

Petitioner's Oral Hearing Demonstratives

Apple Inc. (Petitioner) v. Resonant Systems, Inc. (Patent Owner)

Case No. IPR2024-00806
U.S. Patent No. 9,941,830

Before Hon. Karl D. Easthom, Norman H. Beamer, and Brian D. Range

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The Challenged Patent

The '830 Patent



US009941830B2

(12) **United States Patent**
Elena et al.

(10) **Patent No.:** US 9,941,830 B2
(45) **Date of Patent:** Apr. 10, 2018

(54) **LINEAR VIBRATION MODULES AND LINEAR-RESONANT VIBRATION MODULES**

(58) **Field of Classification Search**
CPC H02P 25/032; H02K 7/1876; B06B 1/166
See application file for complete search history.

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/181,249**

(22) Filed: **Jun. 13, 2016**

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Related U.S. Application Data

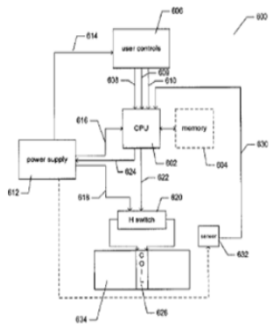
(63) Continuation of application No. 14/469,210, filed on Aug. 26, 2014, now Pat. No. 9,369,081, which is a continuation of application No. 13/345,607, filed on Jan. 6, 2012, now Pat. No. 8,860,337, which is a continuation-in-part of application No. 12/782,697, filed on May 18, 2010, now Pat. No. 8,093,767.

(60) Provisional application No. 61/179,109, filed on May 18, 2009.

(51) **Int. Cl.**
H02K 33/00 (2006.01)
H02P 25/032 (2016.01)
H02K 33/16 (2006.01)

(52) **U.S. Cl.**
CPC **H02P 25/032** (2016.02); **H02K 33/16** (2013.01)

20 Claims, 20 Drawing Sheets



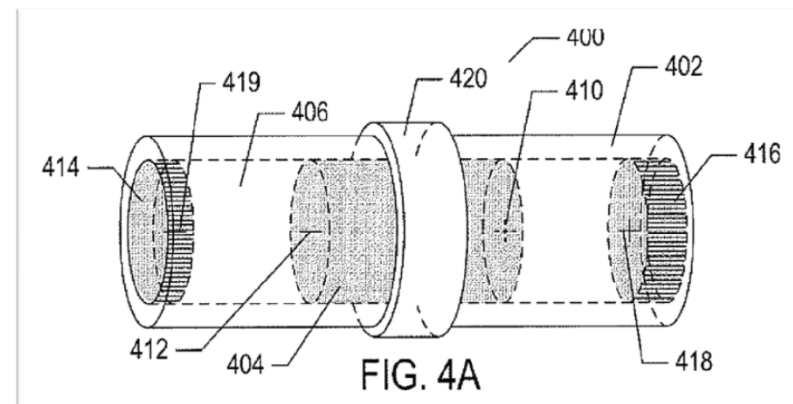
EX1001 ('830 patent), page 1

(57)

ABSTRACT

The current application is directed to various types of linear vibrational modules, including linear-resonant vibration modules that can be incorporated in a wide variety of appliances, devices, and systems to provide vibrational forces. The vibrational forces are produced by linear oscillation of a weight or member, in turn produced by rapidly alternating the polarity of one or more driving electromagnets. Feedback control is used to maintain the vibrational frequency of linear-resonant vibration module at or near the resonant frequency for the linear-resonant vibration module. Both linear vibration modules and linear-resonant vibration modules can be designed to produce vibrational amplitude/frequency combinations throughout a large region of amplitude/frequency space.

EX1001 ('830 patent), page 1



EX1001 ('830 patent), page 6 (FIG. 4A)

The '830 Patent – Claim 1

[1pre] A vibration module comprising:
[1a] a housing;
[1b] a moveable component;
[1c] a power supply;
[1d] user-input features;
[1e] a driving component that drives the moveable component to oscillate within the housing; and
[1f] 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.

EX-1001, 15:57-67.

The '830 Patent – Claims 14 and 19

[14] The vibration module of claim 1 further including flux paths comprising a paramagnetic material that is shaped and positioned to reduce the reluctance of one or more magnetic circuits within the vibration module.

[19pre] A vibration module comprising:

[19a] a housing;

[19b] a moveable component;

[19c] a power supply;

[19d] user-input features;

[19e] a driving component that drives the moveable component to oscillate within the housing;

[19f] 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; and

[19g] flux paths comprising a paramagnetic material that is shaped and positioned to reduce the reluctance of one or more magnetic circuits within the vibration module.

Highlights from Asserted Prior Art in Grounds 2A and 2B

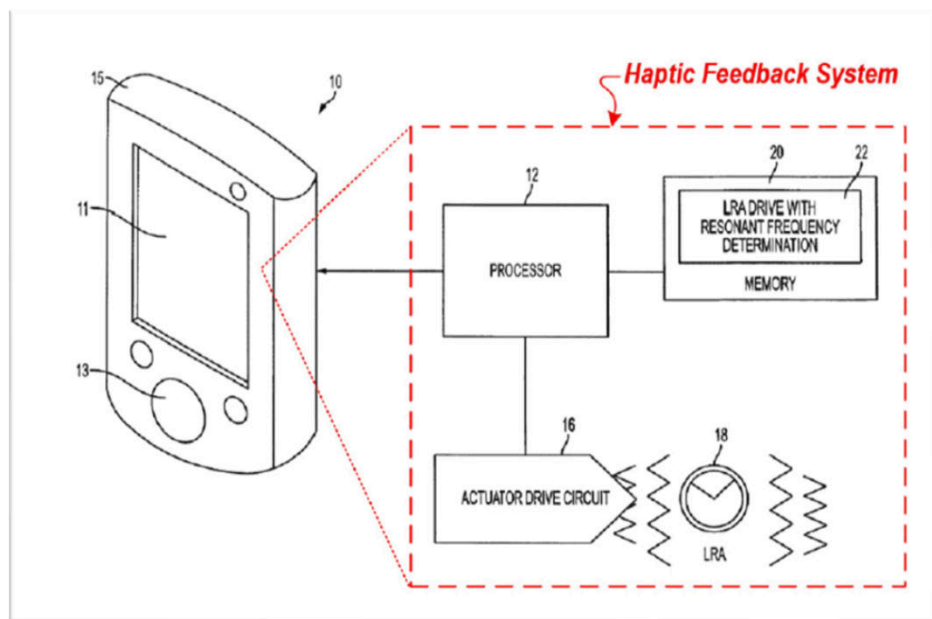
IPR Instituted Grounds

Ground	Claim(s) Challenged
Gregorio	1-18, 19, 20
Gregorio, Wakuda	8, 14, 19
Gregorio, Tierling	15, 16, 20
Gregorio, Ramsay	1-7, 15, 17, 20
Gregorio, Ramsay, Wakuda	8, 14, 19
Gregorio, Ramsay, Tierling	15, 16, 20
Gregorio, Ramsay, Rossi, Aldrich	1-7, 15, 17, 20
Gregorio, Ramsay, Rossi, Aldrich, Wakuda	8, 14, 19
Gregorio, Ramsay, Rossi, Aldrich, Tierling	15, 16, 20

* Independent claim noted in green

Petition (Pet.), 1-2; Institution Decision (ID), 7

Overview of Gregorio



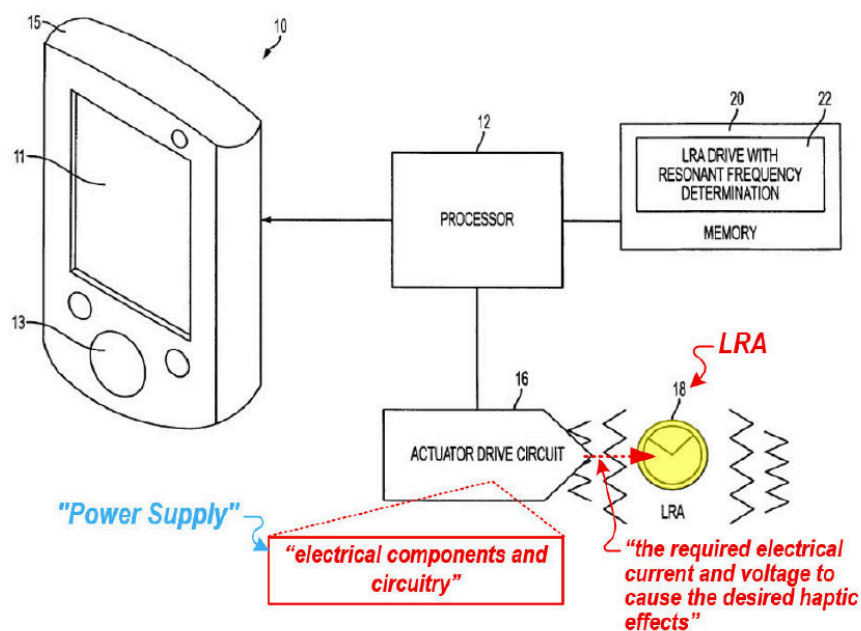
Pet., 9 (reproducing and annotating Gregorio (APPLE-1004), FIG. 1)

FIG. 1 is a block diagram of a haptically-enabled system 10 in accordance with one embodiment. System 10 includes a touch sensitive surface 11 or other type of user interface mounted within a housing 15, and may include mechanical keys/buttons 13. Internal to system 10 is a haptic feedback system that generates vibrations on system 10. In one embodiment, the vibrations are generated on touch surface 11.

The haptic feedback system includes a processor 12. Coupled to processor 12 is a memory 20 and an actuator drive circuit 16, which is coupled to an LRA actuator 18. Processor 12 may be any type of general purpose processor or could be

Gregorio (APPLE-1004), 2:10-20; Pet., 8-11

Overview of Gregorio

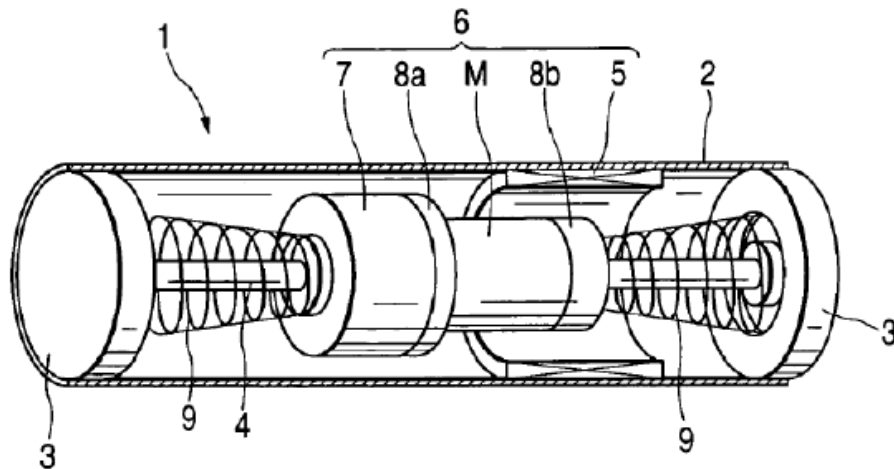


Pet., 14 (reproducing and annotating Gregorio (APPLE-1004), FIG. 1)

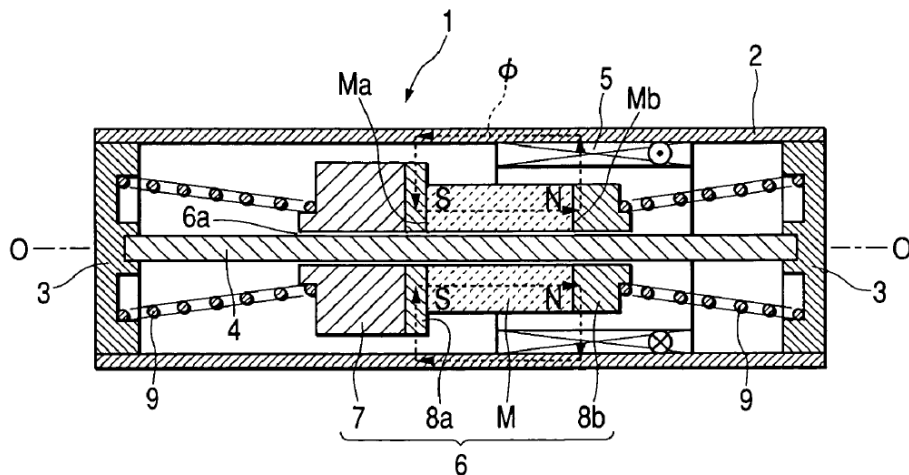
Processor 12 outputs the control signals to drive circuit 16 which includes electronic components and circuitry used to supply LRA 18 with the required electrical current and voltage to cause the desired haptic effects. System 10 may include more than one LRA 18, and each LRA may include a separate drive circuit 16, all coupled to a common processor 12. Memory device 20 can be any type of storage device or computer-readable medium, such as random access memory (“RAM”) or read-only memory (“ROM”). Memory 20 stores instructions executed by processor 12. Among the instructions, memory 20 includes an LRA Drive with Resonant Frequency Determination module 22 which are instructions that, when executed by processor 12, generate drive signals for LRA 18 while also determining the resonant frequency of LRA 18 and adjusting the drive signals accordingly. The functionality of module 22 is discussed in more detail below. Memory 20 may also be located internal to processor 12, or any combination of internal and external memory.

Gregorio (APPLE-1004), 2:36-53; Pet., 8-11

Overview of Wakuda



Wakuda (APPLE-1005), FIG. 1A; Pet., 26)



Wakuda (APPLE-1005), FIG. 1B; Pet., 30)

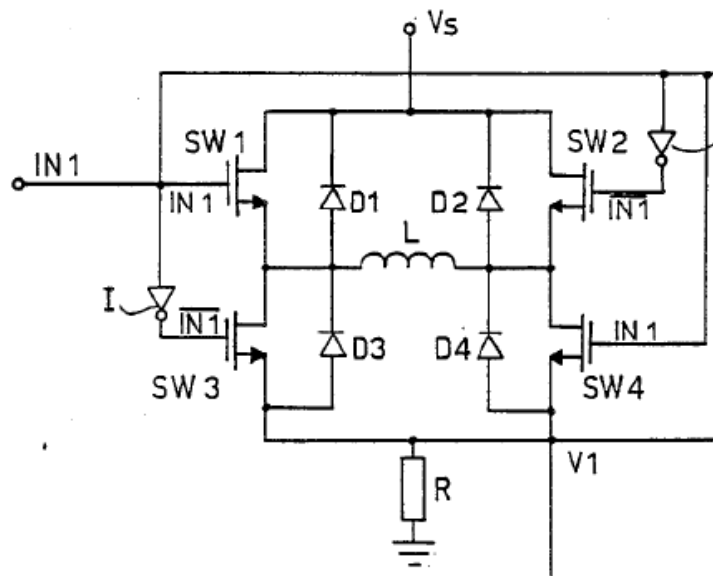
A vibration generator system according to the invention comprises vibration generating means 1 shown in FIG. 1 and control means shown in FIG. 3.

The vibration generating means 1 shown in FIG. 1 comprises a cylindrical-shaped casing 2 made of a magnetic substance as a support, and covers 3, 3 made of a non-magnetic substance and being mountable on both ends of the casing. A shaft 4 made of a non-magnetic substance is supported on inner surfaces of the covers 3, 3, the shaft 4 being in agreement with an imaginary center line O—O, which extends centrally of the casing 2 and the covers 3, 3.

A coil 5 is fixed to an inner wall of the casing 2. The coil 5 is formed by winding a length of covered copper wire, such as enameled wire or the like, in a cylindrical shape, and is fixed in a position somewhat to one (a X1 side in FIG. 1) of the covers 3 from a center of a length of the casing 2 in a direction X shown.

A movable body 6 is provided inside the casing 2. The movable body 6 is provided at one end thereof (a X2 side) with a weight 7 made of a non-magnetic substance and at the other end thereof (a X1 side) with a magnet M. Also, the magnet M is provided on both end surfaces thereof with yoke members 8a, 8b, which are formed from a magnetic material. The weight 7, yoke member 8a, magnet M, and the yoke member 8b are column- or disk-shaped, and all outer peripheral surfaces thereof are positioned in circles concentric with a center of the shaft 4.

Overview of Rossi



APPLE-1020, Figure 6 (partial)

Rossi (APPLE-1020), FIG. 6 (partial) (cited in Pet. 55)

Petition's Construction

Rossi's H-bridge switching circuit includes "two pairs of analog switches arranged in a bridge configuration." APPLE-1020, Abstract; 1:65-3:55, Figures 4, 6, cls. 1, 3, 4. The H-bridge circuit includes a "driving signal $IN1$ " input, which is split and a portion passed through an "inverter I " to generate an internal "driving signal $IN1$ " and an "inverted signal thereof $\overline{IN1}$." *Id.*; APPLE-1003, [77]-[80].

Pet. 54

**Ground 2A Gregorio, Ramsay, Aldrich and
Rossi Combination
Ground 2B: Ground 2A + Wakuda**

Topics For Discussion

1. **Ground 2A renders obvious the Power Supply ([1c])**
2. Ground 2A renders obvious the Control Component ([1f])
3. Ground 2B renders obvious Paramagnetic Flux Paths ([14], [19])

The '830 Patent – Independent Claim 1

[1pre] A vibration module comprising:
[1a] a housing;
[1b] a moveable component;
[1c] a power supply;
[1d] user-input features;
[1e] a driving component that drives the moveable component to oscillate within the housing; and
[1f] 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.

EX-1001, 15:57-67

Gregorio's Express Disclosure of the Power Supply

Pet., 13-14; Pet. Rep., 2-3

Gregorio

“Processor 12 outputs the control signals to drive circuit 16 which includes electronic components and circuitry used to supply LRA 18 with the required electrical current and voltage to cause the desired haptic effects.”

Gregorio (APPLE-1004), 2:36-39 (cited in Pet., 9, 17)

Plain and Ordinary Meaning of “Power Supply” Supports Gregorio’s Express Disclosure

Pet. Rep., 3-4

Hannaford Testimony

“A POSITA would have understood and found obvious that Gregorio’s actuator drive circuit corresponds to the power supply, given the plain and ordinary meaning of the term “power supply.”

APPLE-1049, [4] (citing APPLE-1050, 1, APPLE-1051, APPLE-1052, APPLE-1053, ID (Paper 11), 31-32)



WIKIPEDIA
The Free Encyclopedia

Power supply

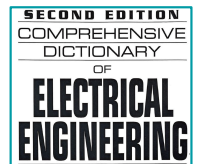
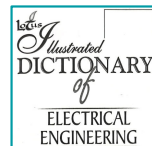
A **power supply** is an electrical device that supplies electric power to an electrical load. The main purpose of a power

APPLE-1050, 1 (cited in Pet. Rep., 4)

■ power supply

a separate unit or part of a circuit that supplies power to the rest of the circuit or to a system.

APPLE-1052 (cited in Pet. Rep., 4)



power supply an electronic module that converts power from some power source to a form which is needed by the equipment to which power is being supplied.

APPLE-1051 (cited in Pet. Rep., 4)

power supply *noun* ELEC 1. an electrical circuit that provides certain direct current voltage and current levels from an alternating current source for use in other electrical circuits ○ If the power supply from the amplifier to the gauge fails, the needle slowly falls to zero. 2. sa
power supply unit



APPLE-1053 (cited in Pet. Rep., 4)

Resonant's Own Expert Acknowledges Gregorio's Disclosure of the Power Supply

Pet. Rep., 3

Goosen's Testimony

Q. Would you agree that if you supply current and voltage, that you are supplying power?

A. **Yes**. But, he doesn't explain how.

APPLE-1055 (Goossen Decl. Tr.), 76:11-14 (cited in Pet. Rep., 3)

Gregorio's Express Disclosure of the Power Supply

Pet., 13-14; Pet. Rep., 2-3

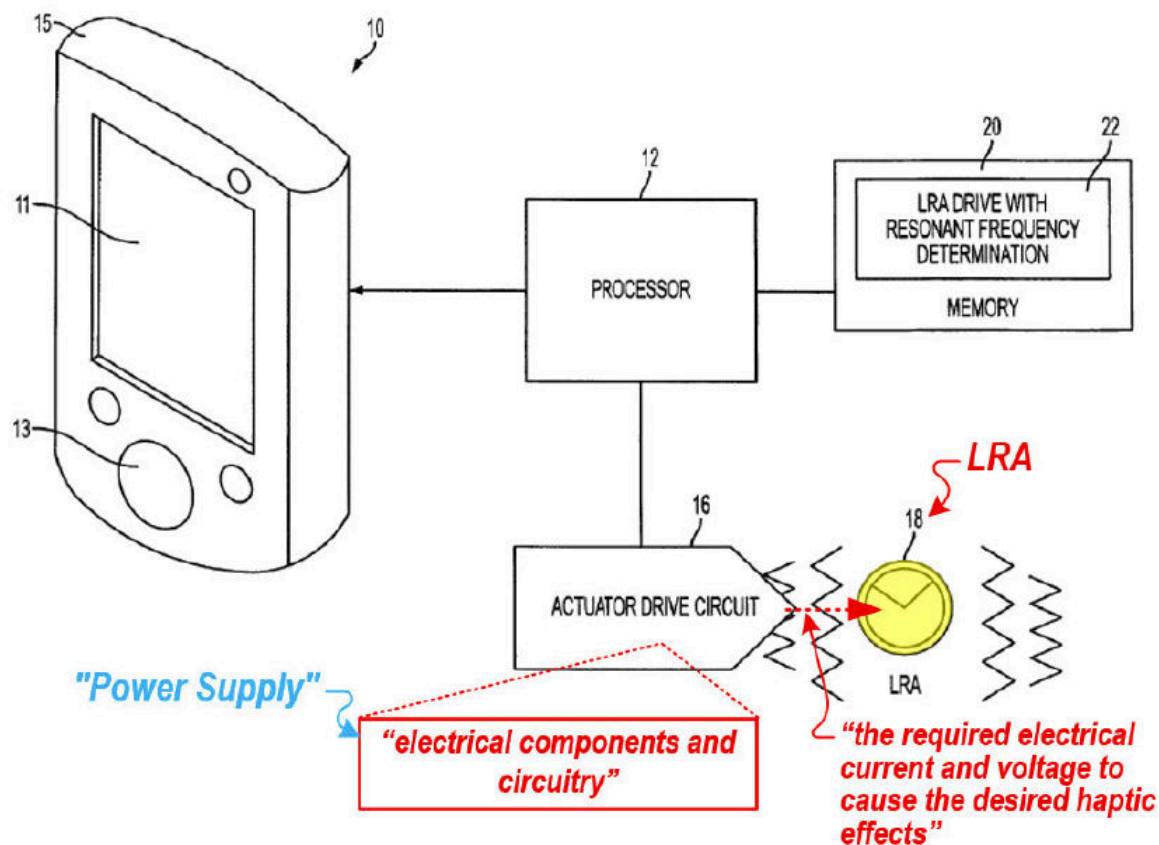
Gregorio

“Processor 12 outputs the control signals to drive circuit 16 which includes **electronic components and circuitry used to supply** LRA 18 with the required electrical current and voltage to cause the desired haptic effects.”

Gregorio (APPLE-1004), 2:36-39 (cited in Pet., 9, 17)

Gregorio's Express Disclosure of the Power Supply

Pet., 13-14; Pet. Rep., 2-3



Gregorio (APPLE-1004), FIG. 1 (annotated in Pet. 14)

The Board Discussed the Power Supply was Well-Known

ID, 31-32

Institution Decision

“Moreover, the '830 patent does not disclose any detail or structure for the controllable power supply, indicating that such a controllable power supply was well-known.”

ID (Paper 11), 31-32 (cited in Pet. Rep., 4)

Topics For Discussion

1. The Combination renders obvious the Power Supply ([1c])
2. The Ground 2A Combination renders obvious the Control Component ([1f])
3. The Ground 2A Combination renders obvious Paramagnetic Flux Paths ([14], [19])

The '830 Patent – Independent Claim 1

[1pre] A vibration module comprising:

- [1a] a housing;
- [1b] a moveable component;
- [1c] a power supply;
- [1d] user-input features;
- [1e] a driving component that drives the moveable component to oscillate within the housing; and
- [1f] 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.

EX-1001, 15:57-67

The Combination renders obvious the Control Component ([1f])

2. The Combination renders obvious the Control Component ([1f])

- a. **Means-Plus-Function Construction of “Control Component”**
- b. The Combination renders obvious the Recited Amplitude (“output p”)
- c. The Combination renders obvious the Recited Frequency (“output d”)
- d. All limitations are met under Patent Owner’s untimely construction

Both Parties' Means-Plus-Function Constructions

POR, 7-14

Petition's Construction

“This Petition treats ‘control component’ in claims 1 and 19 as including one of the switches shown in Figures 5A-6 and described at 5:52-6:5, 6:9-16, and the processor (also referred to as microprocessor, microcontroller, or CPU) that performs the algorithm shown in Figures 7A-7C and described at 6:52-8:40.”

Pet. 4

Resonant's Construction in Parallel Proceeding

Structure: oscillator circuit; (except as to claim 20); microcontroller with internal or external memory; processor; CPU; microprocessor; and equivalents thereof

Where the corresponding structure is a processor, CPU, or microprocessor, the processor / CPU / microprocessor is programmed with an algorithm comprising the following steps: (a) set the mode and strength to default values or values representing selections made by user input to the user input features; and (b) provide a corresponding output to the power supply so that the power supply provides a corresponding output to the driving component.

Means-Plus-Function Construction of “Control Component” in Institution Decision

POR, 7-14

Institution Decision

“In summary, the corresponding structure of the “control component” under a means plus function interpretation that relies upon a microprocessor (and memory) as corresponding structure further requires algorithmic structure at least for 1) operating a timer or its equivalent to flip the polarity of a control value periodically corresponding to a user-selected frequency and input the control value to an H-bridge switch circuit to change the direction of the current through the coil as supplied by the power supply, and 2) computing an output value corresponding to a user-selected amplitude of oscillation and outputting the value to the claimed power supply so that the power supply outputs an appropriate current amplitude to a coil.”

ID (Paper 11), 20

Resonant's Argument

Pet. Rep., 7-10

Resonant's POR

Also, the means-plus-function construction requires at least two outputs from the control component, namely ***the output 'd,' corresponding to the desired direction***, as produced by the frequency timer, and ***the output 'p'*** to the power supply. (Ex. 2009, ¶ 123.) The petition does not and cannot show both of these outputs.”

POR, 19-20

The Combination renders obvious the Control Component ([1f])

2. Control Component

- a. Means-Plus-Function Construction of “Control Component”
- b. **The Combination renders obvious the Recited Amplitude (“output p” - Power Supply)**
- c. **The Combination renders obvious the Recited Frequency (“output d” - Direction)**
- d. All limitations are met under Patent Owner’s untimely construction

Resonant's Argument

Pet. Rep., 7-10

Resonant's POR

“The petition does not contend that Gregorio discloses any processor or algorithm that provides an ‘output value p corresponding to the currently selected strength’ or *an ‘output p to the power supply,’ ...*

POR, 19-20

Gregorio's "Control Signals" for Amount of Current

Pet., 16

The Petition discussed that Gregorio controls the actuator drive circuit 16 (the power supply) to change both the frequency and the amplitude of the oscillation

Petition

Gregorio's vibration module includes a control component (combination of "processor 12," "memory 20," and either "LRA Drive with Resonant Frequency Determination module 22" or circuit 400) that **controls** the supply of power from the power supply ("actuator drive circuit 16") to the driving component ("coil 28") to cause the moveable component ("movement/oscillation of magnet 27") to oscillate at a frequency (high-level frequency, assumed resonance frequency, or determined resonance frequency) and an **amplitude** (high level "magnitude," "desired amplitude," or "present amplitude") specified by one or more corresponding values ("high level parameters that define a particular haptic effect" or "**instructions** that, when executed by processor 12, generate drive signals for LRA 18") stored in memory 20. APPLE-1004, 2:18-2:50, 4:20-65; APPLE-1003, [103].

Pet., 16 (Element [1f])

Resonant's Limited Reading of Gregorio's "Actuator Drive Circuit" Is Erroneous

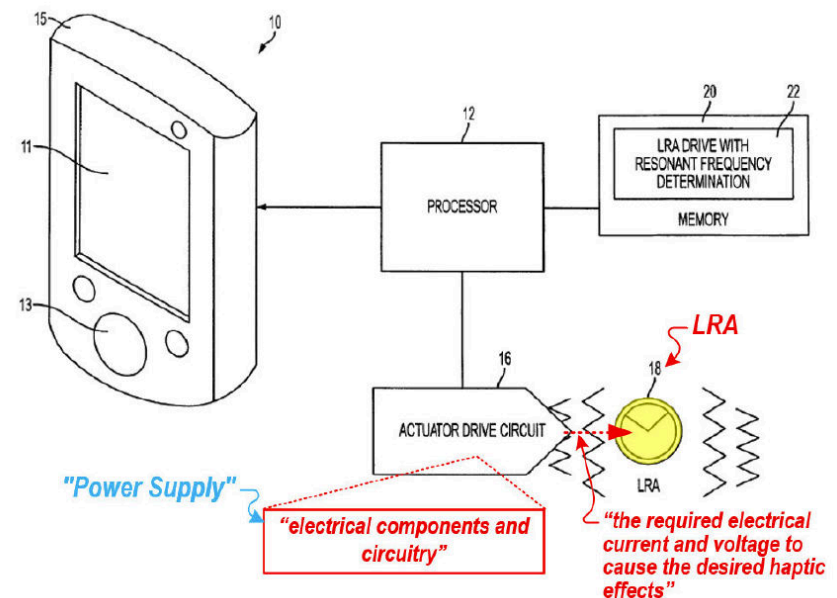
Pet. Rep., 5; Pet. 16-18

Gregorio's "control signals" are for controlling the amount of current being supplied by the drive circuit 16 (the power supply), as well as the direction of current being supplied by the drive circuit 16 (i.e., Resonant's "conduit of power" part)

Petitioner Reply

Gregorio's processor 12 "decide[s] what haptic effects are to be played and the order in which the effects are played based on **high level parameters**," such as "**magnitude, frequency and duration**," which can dynamically vary "based on a user's interaction."

Pet. Rep. 5 (citing Gregorio (APPLE-1004), 2:25-30)



Gregorio (APPLE-1004), FIG. 1 (annotated in Pet. 14)

Gregorio's "Control Signals" for Both Direction and Amount of Current

Pet., 24

Cont'd

Petition

Gregorio's one or more operational control outputs (**"control signals" output from processor 12 to drive circuit 16 and/or the resulting "drive signals"/"drive pulses"**) is a control output that determines **a current supplied by the power supply ("actuator drive circuit 16" or "current generator 422")** to the driving component ("coil 28") and **a frequency** (the determined "resonant frequency" and the high-level frequency parameter of the haptic effect) at which the control component drives the moveable component to oscillate. APPLE-1003, [138]-[141]; APPLE-1004, 2:5-2:50, 3:65-6:9. **The amplitude and duration of the drive signals/pulses determine the amount of current** supplied by the power supply to the driving component. APPLE-1003, [138]; APPLE-1004, 2:36-39 (confirming that drive circuit 16 supplies "the required electrical current and voltage" in response to the "control signals"), 5:49-50, Figures 4, 6. And *the frequency of the signals/pulses is the frequency at which the control component drives the moveable component to oscillate. Supra, [1f].*

Pet., 24 (Element [6b])

The Combination renders obvious the Control Component ([1f])

2. Control Component

- a. Means-Plus-Function Construction of “Control Component”
- b. The Combination renders obvious the Recited Amplitude (“output p”)
- c. **The Combination renders obvious the Recited Frequency (“output d”)**
- d. All limitations are met under Patent Owner’s untimely construction

Means-Plus-Function Construction of “Control Component” in Institution Decision

POR, 7-14

Institution Decision

“In summary, the corresponding structure of the “control component” under a means plus function interpretation that relies upon a microprocessor (and memory) as corresponding structure further requires algorithmic structure at least for 1) operating a timer or its equivalent to flip the polarity of a control value periodically corresponding to a user-selected frequency and input the control value to an H-bridge switch circuit to change the direction of the current through the coil as supplied by the power supply, and 2) computing an output value corresponding to a user-selected amplitude of oscillation and outputting the value to the claimed power supply so that the power supply outputs an appropriate current amplitude to a coil.”

ID (Paper 11), 20

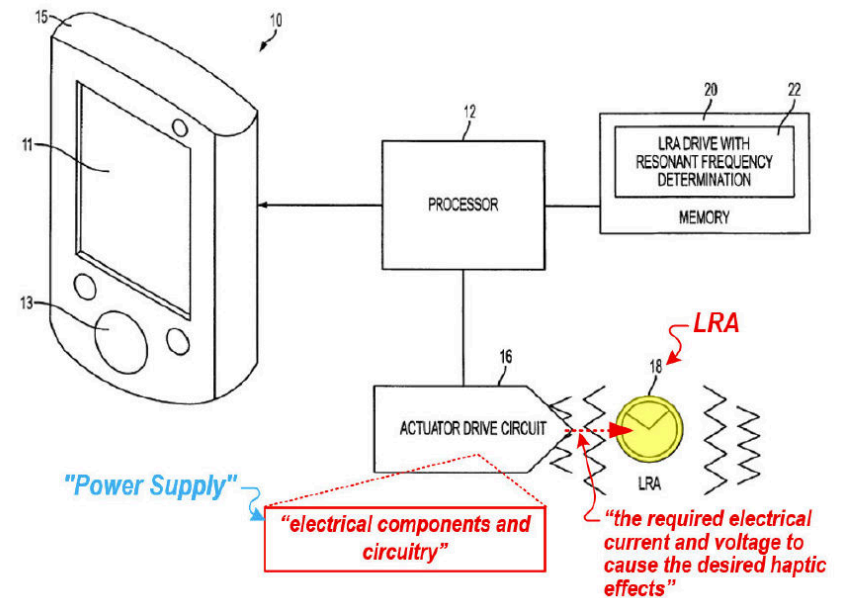
Gregorio discloses “frequency” as one of several high level parameters

Pet. Rep., 5; Pet. 16-18

Petitioner Reply

Gregorio’s processor 12 “decide[s] what haptic effects are to be played and the order in which the effects are played based on **high level parameters**,” such as “**magnitude, frequency** and **duration**,” which can dynamically vary “based on a user’s interaction.”

Pet. Rep. 5 (citing Gregorio (APPLE-1004), 2:25-30)



Gregorio (APPLE-1004), FIG. 1 (annotated in Pet. 14)

The Combination specifies the Direction and Amount of Current in Gregorio-Ramsay-Rossi Combo

Pet. Rep., 7-10

Rossi's H-bridge specifically implements the directional control part of Gregorio's actuator drive circuit 16, while preserving the current amount control part of the actuator drive circuit 16

Petitioner Reply

In the Gregorio-Ramsay-Rossi combination, Rossi's H-bridge is implemented as **part** of Gregorio's actuator driver circuit 16 to switch the direction/polarity of drive signals to the LRA, thereby adjusting the frequency of haptic effect. **Pet., 56**; APPLE-1003, [211]-[218]; APPLE-1049, [13][.]

Rossi's H-bridge does not replace the entirety of Gregorio's drive circuit 16. APPLE-1049, [14]. Instead, it provides an example of how to implement the frequency control part (e.g., directional signal control part) of Gregorio's actuator drive circuit 16. *Id.* Accordingly, Gregorio's drive circuit 16 preserves the capability to adjust the amplitude of current applied to LRA 18 to adjust the strength/magnitude of the haptic effect. *Id.*; see generally **Pet., 56-58, 64-65**; APPLE-1003, [211]-[218], [235].

Pet. Rep. 9 (citing Pet., 56-58, 64-65)

The Board Acknowledged Modification to Gregorio Based on Rossi's H-Bridge Switch

Pet. Rep., 9

Institution Decision

“Petitioner further argues that it would have been obvious to use the H-bridge switch of Rossi as part of the Gregorio actuator drive circuit 16 in the asserted Gregorio-Ramsay combination to periodically switch the polarity of drive signals to electric coil 28 of Gregorio, and thus oscillate magnet 27, under the control of a signal from processor 12 of Gregorio.”

ID (Paper 11), 26

Gregorio's "Control Signals" for Both Direction and Amount of Current

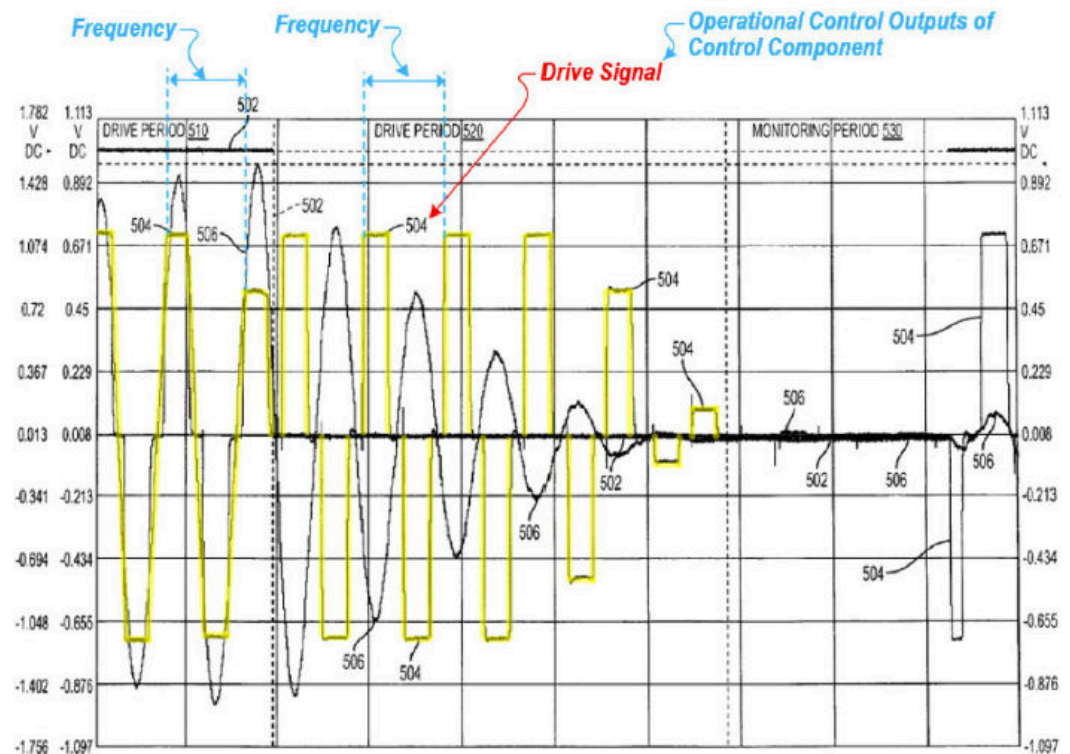
Pet. Rep., 6-7; Pet., 23; APPLE-1003 (Hannaford Org. Dec., [131])

Gregorio's drive signal (also referred to as "drive signal pulses" or "drive pulses"), resulting from the "control signals," determine both the amount and the direction of the current being supplied to LRA.

Hannaford Testimony

In fact, Gregorio's drive signal 504, which is applied to LRA 18 to generate a desired haptic effect, has a varying magnitude, which is adjusted by varying the amplitude of current or the level of power.

APPLE-1049, [9] (citing APPLE-1004, 4:1-2, 4:5-7, 5:60-61, FIG. 5, cl. 2); see also APPLE-1003 (Hannaford Org. Dec.), [128]-[133] (element [5b]), [138]-[140] (element [6b])



Gregorio (APPLE-1004), FIG. 5
(annotated in APPLE-1003, [131], which is cited in Pet. 23)

The Combination renders obvious the Control Component ([1f])

2. Control Component

- a. Means-Plus-Function Construction of “Control Component”
- b. The Combination renders obvious the Recited Amplitude (“output p”)
- c. The Combination renders obvious the Recited Frequency (“output d”)
- d. **All limitations are met under Patent Owner’s untimely construction**

All limitations are met under Patent Owner's untimely construction

Pet. Rep., 7-10

Resonant's POR

"The petition does not contend that Gregorio discloses any processor or algorithm that provides an 'output value p corresponding to the currently selected strength' or ***an 'output p to the power supply,'*** ...

Also, the means-plus-function construction requires at least two outputs from the control component, namely ***the output 'd,' corresponding to the desired direction,*** as produced by the frequency timer, and ***the output 'p' to the power supply.*** (Ex. 2009, ¶ 123.) The petition does not and cannot show both of these outputs."

POR, 19-20

Resonant's Sur-Reply

"In particular, ***[the Petition] fails to show that the "output d" and "output p" occur separately,*** on different iterations of the Figure 7A loop, as required by the algorithm of the Board's construction."

"Nowhere does Gregario teach ***separately outputting d and p signals at separate steps*** of the algorithm as required by the means-plus-function corresponding structures proposed by Apple and adopted in the Board's Institution Decision."

Sur-reply, 1, 7

The zero crossing time of the LRA is measured and the polarity status is latched until the end of the drive pulse

Gregorio (APPLE-1004),4:37-42, which is cited in Pet. 16)

wave.

At 302, at each half crossing of the drive pulse (i.e., when the square wave pulse goes from positive to negative and vice versa), the zero crossing time of the LRA back EMF is measured and the polarity status is latched until the end of the drive pulse.

At 304, during each drive cycle, after the end of the last

Gregorio describes the “generation or variation” of these parameters “based on a user’s interaction”

Gregorio (APPLE-1004),2:18-35, which is cited in Pet. 16)

The haptic feedback system includes a processor 12. Coupled to processor 12 is a memory 20 and an actuator drive circuit 16, which is coupled to an LRA actuator 18. Processor 12 may be any type of general purpose processor, or could be a processor specifically designed to provide haptic effects, such as an application-specific integrated circuit (“ASIC”). Processor 12 may be the same processor that operates the entire system 10, or may be a separate processor. Processor 12 can decide what haptic effects are to be played and the order in which the effects are played based on high level parameters. In general, the high level parameters that define a particular haptic effect include magnitude, frequency and duration. Low level parameters such as streaming motor commands could also be used to determine a particular haptic effect. A haptic effect may be considered “dynamic” if it includes some variation of these parameters when the haptic effect is generated or a variation of these parameters based on a user’s interaction.

Processor 12 outputs the control signals to drive circuit 16

Topics For Discussion

1. The Combination renders obvious the Power Supply ([1c])
2. The Combination renders obvious the Control Component ([1f])
3. **The Combination renders obvious Paramagnetic Flux Paths ([14], [19])**

The '830 Patent – Claims 14 and 19

[14] The vibration module of claim 1 further including flux paths comprising a paramagnetic material that is shaped and positioned to reduce the reluctance of one or more magnetic circuits within the vibration module.

[19pre] A vibration module comprising:

[19a] a housing;

[19b] a moveable component;

[19c] a power supply;

[19d] user-input features;

[19e] a driving component that drives the moveable component to oscillate within the housing;

[19f] 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; and

[19g] flux paths comprising a paramagnetic material that is shaped and positioned to reduce the reluctance of one or more magnetic circuits within the vibration module.

Topics For Discussion

1. Power Supply

2. Paramagnetic Flux Paths

- a. **Gregorio-Wakuda Combination in the Petition**
- b. Resonant's Argument Contradicts The '830 Patent's Disclosure
- c. Resonant's Preference of Ferromagnetic Materials Does Not Obviate the Petition's Motivation for Gregorio-Wakuda Combination
- d. The POSITA's Knowledge and Skill Would Have Been Sufficient to Implement A Paramagnetic Material in The Gregorio-Wakuda Actuator
- e. Resonant's Tangential Criticism Of The Petitioner's Other Corroborating Evidence Is Misleading

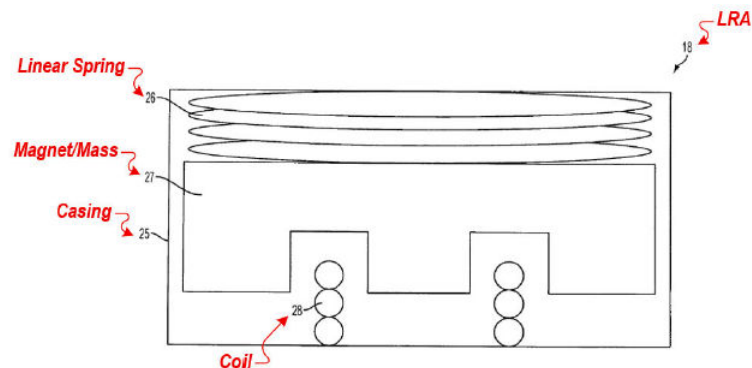
Gregorio-Wakuda Combination – Overall

Pet., 26-29

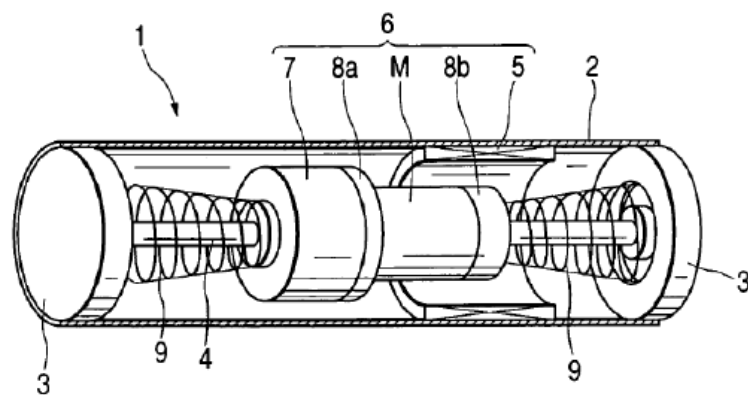
Petition

In the predictable combination, Gregorio's LRA is implemented based on Wakuda's "vibration generating means" structure. APPLE-1003, [143]-[144]. The modified LRA is operated in a manner described in Wakuda, like Gregorio's operation. Id.; APPLE-1005, 5:51-6:10; APPLE-1004, 3:17-28. For example, in the resulting system, Gregorio's system including "casing 25," "coil 28," "magnet/mass 27," and "spring 26" is implemented according to Wakuda's "cylindrical-shaped casing 2," "coil 5," "movable body 6," and "energizing members 9," respectively. APPLE-1003, [144]; APPLE-1004, 3:12-28, Figure 2; APPLE-1005, 4:33-5:64, Figure 1B.

Pet., 26-27



Gregorio (APPLE-1004), FIG. 2 (cited in Pet. 10 with annotations)



Wakuda (APPLE-1005), FIG. 1A (cited in Pet. 26)

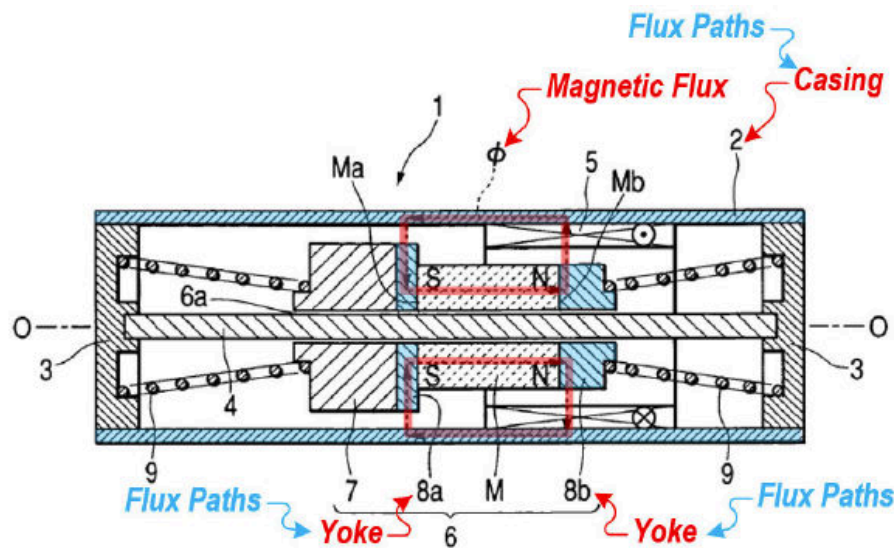
Gregorio-Wakuda Combination – Flux Paths

Pet., 30-36

Petition

A POSITA would have understood and found obvious that, in the resulting actuator, the casing, alone or along with the yoke members, corresponds to the **flux paths** because **the casing and the yoke members are made of magnetic material**, thereby reducing the reluctance of the magnetic path defined at the actuator (i.e., magnetic circuits within the vibration module) despite air gaps between the actuator components (e.g., casing 2 and movable body 6 in Wakuda). APPLE-1003, [154]; APPLE-1005, 4:34-4:54. Indeed, the concept that air gap increases the reluctance of a magnetic circuit was well-known. APPLE-1003, [154] (citing APPLE-1012). Therefore, it was well-known and obvious to shape and position the components of an actuator (or the materials thereof) that define a magnetic path such that the components reduce magnetic reluctance and increase magnetic flux. *Id.*

Pet., 31-32



Wakuda (APPLE-1005), FIG. 1B
(cited in Pet. 31)

Wakuda's Disclosure of Flux Paths

Pet. 30-36

Wakuda

"The vibration generating means 1 shown in FIG. 1 comprises a cylindrical-shaped casing 2 made of a **magnetic substance** as a support, and covers 3, 3 made of a non-magnetic substance and being mountable on both ends of the casing."

"Also, the magnet M is provided on both end surfaces thereof with yoke members 8a, 8b, which are formed from a **magnetic material**."

"Further, the magnetic flux ϕ form a magnetic path, along which the flux pass inside the casing 2 made of a magnetic substance to be conducted to a position opposed to the other of the yoke members 8 a, and are output toward the yoke member 8 a from the position to reach the S pole of the magnet M."

APPLE-1005, 4:34-36, 4:51-54 (cited in Pet. 30)

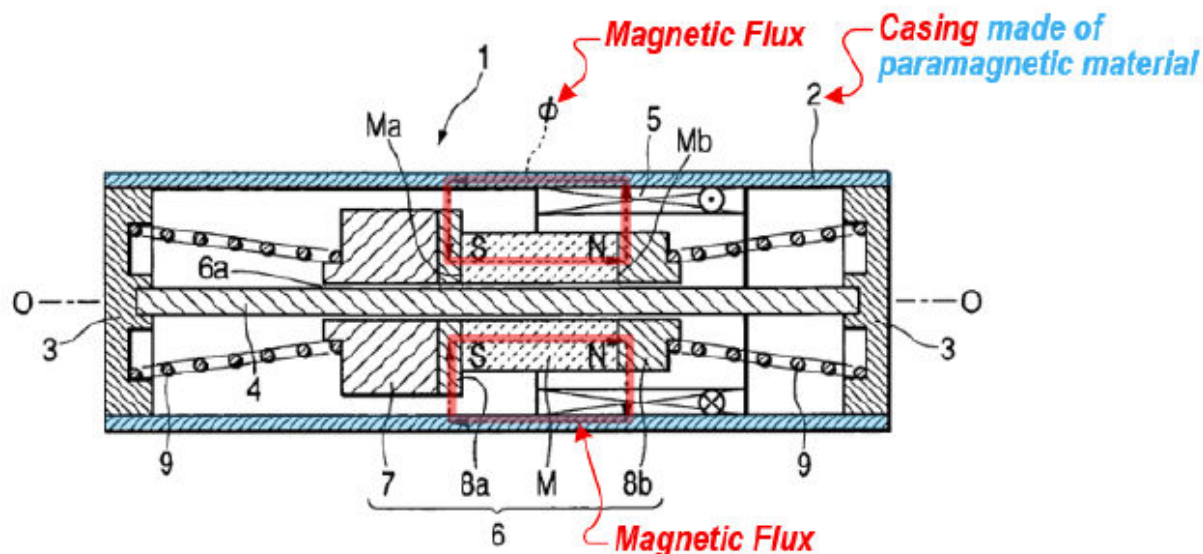
Gregorio-Wakuda Combination – Paramagnetic Material

Pet., 30-36

Hannaford Testimony

Additionally, a POSITA would have understood and found obvious that a **paramagnetic material** would be beneficially used **for Wakuda's "magnetic material" for the casing and the yoke members** of the Gregorio-Wakuda's actuator. APPLE-1003, [155]; APPLE-1005, 4:34-4:54, 5:56-64. Indeed, paramagnetic materials are one of a few categorical options for magnetic materials. APPLE-1003, [155] (citing APPLE-1032 (describing paramagnets as one of four types of magnetic material), APPLE-1035, APPLE-1037). For example, a POSITA would have readily recognized that **aluminum was a known example of a paramagnetic material**, and that aluminum was widely used for housings of haptic feedback actuators or housings of user devices employing the actuators, which can be involved in creating a magnetic path. APPLE-1003, [155] (citing APPLE-1031, APPLE-1013).

Pet., 31-32



APPLE-1005 (Wakuda), FIG. 1B
(cited in Pet. 32)

Gregorio-Wakuda Combination – Paramagnetic Material

Corroborating Evidence

Pet. 30-36

Hannaford Testimony

“Indeed, paramagnetic materials are one of a few categorical options for magnetic materials.”

Pet., 32; APPLE-1003, [155]
(citing APPLE-1032,
APPLE-1035, APPLE-1037)

Phys 251 (Apple-1032)

Magnetic Materials

“Diamagnetism”
“Paramagnetism”
“Ferromagnetic”

APPLE-1032 (cited in Pet., 32))

Apple-1035

 UNIVERSITY OF CAMBRIDGE

Types of magnetism

“Paramagnetism”
“Ferromagnetism”
“Antiferromagnetism”
“Ferrimagnetism”

APPLE-1035 (cited in Pet., 32))

Apple-1037

 UNIVERSITY OF MINNESOTA
Driven to Discover

2. Classes of Magnetic Materials

“Diamagnetism”
“Paramagnetism”
“Ferromagnetism”
“Ferrimagnetism”
“Antiferromagnetism”

APPLE-1037 (cited in Pet., 32))

Gregorio-Wakuda Combination – Paramagnetic Material

Pet. 30-36

Corroborating Evidence

Hannaford Testimony

“Further, a POSITA would have readily recognized that aluminum was a known example of a paramagnetic material, and that aluminum was widely used for the housing of haptic feedback actuators and user devices employing the actuators, which can be involved in creating a path for magnetic flux.”

Pet., 33; APPLE-1003, [155]
(citing APPLE-1031, APPLE-1013)

Brooks (Apple-1031)

“In applications where it is desired to ensure actuation times are as low as possible, the piston 92 is made of material having a suitably high ratio that is also non-magnetic, non-ferrous and, if desired, can be paramagnetic. Aluminum, copper and magnesium and alloys thereof are examples of suitable materials meeting these requirements.”

APPLE-1031, 21:61-66; Pet., 32

Tremblay (Apple-1013)

“The casing may be made from any rigid material, or variety of materials, such as aluminum[.]”

APPLE-1013, 9:36-39; Pet., 32

Topics For Discussion

1. Power Supply

2. Paramagnetic Flux Paths

- a. Gregorio-Wakuda Combination in the Petition
- b. Resonant's Argument Contradicts The '830 Patent's Disclosure**
- c. Resonant's Preference of Ferromagnetic Materials Does Not Obviate the Petition's Motivation for Gregorio-Wakuda Combination
- d. The POSITA's Knowledge and Skill Would Have Been Sufficient to Implement A Paramagnetic Material in The Gregorio-Wakuda Actuator
- e. Patent Owner's Tangential Criticism Of The Petitioner's Other Corroborating Evidence Is Misleading

Where the Dispute Is

Pet. Rep., 10

[14] The vibration module of claim 1 further including flux paths comprising a paramagnetic material that is shaped and positioned to reduce the reluctance of one or more magnetic circuits within the vibration module.

Only Dispute

No Dispute

Resonant's Argument Contradicts '830 Patent

Pet. Rep., 11-12

Resonant's POR

Paramagnetic materials are “so weakly magnetic” that they are “commonly considered to be ‘non-magnetic,’ and thus a POSITA would not have considered a paramagnetic material for Wakuda’s “magnetic material.”

POR, 19-20

'830 Patent

[14] The vibration module of claim 1 further including flux paths comprising **a paramagnetic material** that is shaped and positioned **to reduce the reluctance of one or more magnetic circuits** within the vibration module.

APPLE-1001, 17:26-29, 18:20-22

'830 Patent

“When introduced into a magnetic field, **paramagnetic materials provide a lower-resistance path for magnetic flux**, providing that they have adequate permeability and size to avoid saturation. Paramagnetic materials of appropriate permeability and size reduce the reluctance of a magnetic circuit and can therefore allow a magnetic field to more efficiently perform more work.”

APPLE-1001, 14:4-19 54

Resonant's Argument Contracts Its Own Expert Testimony

Pet. Rep., 11-12

Resonant's POR

Paramagnetic materials are “so weakly magnetic” that they are “commonly considered to be ‘non-magnetic,’ and thus a POSITA would not have considered a paramagnetic material for Wakuda’s “magnetic material.”

POR, 19-20



Resonant's Own Goossen Testimony

Q. Okay. So, do you agree according to Claim 14 that the paramagnetic material has sufficient permeability so as to provide a lower resistance path for the magnetic circuit in the vibration module and thus improve the efficiency of the magnetic field?

A. It can -- yeah, it has -- I mean a paramagnetic material has generally very low permeability, but sufficient to cause the flux paths to concentrate in them to some extent.

Q. So provide a lower resistance path for the magnetic circuit?

A. Yes.

APPLE-1055 (Goossen Decl. Tr.), 93:10-22

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- d. The POSITA's Knowledge and Skill Would Have Been Sufficient to Implement A Paramagnetic Material in The Gregorio-Wakuda Actuator
- e. Resonant's Tangential Criticism Of The Petitioner's Other Corroborating Evidence Is Misleading

Resonant's Preference of Ferromagnetic Materials Is Irrelevant

Pet. Rep., 12-13

Resonant's POR

Paramagnetic materials are “so weakly magnetic” that they are “commonly considered to be ‘non-magnetic,’ and thus a POSITA would not have considered a paramagnetic material for Wakuda’s “magnetic material.”

“As this figure is drawn, showing strong bending of the magnetic field lines into the casing, it is clearly represented as ferromagnetic. (Ex. 2009, ¶ 139.) A paramagnetic material would not so strongly bend the lines. (Id.)”

POR, 19-20, 26

Resonant's Preference of Ferromagnetic Materials Is Irrelevant

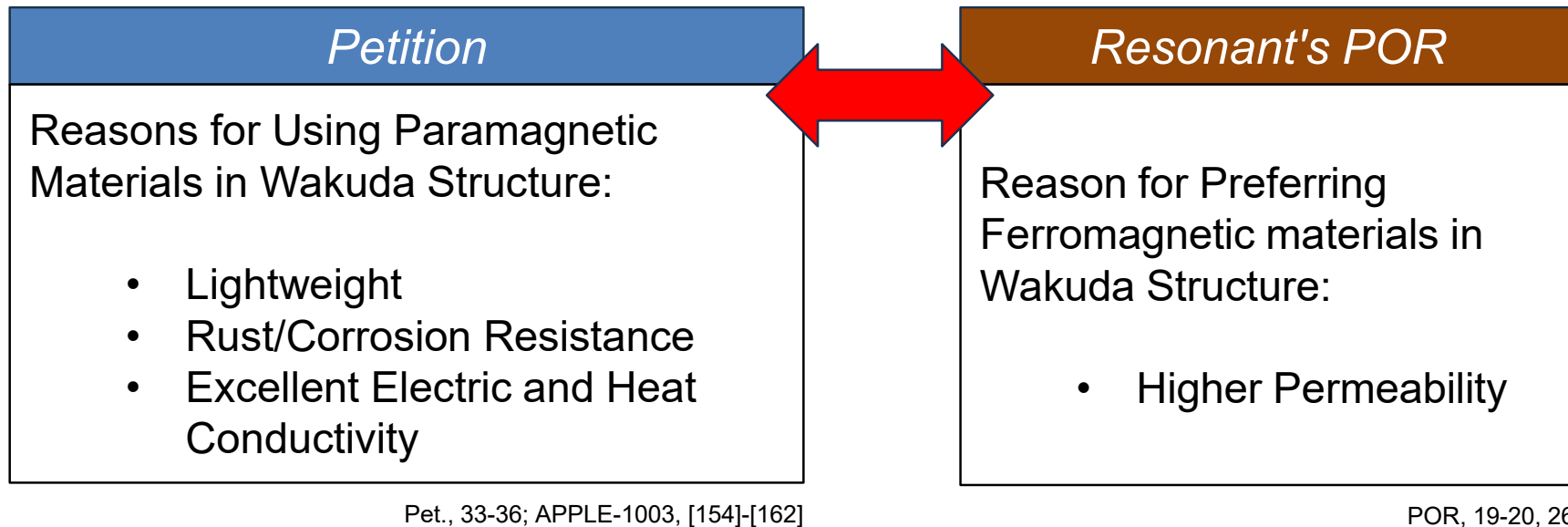
Pet. Rep., 12-13



“A given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine.” *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006)

Resonant's Preference of Ferromagnetic Materials Is Irrelevant

Pet. Rep., 12-13



Hannaford Testimony

“A competing disadvantage of paramagnetic materials that the Patent Owner alleges, such smaller permeabilities than ferromagnetic materials, does not obviate the motivation arguments in the Original Declaration.”

Pet. Rep., 12-13; APPLE-1049, [21]; APPLE-1003, [156]-[162]

Topics For Discussion

1. Power Supply

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- d. **The POSITA's Knowledge and Skill Would Have Been Sufficient to Implement A Paramagnetic Material in The Gregorio-Wakuda Actuator**
- e. Resonant's Tangential Criticism Of The Petitioner's Other Corroborating Evidence Is Misleading

Resonant's Arguments Disregard POSITA's Knowledge/Skill Informed by the '830 Patent

Pet. Rep., 13-16

Resonant's POR

"As this figure is drawn, showing strong bending of the magnetic field lines into the casing, it is clearly represented as ferromagnetic. (Ex. 2009, ¶ 139.) A paramagnetic material would not so strongly bend the lines. (Id.)"

"Thus replacing the casing with a paramagnetic material would result in the device not working, according to Wakuda's design."

POR, 26-27

Resonant's Sur-Reply

The Reply quotes from the teachings of the '830 patent itself, as allegedly contrasting with Resonant's arguments. (Reply at 11–12.) But the quoted material actually supports the positions taken in the Response:

When introduced into a magnetic field, paramagnetic materials provide a lower-resistance path for magnetic flux, providing that they have **adequate permeability and size** to avoid saturation. ...

... As the Reply points out, "a paramagnetic material such as aluminum" lacks adequate or appropriate permeability.

PO Sur-reply, 8

Resonant alleges that, on one hand, paramagnetic materials would not work in Gregorio-Wakuda actuator (in POR), and on the other hand, certain paramagnetic materials having "adequate permeability and size" would work in Gregorio-Wakuda actuator (in Sur-reply).

These inconsistent positions are meaningless, given the POSITA's knowledge/skill, for example the one informed by the '830 patent.

Standard of POSITA's Sufficient Knowledge/Skill

Pet. Rep., 13-16



“A person of ordinary skill in the art is also a person of ordinary creativity, not an automaton.” *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 421 (2007)

The '830 Patent Informs POSITA's Knowledge/Skill

Pet. Rep., 13-16



“The specification ... is entirely silent on how to transmit user locations and maps from a server to a user’s mobile device, suggesting that a person of ordinary skill in the art was more than capable of selecting between the known methods of accomplishing this.” *Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1339 (Fed. Cir. 2020)

“[T]he Board’s observation that appellant did not provide the type of detail in his specification that he now argues is necessary in prior art references supports the Board’s finding that one skilled in the art would have known how to implement the features of the references and would have concluded that the reference disclosures would have been enabling.” *In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994)

“But as the examiner and Board correctly found, Publicover’s specification is just as sparse on how a system would identify this type of eye movement. Under the circumstances, we find this attorney argument as to the capabilities of a skilled artisan unpersuasive.” *In re Publicover*, 813 F. App’x 527, 532 (Fed. Cir. 2020)

The '830 Patent Informs POSITA's Sufficient Knowledge/Skill to Implement Paramagnetic Material

Pet. Rep., 13-16

Hannaford Testimony

“Indeed, the '830 patent uses the same material (“paramagnetic material”) to achieve the same resulting actuator as Wakuda, and offers no other hint on how to select and use a paramagnetic material in the claimed vibration module, much less a suitable permeability of the material.”

APPLE-1049, [25]; Pet. Rep. 14

The '830 Patent Informs POSITA's Sufficient Knowledge/Skill to Implement Paramagnetic Material

Pet. Rep., 13-16

Hannaford Testimony

“Rather, the '830 patent provides **limited disclosure (three paragraphs)** of how to implement the claimed paramagnetic flux paths, **leaving implementations details up to the knowledge and skill of a POSITA.**

APPLE-1049, [25]

General Characteristics of
Paramagnetic Materials
(’830 Patent, 14:3-19)

Comparative Examples
with/without paramagnetic flux
paths (’830 Patent, 14:20-35)

Example module with “flux-path
magnetic stops”
(’830 Patent, 14:36-58)

These “offer[] no other hint on how to select and use a paramagnetic material in the claimed vibration module, much less a suitable permeability of the material.”

APPLE-1049 (Hannaford Supp. Dec.), [25]

Resonant's Sur-Reply Argument Disregards POSITA's Knowledge/Skill Informed by the '830 Patent

Pet. Rep., 13-16

Resonant's Sur-Reply

The Reply quotes from the teachings of the '830 patent itself, as allegedly contrasting with Resonant's arguments. (Reply at 11–12.) But the quoted material actually supports the positions taken in the Response:

When introduced into a magnetic field, paramagnetic materials provide a lower-resistance path for magnetic flux, providing that they have **adequate permeability and size** to avoid saturation. ...

... As the Reply points out, **"a paramagnetic material such as aluminum" lacks adequate or appropriate permeability.**

PO Sur-reply, 8

Hannaford Testimony

"Indeed, the '830 patent uses the same material ("paramagnetic material") to achieve the same resulting actuator as Wakuda, and **offers no other hint on how to select and use a paramagnetic material** in the claimed vibration module, much less a suitable permeability of the material."

APPLE-1049, [25]; Pet. Rep. 14

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- e. **Resonant's Tangential Criticism Of The Petitioner's Other Corroborating Evidence Is Misleading**

Resonant's Criticism Of *Phys251* (APPLE-1032) Is Misleading

Pet. Rep., 16-20

Phys251 was corroborating evidence that shows three categories of magnetic material (Pet. at 33)

POR's attack of Phys251 (Apple-1032)

"But this document states that '**All** materials are magnetic in the sense that they are affected by magnetic fields' and that 'll materials are diamagnetic,' one of the three categories of "magnetic materials" listed in exhibit 1032." (emphasis added in Response)

"It also states that 'most applications of magnetic materials call for ferromagnetic materials,' confirming that the categories in exhibit 1032 would not be seen by a POSITA as equally suitable for use in Wakuda's device."

POR, 22

Petitioner Reply

"In particular, Patent Owner attempts to blur three categorizations of magnetic materials—diamagnetic, paramagnetic, and ferromagnetic—and treat diamagnetic materials the same as paramagnetic materials, as opposed to ferromagnetic materials."

"However, '**most** applications,' are not all applications."

Pet. Rep., 16-17

Resonant's Own Goossen Testimony

Q. Do you really think that paramagnetic materials are nonmagnetic?
A. I didn't say that.

APPLE-1055 (Goossen Decl. Tr.), 103:3-5 68

Resonant's Criticism Of *Hitchhiker* (APPLE-1037) Is Misleading

Pet. Rep., 16-20

Hitchhiker was corroborating evidence that shows five categories of magnetic material (Pet. at 33)

POR's attack of Hitchhiker (Apple-1037)

"The document then states: 'Ferromagnetic and ferrimagnetic materials are usually what we consider as being magnetic (ie., behaving like iron). The remaining three are so weakly magnetic that they are usually thought of as 'nonmagnetic'.'

POR, 22-23

Petitioner Reply

This statement ("The remaining three are so weakly magnetic that they are **usually** thought of as 'nonmagnetic'") does not support Patent Owner's proposition that paramagnetic materials are non-magnetic.

Pet. Rep., 17-18

Resonant's Own Goossen Testimony

Q. Do you really think that paramagnetic materials are nonmagnetic?
A. I didn't say that.

APPLE-1055 (Goossen Decl. Tr.), 103:3-5

Resonant's Criticism Of *Brooks* (APPLE-1031) Is Misleading

Pet. Rep., 16-20

Brooks was corroborating evidence that shows a known use of paramagnetic material (Pet. at 31)

Brooks (Apple-1031)

“In applications where it is desired to ensure actuation times are as low as possible, the piston 92 is made of material having a suitably high ratio that is also non-magnetic, non-ferrous and, **if desired, can be paramagnetic**. Aluminum, copper and magnesium and alloys thereof are examples of suitable materials meeting these requirements.”

APPLE-1031, 21:61-66

POR's attack of Brooks (Apple-1031)

“This paragraph clearly refers to paramagnetic materials—and to aluminum specifically—as ‘non-magnetic.’”

POR, 23-24

Resonant's Criticism Of *Brooks* (APPLE-1031) Is Misleading

Pet. Rep., 16-20

Brooks was corroborating evidence that shows a known use of paramagnetic material (Pet. at 31)

Petitioner Reply

“Rather, **Brooks** distinguishes ‘paramagnetic’ materials from ‘non-magnetic, non-ferrous,’ and **expressly identifies paramagnetic materials as a different option from non-magnetic material.**”

Pet. Rep, 18)

Brooks (Apple-1031)

“the driven element is ... comprised of one of a ***non-magnetic material*** and a ***paramagnetic material***”

APPLE-1031, 38:2-3

Resonant's Criticism Of *McLyman (APPLE-1012)* Is Misleading

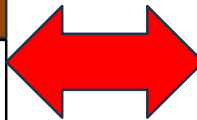
Pet. Rep., 16-20

McLyman was corroborating evidence that explains a known issue of an air gap in a magnetic circuit (Pet. at 31)

POR's attack of McLyman (Apple-1012)

Resonant alleges that McLyman reveals a lack of motivation to use a paramagnetic material to implement Wakuda's actuator illustrated in FIG. 1B.

POR, 24-29



Petitioner reply

- “McLyman is not part of the proposed combination.”
- “[T]he Petition relies on the McLyman textbook to demonstrate a simple, known concept that an air gap increases the reluctance of a magnetic circuit[.]”
- McLyman “is completely silent as to paramagnetic materials” and “does not identify aluminum or any other paramagnetic materials as nonmagnetic.”
- “McLyman merely states that ‘[a] vacuum has a [relative] permeability of 1.0, and nonmagnetic materials, such as air, paper, and copper have [relative] permeabilities of the same order.’”

Pet. Rep. 18-20 72

Resonant's Criticism Of *McLyman (APPLE-1012)* Is Misleading

Pet. Rep., 16-20

McLyman was corroborating evidence that explains a known issue of an air gap in a magnetic circuit (Pet. at 31)

POR's attack of McLyman

“The CGS susceptibility of solid aluminum is 16.5×10^{-6} , making the permeability $1 + 4\pi\kappa$ approximately 1.000022, and making it one of the ‘non-magnetic materials’ with ‘permeabilities of the same order’ as 1.0, according to McLyman.

POR, 28

Hannaford Testimony

“Thus, aluminum, one example of paramagnetic materials, can produce a stronger magnetic field than nonmagnetic materials, such as air.”

“This is exactly what the '830 patent contemplates.”

APPLE-1054 (cited in POR)

Magnetic susceptibility and permeability d

Medium	Susceptibility, volumetric, SI, χ_m	Relative permeability, max., μ/μ_0
Vacuum	0	1, exactly ^[7]
Metglas 2714A (annealed)		1 000 000 ^[8]
Platinum		1.000 265
Aluminum	2.22×10^{-5} ^[32]	1.000 022
Wood		1.000 000 43 ^[32]
Air		1.000 000 37 ^[33]
Concrete (dry)		1 ^[34]
Hydrogen	-2.2×10^{-9} ^[32]	1.000 0000
Teflon		1.0000
Sapphire	-2.1×10^{-7}	0.999 999 76
Copper	-6.4×10^{-6} or -9.2×10^{-6} ^[32]	0.999 994
Water	-8×10^{-6}	0.999 992

APPLE-1054, 5 (cited in POR at footnote 122)