 to generate vibration and sound simultaneously.” *Fukumoto*, [0307]. “[A]s explained in the first embodiment, by applying an audible band audio signal to the coil 121 of the oscillatory actuator 115, it is possible to use the oscillatory actuator 115 as a speaker 604 (sound source).” *Id.*, [0306]. “The waveform shown in [FIG. 51] is a combination of the waveform for generating vibration shown in FIG. 49 and the waveform for generating sound shown in FIG. 50.” *Id.*, [0307].

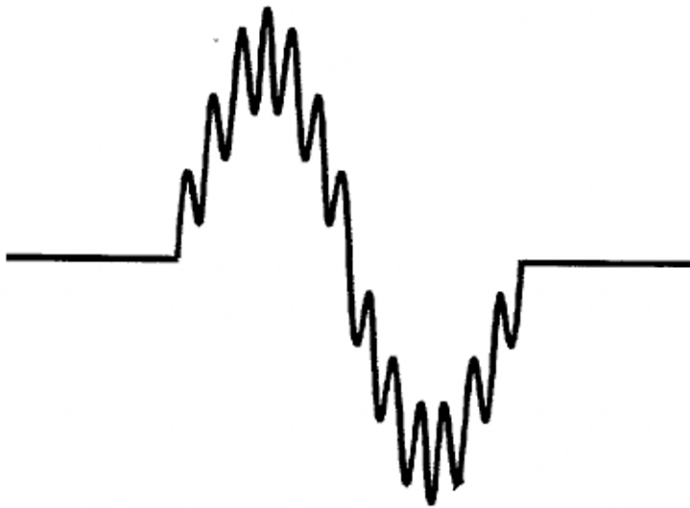


Declaration, ¶253 (citing *Fukumoto*, Figs. 49-51).

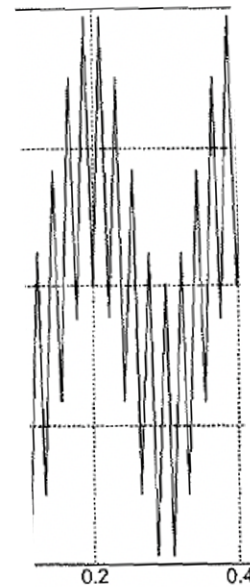
The waveform of Fukumoto’s Figure 51 is the result of combining a higher frequency waveform (i.e., the audio signal) with a lower frequency waveform (i.e., the vibration signal) and is comparable to the waveform of ’830 Figure 23:

⁶ Petitioners note this is the only disclosure relating to the claimed beat frequency in the ’081 Patent specification.

Fukumoto Fig. 51



'830 Fig. 23



Id., ¶254 (citing Fukumoto, Fig. 51; '830 Patent, Fig. 23).

Therefore, Fukumoto teaches generating a beat frequency within the meaning of the '830 Patent. *Id.*, ¶255.

It would have been obvious, and a POSITA would have been motivated to configure Houston's vibration controller/microprocessor to output a beat frequency, as taught by Fukumoto. *Id.*, ¶256. A POSITA would have understood the advantages of configuring Houston's haptic interfaces to generate sounds in addition to vibrations. *Id.* For example, this would have allowed the user to receive audible feedback in addition to visual and haptic feedback thereby enhancing the user's experience. *Id.* Thus, a POSITA would have been motivated to improve similar haptic feedback devices in the same way. *Id.*

A POSITA would have also understood that Houston's linear actuators are the same type of actuator used by Fukumoto to generate sounds and vibrations. *Id.*, ¶257. Therefore, no hardware changes to Houston's haptic interface would have been required to enable it to output sounds and vibrations simultaneously. *Id.* A POSITA would have understood that audible feedback was an important form of user feedback. *Id.* Thus, there would have been a reasonable expectation of success configuring Houston's microprocessor to output a beat frequency. *Id.*

(c) Claim 16(c)

Regarding the claimed aperiodic oscillation waveform, the '830 Patent discloses, "By varying the number, relative amplitudes, and frequencies of two or more driving signals, a microprocessor-controlled or microcontroller-controlled linear-resonance vibration module can be controlled to produce any number of complex vibrational patterns and modes, including...fully **aperiodic vibration modes that do not repeat time**." '830 Patent, 13:52-59. Therefore, Petitioners interpret an aperiodic oscillation waveform to at least include a waveform that does not repeat in time.

Goldenberg teaches "a nonperiodic effect, such as a spring, damper, obstruction, or vector force, and the mapped vibrotactile haptic effect can be a vibration having a magnitude based on a magnitude of the nonperiodic effect." *Goldenberg*, [0006]. "Nonperiodic effects are determined based not on time and

magnitude parameters, but on other parameters instead of or in addition to these parameters.” *Id.*, [0075]. Examples of nonperiodic effects include vector forces, “which provide a force in a specified direction in one or more degrees of freedom of the manipulandum.” *Id.*, [0079]. “For example, in a racing or driving game, a vector force is used to output a collision sensation in the rotation of a steering wheel when the car impacts an object such as a wall or other car, a shift sensation when a stickshift [is] moved, or a spin out sensation when the car loses control.” *Id.* Another nonperiodic effect is a jolt or vibration. *Id.*, [0080]. “[F]or example, a single jolt can be output by commanding a 1 Hz frequency with a duration of 1 second, to provide a single rotation.” *Id.*

Because Goldenberg’s nonperiodic effects by definition, do not repeat in time, each qualifies as an aperiodic oscillation waveform within the meaning of the ’830 Patent. *Declaration*, ¶262. Moreover, a POSITA would have understood that multiple nonperiodic effects would occur simultaneously in a driving game when, for example, the user’s car is spinning out of control and impacts an object. *Id.* (citing *Goldenberg*, [0079]).

It would have been obvious, and a POSITA would have been motivated to configure Houston’s vibration controller/microprocessor to output an aperiodic oscillation waveform, as taught by Goldenberg. *Id.*, ¶263. Houston, like Goldenberg, teaches generating haptic effects for a driving simulation. *Houston*, [0218]-[0219].

A POSITA would have understood that Goldenberg's nonperiodic effects would apply equally to Houston's driving simulation. *Declaration*, ¶263. Thus, a POSITA would have been motivated to configure Houston's microprocessor to output the same types of nonperiodic effects, including simultaneous nonperiodic effects, to enhance the realism of Houston's driving simulation, thereby improving similar haptic systems in the same way. *Id.* Because producing nonperiodic vibration waveforms corresponding to user actions in games was well-known and common for many years prior to the '830 Patent, there would have been a reasonable expectation of success configuring Houston's microprocessor to output an aperiodic oscillation waveform corresponding to user actions in the driving simulation. *Id.*

VII. DISCRETION UNDER 35 U.S.C. §325(D)

Houston '817, which is a child of the Houston referenced cited in this Petition, was cited during the prosecution of the '830 Patent. *See* Section II.C. During prosecution, Applicant argued that Houston's controller resides in a computer and is separate from the vibrating device. *Id.* As demonstrated above, the Examiner overlooked the embodiment of Houston that this Petition relies on where the vibration controller 632 resides in the haptic interface device 634 – not the system controller/computer 622. *Supra.* Applicant further argued that the stored values of Houston are not in the same module as the vibrating device. *See* Section II.C. However, the combination of Houston and Goldenberg, which was not considered

by the Examiner, renders this obvious. *Supra*. Accordingly, the Examiner erred in overlooking the highly material disclosures of Houston '817 and its counterparts. Goldenberg was not cited or considered during prosecution of the '830 Patent. Thus, part two of the *Advanced Bionics* Framework is not met.

VIII. THE *GENERAL PLASTIC* FACTORS FAVOR INSTITUTION

The '830 Patent has been challenged in a prior IPR petitions by Samsung, IPR2023-00993 and IPR2023-01025 and (“Samsung IPRs”). There, Samsung presented numerous grounds of unpatentability relying on more than 10 references. The only overlap in references is Fukumoto, which Petitioners only rely on for dependent claim 16. The proposed grounds in the instant petition differ substantially from those in Samsung’s petitions, relying on non-cumulative art in a non-cumulative manner. Samsung’s petitions were prepared independently of Petitioners’. Petitioners were not involved in Samsung’s IPRs and only learned of them after they were filed. Nor did Samsung contribute to this petition in any way.

Given the independent nature of Petitioners’ IPR, the non-cumulative grounds, and impossibility of road-mapping concerns, the Board should decline to exercise its discretion under § 314(a).

A. Factor 1

That Petitioners are not a party to any prior proceeding and that this is Petitioners’ first challenge to the '830 Patent “weighs especially heavily against a

discretionary denial.” *Unified Patents, Inc. v. Certified Measurement, LLC*, IPR2018-00548, Paper No. 7 at 7-8 (Sep. 5, 2018). “[A]pplication of the General Plastic factors is not limited solely to instances when multiple petitions are filed by the same petitioner.” *Valve Corp. v. Electronic Scripting Products, Inc.*, IPR2019-00062, Paper No. 11 at 2 (Apr. 2, 2019). In *Valve*, however, the Board found that petitioner (Valve) had a “significant relationship” with previous petitioner (HTC) and filed its petition only after HTC’s petition had been denied by the Board. *Id.*, 9-10, 12-13. Petitioners neither had, nor have, any “significant relationship” with Samsung. Petitioners are not coordinating with Samsung on any petitions for IPR, there is no business relationship between Samsung and Petitioners, and there is no overlap in accused products. *Signify North America Corp. v. Cao Lighting, Inc.*, IPR2023-00214, Paper 14 at 20-24 (June 15, 2023); *Foursquare Labs, Inc. v. Mimzi LLC*, IPR2019-01287, Paper 11 (Jan. 14, 2020) (petitioners individually sued with no evidence of coordination weighed against denying institution).

B. Factors 2-5

The second to fifth factors “bear little relevance” here because Petitioners have never challenged the ’830 Patent. *Unified Patents* at 7-8 (“Once resolution of factor 1 indicates that Petitioner had not previously filed a petition against the same patent, factors 2-5 bear little relevance unless there is evidence in the record of extenuating circumstances such as a showing that there was a previous petitioner

who challenged the same patent and that the previous petitioner and the current petitioner planned the staggered petitions.”). No such extenuating circumstances are present here. Nor is there a possibility of “road-mapping” from an earlier Board decision at least because Petitioners are using different claim constructions and different art than Samsung.

C. Factor 6

“The sixth and seventh factors are efficiency considerations.” *Valve*, 15. Petitioners’ Petition presents non-cumulative Grounds with new art. Samsung presented several grounds relying on numerous references. Petitioners present five grounds using the same primary reference for each ground and challenging 13 claims in view of new art with one exception. Petitioners’ combination is fundamentally different than Samsung’s. Petitioners’ grounds, therefore, rely on non-cumulative art with fundamentally different disclosures.

D. Factor 7

There is no readily identifiable roadblock for the Board to issue a final determination within the statutory one-year limit.

IX. THE *FINTIV* FACTORS FAVOR INSTITUTION

Petitioners stipulate that if the Petition is instituted, Petitioners will not seek resolution in the district court of any ground of invalidity raised in the Petition or that could have been raised in the Petition. *Sotera Wireless v. Masimo*, IPR2020-01019, Paper 12 at 18-19 (Dec. 1, 2020) (precedential). This stipulation “mitigates

concerns of potentially conflicting decisions and duplicative efforts between the district court and the PTAB,” and the Director has instructed that the Board will not discretionarily deny institution under 35 U.S.C. § 314(a). *Interim Procedure for Discretionary Denials*, pp. 7-8 (June 21, 2022).

X. CONCLUSION

For the foregoing reasons, Petitioners respectfully request *inter partes* review of the Challenged Claims.

Respectfully submitted,

ERISE IP, P.A.

BY: /s/ Eric A. Buresh

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XI. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8

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

Petitioners are the real parties in interest. Petitioners also identify Sony Interactive Entertainment LLC as a real party-in-interest.

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

The '830 Patent is presently the subject of a patent infringement lawsuit filed against Sony Group Corporation and Sony Interactive Entertainment, Inc. in the United States District Court for the Eastern District of Texas Marshall Division. *Resonant Systems, Inc. v. Sony Group Corporation, et al.*, Case No. 2:22-cv-00424. Petitioners understand the '830 Patent has also been asserted in *Resonant Systems, Inc. v. Samsung Electronics Co., LTD, et al.*, Case No. 2:22-cv-00423 (EDTX) and *Resonant Systems, Inc. v. Apple, Inc.*, Case No. 7:23-cv-00077 (WDTX). Samsung has filed petitions for *inter partes* review of the '830 Patent and related U.S. Patent No. 9,369,081. *See* IPR2023-00992, IPR2023-00993, and IPR2023-01025.

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

Petitioner provides the following designation and service information for lead and back-up counsel. 37 C.F.R. § 42.8(b)(3) and (b)(4).

Lead Counsel	Back-Up Counsel
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CLAIM LISTING APPENDIX
U.S. Patent No. 9,941,830 for Claims 1-8, 11, 15-17, and 20

Claim Designation	Claim Language
Claim 1(Pre)	1. A vibration module comprising:
Claim 1(a)	a housing;
Claim 1(b)	a moveable component;
Claim 1(c)	a power supply;
Claim 1(d)	user-input features;
Claim 1(e)	a driving component that drives the moveable component to oscillate within the housing; and
Claim 1(f)	a control component that controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values.
Claim 2	2. The vibration module of claim 1 wherein the control component is one of: an variable oscillator circuit with additional control circuitry; and a control component that includes a microprocessor, a control program, stored in an electronic memory within, or separate from, the microprocessor, the control program executed by the microprocessor to control supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by the one or more stored values.

Claim 3	3. The vibration module of claim 1 wherein the control component receives output signals from sensors within the vibration module during operation of the vibration module and adjusts one or more operational control outputs of the control component according to the received output signals from the sensors.
Claim 4	4. The vibration module of claim 1 wherein the control component adjusts the 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 the vibration module produces desired outputs from the one or more sensors corresponding to one or more operational control parameters.
Claim 5	5. The vibration module of claim 4 wherein the one or more operational control parameters is a strength of vibration produced by the oscillation of the moveable component; and wherein the one or more operational control outputs is a frequency at which the control component drives the moveable component to oscillate, the control component dynamically adjusting the power supplied to the driving component to produce oscillation of the movable component at a resonant frequency for the vibration module.
Claim 6(a)	6. The vibration module of claim 4 wherein the one or more operational control parameters include both a strength of vibration produced by the oscillation of the moveable component and a current operational mode; and
Claim 6(b)	wherein the one or more operational control outputs is a control output that determines a current supplied by the power supply to the driving component and a frequency at which the control component drives the moveable component to oscillate.
Claim 7	7. The vibration module of claim 1 wherein the driving component comprises one or more electromagnetic coils that generate magnetic fields parallel to the directions in which the moveable component is driven by the driving component.
Claim 8(a)	8. The vibration module of claim 1 wherein the housing is a tube, capped at both ends by movable-component-repelling components selected from one of mechanical springs and magnets;

Claim 8(b)	wherein the movable component is a magnet shaped to slide within the tube; and
Claim 8(c)	wherein the driving component is an electromagnetic coil.
Claim 11	11. The vibration module of claim 1 wherein the vibration module further includes two or more driving components, each, when activated, driving the moveable component to oscillate with an amplitude particular to the activated driving component.
Claim 15	15. The vibration module of claim 1 wherein the control component drives simultaneous oscillation of the moveable component at two or more frequencies to generate complex vibration modes.
Claim 16(a)	16. The vibration module of claim 15 wherein the complex vibration modes include: a primary oscillation frequency modulated by a modulating oscillation frequency;
Claim 16(b)	a beat frequency; and
Claim 16(c)	an aperiodic oscillation waveform.
Claim 17	17. The vibration module of claim 1 wherein the control component controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude that are independently specified by user input received from the user input features.
Claim 20(Pre)	20. A vibration module comprising:
Claim 20(a)	a housing;
Claim 20(b)	a moveable component;
Claim 20(c)	a power supply;
Claim 20(d)	user-input features;

Claim 20(e)	a driving component that drives the moveable component to oscillate within the housing; and
Claim 20(f)	a control component that controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values,
Claim 20(g)	wherein the control component drives simultaneous oscillation of the moveable component at two or more frequencies to generate complex vibration modes.

APPENDIX OF EXHIBITS

Exhibit 1001	U.S. Patent No. 9,941,830 to Elenga et al.
Exhibit 1002	File History of U.S. Patent No. 9,941,830
Exhibit 1003	Declaration of Gregory F. Welch
Exhibit 1004	Resonant's Opening Claim Construction Brief
Exhibit 1005	U.S. Patent Publication No. 2006/0290662A1 to Houston et al.
Exhibit 1006	U.S. Patent Publication No. 2004/0056840 to Goldenberg et al.
Exhibit 1007	U.S. Patent No. 6,441,571 to Ibuki et al.
Exhibit 1008	U.S. Patent No. 5,805,140 to Rosenberg et al.
Exhibit 1009	U.S. Patent Publication No. 2007/0285216A1 to Tierling et al.
Exhibit 1010	U.S. Patent Publication No. 2002/0149561A1 to Fukumoto et al.
Exhibit 1011	Raymond A. Serway & John W. Jewett, <u>Principles of Physics: A Calculus-Based Text</u> (4th ed. 2006)
Exhibit 1012	Rex Miller & Mark R. Miller, <u>Electronics the Easy Way</u> (4th ed 2002)
Exhibit 1013	Rockwell Automation, <u>Industrial Automation Glossary</u> (5 th ed. 1997)
Exhibit 1014	Bill Black, Mike Lopez, and Anthony Morcos, <i>Basics of Voice Coil Actuators</i> , PCIM, 44-46 (July 1993)
Exhibit 1015	Hi-Dong Chai, <u>Electromechanical Motion Devices</u> , Prentice-Hall, Inc. (1998)
Exhibit 1016	U.S. Patent No. 6,982,696 to Shahoian
Exhibit 1017	B. Lequesne, <i>Permanent Magnet Linear Motors for Short Strokes</i> , 32 IEEE Transactions on Industry Applications 161 (1996)
Exhibit 1018	N. Chen, Y.J. Tang, Y.N. Wu, X. Chen, L. Xu, <i>Study on Static and Dynamic Characteristics of Moving Magnet Linear Compressors</i> , 47 Cryogenics 457 (2007)
Exhibit 1019	I. Boldea & S.A. Nasar, <i>Linear Electric Actuators and Generators</i> , 14 IEEE Transactions on Energy Conversion 712 (1999)
Exhibit 1020	Z. Q. Zhu, X. Chen, D. Howe, and S. Iwasaki, <i>Electromagnetic Modeling of a Novel Linear Oscillating Actuator</i> , 44 IEEE Transactions on Magnetics 3855 (2008)
Exhibit 1021	Jeffrey J. Berkley, <i>Haptic Devices</i> , (Mimic Technologies Inc., 2003)
Exhibit 1022	Jenny Preece, Yvonne Rogers, Helen Sharp, David Benyon, Simon Holland, Tom Carey, <u>Human-Computer Interaction</u> , Addison-Wesley (1994)

Exhibit 1023	Ivan Poupyrev, Shigeaki Maruyama & Jun Rekimoto, <i>Ambient Touch: Designing Tactile Interfaces for Handheld Devices</i> , in Proceedings of the 15th annual ACM symposium on User interface software and technology 51 (2002)
Exhibit 1024	<i>History of Haptic Technology in Video Game Industry Teslasuit Blog</i> , Teslasuit (2017), https://teslasuit.io/blog/history-haptic-technology/ (retrieved Jan 22, 2024)
Exhibit 1025	<i>Sony Analog Controller (DualShock™)</i> , Sony Computer Entertainment Inc. (2000)
Exhibit 1026	<i>Star Fox 64 Instruction Booklet</i> , Nintendo of America Inc. (1997)
Exhibit 1027	John Culbert, <i>Gran Turismo 2 Compendium (Sony Playstation)</i> , https://gamefaqs.gamespot.com/ps/197469-gran-turismo-2/faqs/5146 (October 2000, retrieved Jan 22, 2024)
Exhibit 1028	Martin Watts, <i>Feature: Taking a Look Back at the Nintendo 64 Rumble Pak</i> , https://www.nintendolife.com/news/2013/07/feature_taking_a_look_back_at_the_nintendo_64_rumble_pak (July 2013, retrieved Jan 22, 2024)
Exhibit 1029	<i>Logitech iFeel mice</i> , Dan's Data, http://www.dansdata.com/ifeel.htm (March 15, 2001, retrieved August 1, 2023)
Exhibit 1030	Steven Butts, <i>Logitech iFeel Optical Mouse Review</i> , IGN, https://www.ign.com/articles/2001/02/06/logitech-ifeel-optical-mouse-review
Exhibit 1031	<i>N64 Rumble Pak Instruction Booklet</i> , Nintendo of America Inc. (1997)
Exhibit 1032	Microsoft Press, <i>Microsoft Computer Dictionary</i> (5 th ed. 2002)
Exhibit 1033	G. Davey, <i>Review of the Oxford Cryocooler</i> , in <i>Advances in Cryogenic Engineering: Part A & B</i> 1423 (1990)
Exhibit 1034	Alan V. Oppenheim, Alan S. Willsky & Syed Hamid Nawab, <i>Signals & Systems</i> (2nd ed. 1997)

CERTIFICATION OF WORD COUNT

The undersigned certifies pursuant to 37 C.F.R. §42.24 that the foregoing Petition for *Inter Partes* Review, excluding any table of contents, mandatory notices under 37 C.F.R. §42.8, certificates of service or word count, or appendix of exhibits, contains 13,949 words according to the word-processing program used to prepare this document (Microsoft Word).

Dated: February 16, 2024

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**CERTIFICATE OF SERVICE ON PATENT OWNER
UNDER 37 C.F.R. § 42.105(a)**

Pursuant to 37 C.F.R. §§ 42.6(e) and 42.105(b), the undersigned certifies that on February 16, 2024, a complete and entire copy of this Petition for *Inter Partes* Review and Exhibits were provided via Federal Express to the Patent Owner by serving the correspondence address of record for the '830 Patent:

Westman Champlin & Koehler, P.A.
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Further, a courtesy copy of this Petition for *Inter Partes* Review was sent via email to Patent Owner's litigation counsel:

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