

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD. and
SAMSUNG ELECTRONICS AMERICA, INC.

Petitioner

v.

RESONANT SYSTEMS, INC.,

Patent Owner

Case IPR2023-00993

U.S. Patent No. 9,941,830

**DECLARATION OF ANDREW WOLFE, PH.D.
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 9,941,830**

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I, Andrew Wolfe, declare as follows:

I. INTRODUCTION

1. I have been retained by Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (“Samsung” or “Petitioners”) as an independent expert consultant in this proceeding before the United States Patent and Trademark Office (“PTO”).

2. I am being compensated at a rate of \$650/hour for my services in this proceeding, which is my regular and customary rate.

3. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other interest in this proceeding.

4. I have been asked to consider whether certain references disclose or suggest the features recited in the claims of U.S. Patent No. 9,941,830 (“the ’830 patent”) (Ex. 1001).¹ My opinions are set forth below.

II. BACKGROUND AND QUALIFICATIONS

5. I am an independent consultant. All my opinions stated in this declaration are based on my own personal knowledge and professional judgment. In

¹ Where appropriate, I refer to exhibits I understand will be attached to the petition for *inter partes* review of the ’830 patent (the “Petition”).

forming my opinions, I have relied on my education, experience, and knowledge regarding electrical engineering, computer science, audio engineering, user interface design, and experience with consumer product design.

6. I am over 18 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein. A copy of my current curriculum vitae, which details my education and professional and academic experience, as well as a list of all publications I have authored in the past ten years, is included as Ex. 1004 in this proceeding. The following provides an overview of some of my experience that is relevant to the matters set forth in this declaration.

A. Relevant Academic Experience

7. In 1985, I earned the B.S.E.E. degree in Electrical Engineering and Computer Science from the Johns Hopkins University. In 1987, I received the M.S. degree in Electrical and Computer Engineering from Carnegie Mellon University and in 1992, I received the Ph.D. degree in Computer Engineering from Carnegie Mellon University. My doctoral dissertation proposed a new approach for the architecture of a computer processor.

8. I have taught at some of the world's leading institutions in the fields of processor technology, computer systems, consumer electronics, software, design tools, data security, cryptography and intellectual property issues. These institutions

include Stanford University, Princeton University, Carnegie Mellon University, and Santa Clara University.

9. From 1991 through 1997, I served on the Faculty of Princeton University as an Assistant Professor of Electrical Engineering. At Princeton, I taught undergraduate and graduate-level courses in Computer Architecture, Advanced Computer Architecture, Display Technology, and Microprocessor Systems, and conducted sponsored research in the area of computer systems and related topics. From 1999 through 2002, I taught a Computer Architecture course to both undergraduate and graduate students at Stanford University multiple times as a Consulting Professor. At Princeton, I received several teaching awards, both from students and from the School of Engineering. I have also taught advanced microprocessor architecture to industry professionals in IEEE and ACM sponsored seminars. I am currently a lecturer at Santa Clara University teaching courses on Microprocessor Systems, Advanced Logic Design, Real-Time Computing, and Mechatronics. In my Mechatronics class, I teach electrical engineers, mechanical engineers, and computer engineers about all kinds of electromagnetic actuators, about sensors, and about feedback control.

10. I have published more than fifty peer-reviewed papers in computer architecture and computer systems and IC (integrated circuit) design. My CV,

attached as Exhibit 1004, lists all publications that I have authored in the previous 10 years.

11. I have also chaired IEEE and ACM conferences in microarchitecture and IC design and served as an associate editor for IEEE and ACM journals. I served on the IEEE Computer Society Awards committee. I am an IEEE Fellow, and IEEE Computer Society Distinguished Contributor, and a Member of ACM. I am a named inventor on at least fifty-seven U.S. patents and thirty-seven foreign patents including at least eleven patents related to touch-based input or similar functionality.

12. I have been the invited keynote speaker at the ACM/IEEE International Symposium on Microarchitecture and at the International Conference on Multimedia. I have also been an invited speaker on various aspects of technology or the PC industry at numerous industry events including the Intel Developer's Forum, Microsoft Windows Hardware Engineering Conference, Microprocessor Forum, Embedded Systems Conference, Comdex, and Consumer Electronics Show as well as at the Harvard Business School and the University of Illinois Law School. I have been interviewed on subjects related to technology and the electronics industry by publications such as the Wall Street Journal, New York Times, LA Times, Time, Newsweek, Forbes, and Fortune as well as CNN, NPR, and the BBC. I have also spoken at dozens of universities including MIT, Stanford, University of Texas,

Carnegie Mellon, UCLA, University of Michigan, Rice University, and Duke University.

B. Relevant Professional Experience

13. I am the founder and sole employee of Wolfe Consulting. Through Wolfe Consulting, I provide technical and business analytics to businesses on processor technology, computer systems, consumer electronics, software, design tools, data security, cryptography and intellectual property issues. I have more than thirty years' experience developing products, researching, consulting, and teaching in those fields. In that time, I have worked as a computer architect, computer system designer, and as an executive in the PC and electronics business.

14. I have more than 35 years of experience as a computer architect, computer system designer, personal computer graphics designer, educator, and executive in the electronics industry.

15. In 1983, I began designing touch sensors, microprocessor-based computer systems, and I/O (input/output) cards for personal computers as a senior design engineer for Touch Technology, Inc. During the course of my design projects with Touch Technology, I designed I/O cards for PC-compatible computer systems, including the IBM PC-AT, to interface with interactive touch-based computer terminals that I designed for use in public information systems. I continued designing and developing related technology as a consultant to the Carroll Touch

division of AMP, Inc., where in 1986 I designed one of the first custom touch-screen integrated circuits. I designed the touch/pen input system for the Linus WriteTop, which many believe to be the first commercial tablet computer.

16. From 1986 through 1987, I designed and built a high-performance computer system as a student at Carnegie Mellon University. From 1986 through early 1988, I also developed the curriculum, and supervised the teaching laboratory, for processor design courses.

17. In the latter part of 1989, I worked as a senior design engineer for ESL-TRW Advanced Technology Division. While at ESL-TRW, I designed and built a bus interface and memory controller for a workstation-based computer system, and also worked on the design of a multiprocessor system.

18. At the end of 1989, I (along with some partners) reacquired the rights to the technology I had developed at Touch Technology and at AMP, and founded The Graphics Technology Company. Over the next seven years, as an officer and a consultant for The Graphics Technology Company, I managed the company's engineering development activities and personally developed dozens of touch screen sensors, controllers, and interactive touch-based computer systems.

19. I have consulted, formally and informally, for a number of fabless semiconductor companies. In particular, I have served on the technology advisory boards for two processor design companies: BOPS, Inc., where I chaired the board,

and Siroyan Ltd., where I served in a similar role for three networking chip companies – Intellon, Inc., Comsilica, Inc., and Entridia, Inc. – and one 3D game accelerator company, Ageria, Inc.

20. I have also served as a technology advisor to Motorola and to several venture capital funds in the United States and Europe. Currently, I am a director at Turtle Beach Corporation, providing guidance in its development of premium audio peripheral devices and user input devices for PCs, mobile devices, and gaming consoles.

21. From 1997 through 2002, I held a variety of executive positions at a publicly held fabless semiconductor company originally called S3, Inc. and later called Sonicblue Inc. I held the positions of Chief Technology Officer, Vice President of System Integration Products, Senior Vice President of Business Development, and Director of Technology, among others.

22. My teams developed the Rio MP3 players and a music delivery platform and webstore backend service for selling music. In 1999, this music delivery system was spun out as a separate company called RioPort.com. I served on the RioPort.com board of directors and became involved in its product and technology strategy. I also managed engineering and marketing for the Rio product line for a period of time as an interim general manager. The Rio MP3 players were among the first consumer products to incorporate large quantities of NAND flash

memory. During my time at SonicBlue we launched more than 30 new consumer electronics products.

III. MATERIALS REVIEWED

23. The opinions contained in this declaration are based on the documents I reviewed, my professional judgment, as well as my education, experience, and knowledge regarding electrical engineering, computer science, and haptic and linear actuation sciences.

24. In forming my opinions expressed in this declaration, I reviewed the following materials:

- the '830 patent (Ex. 1001);
- the file history of the '830 patent (U.S. Patent Application 15/181,249) (Ex. 1002);
- the file history of U.S. Patent Application 61/179,109 (provisional) (Ex. 1007);
- the file history of U.S. Patent Application 12/782,697 (non-provisional) (Ex. 1028);
- the file history of U.S. Patent Application 13/345,607 (continuation-in-part) (Ex. 1026);
- the file history of U.S. Patent Application 14/469,210 (continuation) ("081Pat.") (Ex. 1024);

- U.S. Patent Application Publication 2011/0144426A1 (“Blenk”) (Ex. 1030);
- U.S. Patent Application Publication 2011/0248817A1 (“Houston”) (Ex. 1031);
- U.S. Patent Application Publication 2007/0261185A1 (“Guney”) (Ex. 1032);
- U.S. Patent 7,292,227 (“Fukumoto”) (Ex. 1005);
- U.S. Patent Application Publication 2006/0284849A1 (“Grant”) (EX1006);
- U.S. Patent Application Publication 2006/0248183A1 (“Barton”) (EX1007);
- U.S. Patent Application Publication 2004/0169480A1 (“Ueda”) (Ex. 1008);
- U.S. Patent Application Publication 2008/0174187A1 (“Erixon”) (Ex. 1009)
- U.S. Patent Application Publication 2008/0001484A1 (“Fuller”) (Ex. 1010)
- China Patent Application Publication No. CN101488697A (“Dong”) (Ex. 1011);

- Japan Patent Application Publication JPH0819605A (“Ogusu”) (Ex. 1015);
- U.S. Patent 7,006,641 (“Saiki”) (Ex. 1013);
- U.S. Patent 8,917,486 (“Masahiko”) (Ex. 1014);
- U.S. Patent No. 3,919,616 (“Allison”) (Ex. 1033);
- U.S. Patent Application Publication 2009/0295739A1 (“Nagara”) (Ex. 1034);
- U.S. Patent Application Publication 2008/0153554A1 (“Yoon ’554”) (Ex. 1035);
- U.S. Patent Application Publication 2008/0155415A1 (“Yoon ’415”) (Ex. 1036);
- Exar Databook, *XR-8038: Precision Waveform Generator*, Chapter 1 at 213–214 (1985), (“Exar”) (Ex 1037);
- Herbert Friedman, *99 Electronic Projects*, Lafayette Radio Electronics, at 126 (1971), (“Friedman”) (Ex. 1038);
- Paul Horowitz and Winfield Hill, *The Art of Electronics, 2nd Edition*, Cambridge University Press, at 153–293 (1980), (“Horowitz”) (Ex. 1039);

- Water G. Jung, *IC Op-Amp Cookbook, Second Edition, The Art of Electronics, 2nd Edition*, Howard W. Sams & Co., Inc., at 360–362 (1974), (“Jung”) (Ex. 1040);
- STMicroelectronics, *L298: Dual Full-Bridge Driver*, STMicroelectronics at 1–13 (2000), (“STMicroelectronics”) (Ex. 1042);
- Jacob Millman, *Micro-Electronics: Digital and Analog Circuits and Systems*, McGraw-Hill Book Company, at 651–653. (1979), (“Millman”) (Ex. 1041);
- Amended Infringement Contentions in *Resonant Systems, Inc. v. Samsung Elecs. Co., Ltd.*, 2:22-cv-00423 (E.D. Tex.) (Ex.1022);

and any other materials I refer to in this declaration in support of my opinions.

25. All of the opinions contained in this declaration are based on the documents I reviewed and my knowledge and professional judgment. My opinions have also been guided by my appreciation of how a person of ordinary skill in the art would have understood the claims and the specification of the '830 patent at the time of the alleged invention, which I have been asked to initially consider as no earlier than January 6, 2012 (the filing date of U.S. Application No. 13/345,607). *See* Ex. 1026. My opinions reflect how one of ordinary skill in the art would have understood the '830 patent, the prior art to the patent, and the state of the art at the

time of the alleged invention. My opinions would remain the same even if the '830 patent were entitled to priority to U.S. Provisional Patent Application 61/179,109, such that the priority date would be May 18, 2009. *See* Ex. 1029.

26. Based on my experience and expertise, it is my opinion that certain references disclose and/or suggest, alone or in combination, all the features recited in claims 1–9, 11, 14–17, and 19–20 (“Challenged Claims”) of the '830 patent, as I discuss in detail below.

A. Information Considered

27. My opinions are based on my years of education, research and experience, as well as my investigation and study of relevant materials. In forming my opinions, I have considered the materials I identify in this declaration and those listed in the Exhibit List at the end of this declaration.

28. I may rely upon these materials and/or additional materials to respond to arguments raised by the Patent Owner. I may also consider additional documents and information in forming any necessary opinions — including documents that may not yet have been provided to me.

29. My analysis of the materials produced in this matter is ongoing and I will continue to review any new materials as it is provided. This declaration represents only those opinions I have formed to date.

IV. LEVEL OF ORDINARY SKILL IN THE ART

30. The '830 Patent identifies the relevant field of art as follows: "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." EX1001 at Abstract. Based on that description of the field of art, my experience, and the information I have reviewed for purposes of this proceeding, I believe a person of ordinary skill in the art in the field of the '830 Patent in 2009 ("Skilled Artisan" or "POSITA") would have been someone with a bachelor's degree in electrical engineering, mechanical engineering, computer science, or a similar field and two years of experience related to electronic consumer product design. Additional training can substitute for educational or research experience, and vice versa. Such a hypothetical person would have been familiar with various consumer product involving a vibrational component.

31. My opinion of a POSITA does not change even though the priority date of certain limitations of certain claims does. It is my opinion that limitations of claim 1 (e.g. the "user-input features" and "frequency and amplitude specified by one or more stored values") was not disclosed until the first non-provisional filing date associated with the '830 patent on May 18, 2010. It is my opinion that claims 14 and 19 (e.g. "flux paths comprising a paramagnetic material that is shaped and positioned

to reduce the reluctance of one or more magnetic circuits within the linear vibration module”) were not disclosed until the later continuation-in-part application of January 6, 2012. My opinion of the level of knowledge of a POSITA remains consistent despite these 2009, 2010, and 2012 priority dates.

V. RELEVANT LEGAL STANDARDS

32. I am not an attorney and offer no legal opinions, but in the course of my work, I have had experience studying and analyzing patents and patent claims from the perspective of a person skilled in the art.

33. In expressing my opinions and considering the subject matter of the claims of the '830 Patent, I am relying upon certain basic legal principles that have been explained to me.

34. First, I understand that for an invention claimed in a patent to be found patentable, it must be, among other things, new and not obvious in view of what was known before the invention was made.

35. I understand the information that is used to evaluate whether an invention is new and not obvious is generally referred to as “prior art” and generally includes patents and printed publications (e.g., books, journal publications, articles on websites, product manuals, etc.).

36. I understand that in this proceeding the Petitioner has the burden of proving that the claims of the '830 Patent are anticipated by or obvious in view of

the prior art by a preponderance of the evidence. I understand that “a preponderance of the evidence” is evidence sufficient to show that a fact is more likely true than it is not.

37. I understand that in this proceeding, the claims should be given their ordinary and accustomed meaning as understood by one of ordinary skill in the art in view of the patent and its file history. The claims after being construed in this manner are then to be compared to the information in the prior art.

38. I understand that in this proceeding, the information that may be evaluated is limited to patents and printed publications. My analysis below compares the claims to patents and printed publications that are prior art to the claims.

39. I understand that there are two ways in which prior art may render a patent claim unpatentable. First, the prior art can be shown to “anticipate” the claim. Second, the prior art can be shown to have made the claim “obvious” to a person of ordinary skill in the art. In this declaration I focus on “obviousness.” My understanding of the legal standard for “obviousness” is set forth below.

40. I understand that a claimed invention is not patentable if it would have been obvious to a person of ordinary skill in the field of the invention at the time the invention was made.

41. I understand that the obviousness standard is defined in the patent statute (35 U.S.C. § 103(a)) as follows:

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

42. I understand that the following standards govern the determination of whether a claim in a patent is obvious. I have applied these standards in my evaluation of whether the claims of the '830 Patent would have been considered obvious as of the priority date of the patent.

43. I understand that to find a claim in a patent obvious, one must make certain findings regarding the claimed invention and the prior art. Specifically, I understand that the obviousness question requires consideration of four factors (although not necessarily in the following order):

- The scope and content of the prior art;
- The differences between the prior art and the claims at issue;
- The knowledge of a person of ordinary skill in the pertinent art; and
- Whatever objective factors indicating obviousness or non-obviousness may be present in any particular case.

44. In addition, I understand that the obviousness inquiry should not be done in hindsight, but must be done using the perspective of a person of ordinary skill in the relevant art as of the effective filing date of the patent claim.

45. I understand the objective factors indicating obviousness or non-obviousness may include the following: (1) commercial success of products covered by the patent claims; (2) a long-felt need for the invention; (3) failed attempts by others to make the invention; (4) copying of the invention by others in the field; (5) unexpected results achieved by the invention; (6) praise of the invention by those in the field; (7) the taking of licenses under the patent by others; (8) expressions of surprise by experts and those skilled in the art at the making of the invention; and (9) the patentee proceeded contrary to the accepted wisdom of the prior art. I also understand that any of this evidence must be specifically connected to the invention rather than being associated with the prior art or with marketing or other efforts to promote an invention. I am not presently aware of any evidence of “objective factors” suggesting the claims are not obvious, and I reserve my right to address any such evidence if it is identified in the future.

46. I understand the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I also understand that an example of a solution in one field of endeavor may make that solution obvious in another related field. I also understand that market demands or design considerations may prompt variations of a prior art system or process, either in the same field or a different one, and that these variations will ordinarily be considered obvious variations of what has been described in the prior art.

47. I also understand that if a person of ordinary skill can implement a predictable variation, that variation would have been considered obvious. I understand that for similar reasons, if a technique has been used to improve one device, and a Skilled Artisan would recognize that it would improve similar devices in the same way, using that technique to improve the other device would have been obvious unless its actual application yields unexpected results or challenges in implementation.

48. I understand that the obviousness analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim, but instead can take account of the “ordinary innovation” and experimentation that does no more than yield predictable results, which are inferences and creative steps that a Skilled Artisan would employ.

49. I understand that sometimes it will be necessary to look to interrelated teachings of multiple patents; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art. I understand that all these issues may be considered to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue.

50. I understand that the obviousness analysis cannot be confined by a formalistic conception of the words “teaching, suggestion, and motivation.” I

understand that in 2007, the Supreme Court issued its decision in *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398 (2007), where the Court rejected the previous requirement of a “teaching, suggestion, or motivation to combine” known elements of prior art for purposes of an obviousness analysis as a precondition for finding obviousness. It is my understanding that *KSR* confirms that any motivation that would have been known to a person of skill in the art, including common sense, or any motivation derived from the nature of the problem to be solved, is sufficient to explain why references would have been combined.

51. I understand that a person of ordinary skill in the art attempting to solve a problem will not be led only to those elements of prior art designed to solve the same problem. I understand that under the *KSR* standard, steps suggested by common sense are important and should be considered. Common sense teaches that familiar items may have obvious uses beyond their primary purposes, and in many cases a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle. As such, the prior art considered can be directed to any need or problem known in the field of endeavor as of the priority date of the patent and can provide a reason for combining the elements of the prior art in the manner claimed. In other words, the prior art does not need to be directed towards solving the same problem that is addressed in the patent. Further, the individual prior art references themselves need not all be directed towards solving the same problem.

52. I understand that obviousness does not require that the features of a secondary reference be bodily incorporated into the structure of the primary reference. Rather, the test is what the combined teachings of those references would have suggested to a Skilled Artisan. The disclosures of the prior art references need not be physically combinable. Combining the teachings of the references should be the focus of the analysis.

53. I understand that an invention that might be considered an obvious variation or modification of the prior art may be considered non-obvious if one or more prior art references discourages or lead away from the line of inquiry disclosed in the reference(s). A reference does not “teach away” from an invention simply because the reference suggests that another embodiment of the invention is better or preferred. My understanding of the doctrine of teaching away requires a clear indication that the combination should not be attempted (*e.g.*, because it would not work or explicit statements saying the combination should not be made).

54. I understand that a person of ordinary skill is also a person of ordinary creativity.

55. I further understand that in many fields, there may be little discussion of obvious techniques or combination, and it often may be the case that market demand, rather than scientific literature or knowledge, will drive design trends. When there is such a design need or market pressure to solve a problem and there

are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within their technical grasp. If this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense. In that instance the fact that a combination was obvious to try might show that it was obvious. The fact that a particular combination of prior art elements was “obvious to try” may indicate that the combination was obvious even if no one attempted the combination. If the combination was obvious to try (regardless of whether it was actually tried) or leads to anticipated success, then it is likely the result of ordinary skill and common sense rather than innovation.

56. I understand that a petition must identify, for any terms with means-plus-function limitations, the specific portions of the specification that describe the structure, material, or acts corresponding to each claimed function. I also understand a rebuttable presumption exists that without use of the term, “means,” a claim term is not interpreted as means-plus-function, but that other nonce words like “component” have been found to satisfy the rebuttable presumption and invoke a means-plus-function claim construction of such a claim term.

57. I also understand that a petitioner seeking to demonstrate that the prior art discloses a means-plus-function limitation must prove that the corresponding structure—or an equivalent—was present in the prior art and performing the same claimed function.

58. I understand that the standard for determining whether the prior art discloses the corresponding structure or an equivalent is whether there are insubstantial differences, which means that if the assertedly equivalent structure performs the claimed function in substantially the same way to achieve substantially the same result as the corresponding structure described in the specification, it is equivalent.

59. I understand that proving structural equivalence does not require a component-by-component analysis, but rather that it is sufficient to show structure, materials, or acts that perform the claimed function in substantially the same way to achieve substantially the same result because the claim limitation is the overall structure corresponding to the claimed function and not individual components.

60. I understand that for a claim to be valid, its scope must be definite, and that improperly introducing a term can lead to an unascertainable scope of a term, rendering it indefinite. I understand that any claim element first addressed in the claims by the antecedent basis, “a” may then be identified later in the claims by the antecedent basis, “the.” I understand that failing to follow this convention may lead to ambiguity in the identification of the particular claim element in question, leading to an indefinite scope of the claim’s term. For purposes of this proceeding, I identified and provided my best understanding of any such terms despite such ascertainable scope.

VI. SUMMARY OF OPINIONS

61. For the reasons I discuss below, it is my opinion that claims 1–9, 11, 14–17, and 19–20 of the '830 patent are rendered obvious by the prior art.

VII. BRIEF DESCRIPTION OF TECHNOLOGY

A. Background of the Technology

62. As described more fully below, the Fukumoto, Ueda, Grant, Barton, Dong, Ogusu, Saiki, and Masahiko prior art references generally relate to vibration-generating consumer products.

63. The '830 patent at issue in this matter is related to vibration modules that generate vibrational forces and are incorporated into various appliances, devices, and systems. Vibration-generating consumer products come in many forms, and when incorporating a vibration module, generally, require an electrically-driven magnetic circuit that alternates its current to reverse the magnetic fields created by that circuit, which in turn causes a driving component to force a moveable component to move back and forth. In order to provide context for these patents and the state of the technology at the time they were filed, a high-level review of the technology related to computer input and output, software systems related to these functions, and vibrational devices is likely to be beneficial.

1. Computer Hardware

64. Digital computer systems have commonly used the same basic high-level architecture since they began to be developed in the mid-20th century.

65. Computer systems generally include one or more central processing units (“CPU”). A CPU performs all of the primary calculations in the computer. As such, the CPU controls and coordinates the activities of the other connected devices. The CPU would have memory connected to it. This memory holds programs and data that are used to perform the computing and communications functions of the computer. The programs run on the CPU. These programs are generally referred to as “software.” This software includes instructions to the CPU that direct it to perform calculations and to control communications within the computer and to devices connected to the computer.

66. The term input/output (“I/O”) device is used to identify hardware devices that can input or output data to the CPU and/or memory of the computer. One category of I/O devices are “input devices” that are used to communicate information from the user to the computer. These are the devices that give the computer its interactive capability. In general, these devices sense or measure some physical phenomenon such as motion, light, or sound. We use these physical inputs to communicate with the computer. Each of the other input devices operates in a generally similar way. For example, a mouse can use motion sensors to determine

the distance and direction that the mouse is moved and then communicate that information as computer data to the software running on the computer. These types of data are called "input data" and can be processed by software running on the CPU. By 1997, a large number of different input devices were common in computers. These included keyboards for text input; a mouse, trackball, joystick, touchpad, graphics tablet, and touchscreen for cursor positioning; a microphone for sound; and a camera for images.

67. Other I/O devices include output devices. These are the devices that a computer would use to provide information to the user. In general, all of these devices translate computer data to some physical phenomenon, such as motion, light, or sound. For example, a computer monitor converts the data from the computer into an array of light output that form a visible image. This image can include text, graphics, or video. An ink-jet printer converts the computer data to motion by using motors to move the print head and paper and piezoelectric actuators to spray ink at the right time. A sound card uses computer data to generate electrical signals to move the speaker cone back and forth to produce sounds.

68. The computer system provides interactivity by coordinating these various devices through software. The user provides input using an input device. The software on the CPU responds to that input, performs calculations, and retrieves data from memory in order to generate a response. That response is provided back

to the user on an output device. For example, if I move the mouse to the left, the mouse can communicate the direction and amount of motion to the CPU as computer data. The CPU (using software) can then calculate how much the cursor on the screen should move and calculate a new screen image reflecting the new cursor position. This new image is sent to the computer monitor where it is displayed to the user. These type of input/compute/response cycles are at the core of interactive computing.

69. By the mid-1980s, devices called “microcontrollers” or “microcomputers” integrated a CPU, memory, and input/output devices onto a single component. These components were often used to create devices that included computer-controlled input and/or output based on user input. For example there were toys available in the 80s where a child could press a button corresponding to a letter and the CPU would (via execution of software) cause a speaker to vibrate back and forth to make the corresponding sound.

2. Haptics

70. The use of haptics to provide tactile information is a very old technology. I first became familiar with haptic technology when I worked in the signal processing lab at Johns Hopkins. My own research involved touch detection but the professor supervising my work was developing haptic actuators in the lab to assist in communicating with hearing impaired individuals.

71. The use of haptics for force feedback to an input device also has a long history. For example, U.S. Patent No. 3,919,616 (Ex. 1033), filed in 1971, describes a force-feedback joystick input device. The device provides X, Y, and Z positional data to a computer which can then use that positional input to control a display. The computer also generates force-feedback signals to create haptic feedback to the joystick.

72. Nearly 25 years later, the core concepts behind haptic force-feedback devices remained very much the same, but generally-available computer systems had evolved to include multitasking operating systems, graphical user interfaces, icons, windows, and many other common features we see in computers and handheld devices today. As these features appeared, haptic feedback was used along with other input devices such as mice and touchscreens and with the new software applications and operating systems.

73. Generally, haptic feedback is provided by means of an actuator. An actuator is a type of motor or other motion transducer device that moves or controls some mechanism. A motion transducer is any device that moves in response to an electrical signal. These include motors, solenoids, voice coils (i.e. speakers), and piezoelectric devices. With respect to haptic feedback, a variety of different types of actuators can be used to generate haptic feedback. The most basic example of an actuator for haptic feedback is simply using a motor, solenoid, or other motion

transducer to push the user with a rod or stick. For example, a pin might press against a user's finger to notify him that a certain event is occurring. A more complicated example might use a solenoid or pneumatics to impart vibration to the housing of a device, which a user holding the device could feel. Such actuators would provide controllable forces or vibrations which a user would sense upon their activation. In modern electronic devices, another common example of an actuator is an eccentric rotating mass (ERM) motor, which has an offset (non-symmetric) mass attached to the shaft of the motor. As the ERM motor rotates, the offset mass generates a force which generally can be felt as a movement (e.g., a vibration) of the motor and whatever the motor is attached to. ERM motors are commonly called pager motors since, in the 1980s and 1990s, causing a pager to vibrate was a common high-volume application for these devices. Another example of an actuator is a piezoelectric actuator. Piezoelectric actuators include a piezoelectric material that deforms or flexes when a voltage is applied, and the movement of the material creates haptic feedback for anyone touching that material. Traditional speakers can be used to create vibrations as well when they generate audio signals in the low-frequency ranges that people can feel. Speakers were used to create the “Sensurround” haptic

effects in movie theaters for the 1974 film “Earthquake.”² Linear Haptic Resonators use very similar technology to a traditional speaker with a few common modifications. Additional mass may be provided so that vibrations are stronger and the spring action may be provided by a traditional spring or balancing magnets rather than the diaphragm itself. Linear Haptic Resonators are sometimes called voice coil actuators due to the similarity to a speaker’s voice coil.

74. Different actuators are capable of providing different forms of haptic feedback. For example, an ERM motor might only be able to rotate in one direction and at a single speed, while a piezoelectric actuator might be able to output more complex haptic feedback such as simulating textures. Moreover, the same actuator might be able to output different haptic feedback, such as to indicate different information for different events. For example, a solenoid might push a rod against an object once to indicate one event while pushing the rod against the object repeatedly to indicate a different event. Various parameters also can be varied to provide further information, such as pressing the rod harder or more frequently to

²See, e.g., <https://daily.redbullmusicacademy.com/2019/07/earthquake-sensurround-cerwin-vega>;

https://web.archive.org/web/20150207231458/http://ww2.odu.edu/~kwinters/Courses/Film%20Sound/history%2070s_files/thirties.htm

indicate a more urgent event. Various types of actuators relevant to vibration (such as piezoelectric actuators, solenoids, ERM motors, and linear resonators) were all well-known in the art before the patents-in-suit, and were all known to be used for haptic feedback.

75. While much of the academic research on haptics has focused on very sophisticated forms of feedback, haptic feedback also can occur at a basic level. For example, one common form of haptic feedback in the 1980s was the pager, which would vibrate to alert the user of a message. In the 1990s, the popularity of pagers declined while the popularity of mobile phones increased. Many such mobile phones, including the Motorola StarTAC, which I used at the time, would vibrate upon receiving a phone call.

3. Haptics in Graphical User Interfaces

76. As graphical user interfaces became common in the 1980s and the 1990s, various companies and researchers incorporated haptic feedback into graphical user interfaces. One common technique involved adding actuators to a mouse to provide haptic feedback to a user as they encountered various graphical objects such as buttons, menus, and scroll bars. The haptic feedback is provided, for example, as a cursor is moved over each graphical object. These techniques migrated to touch sensors as touch sensors became more popular.

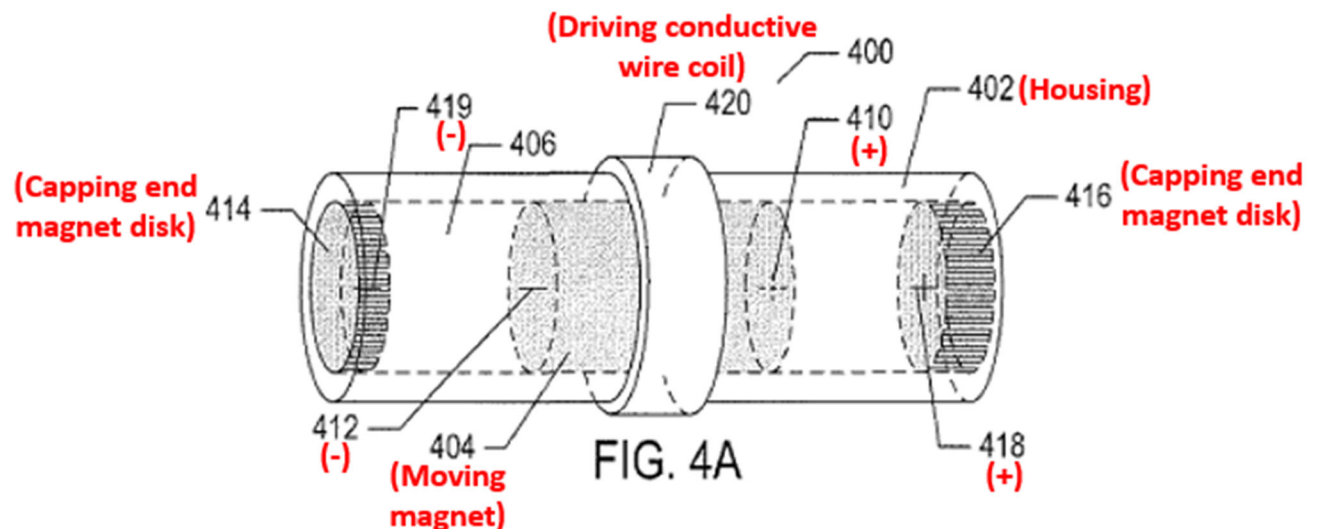
VIII. OVERVIEW OF THE '830 PATENT

A. Specification

77. The '830 Patent (Ex. 1001) relates to “linear vibration modules . . . that can be incorporated in a wide variety of appliances, devices, and systems to provide vibrational forces,” such as “consumer appliances” and “pagers” that “are produced by linear oscillation of a weight or member” further resulting from “rapidly alternating the polarity of one or more driving electromagnets.” *'830Pat.*, Abstract, 1:25–33, 3:1-7, 3:62–64, 4:17-21. The '830 Patent further describes a “linear-resonant vibration module,” which includes “feedback control” to ensure the linear vibration module operates “at or near the resonant frequency.” *Id.* The '830 patent acknowledges that “vibration-inducing motors” were not new at the relevant time. *Id.*, 1:25-33. According to the '830 patent, “[t]he most common electromechanical system used for generating vibrations is an intentionally unbalanced electric motor,” and the '830 patent identifies four problems with using such motors for generating vibration. *Id.*, 1:31-33, 2:15-67 (problems with unbalanced electric motors include “destructive, unbalanced forces within the motor,” “inefficien[cy] in producing vibrational motion,” “elliptical vibrational modes,” and “only a very limited portion of the total vibrational-force/frequency space is accessible”). The '830 patent thus identifies a need “to seek more efficient and capable vibration-generating units for incorporation into many consumer appliances, devices, and systems.” *Id.*, 3:1–7.

78. The '830 patent thus describes linear vibration modules (“LVMs”) and linear-resonant vibration modules (“LRVMs”) that can use used in a variety of applications. *Id.*, 4:17-21. Such LVMs and LRVMs “are 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,” and according to the '830 patent, this “linear nature” addresses the problems associated with prior art unbalanced vibration-inducing motors. *Id.*, 4:21-36.

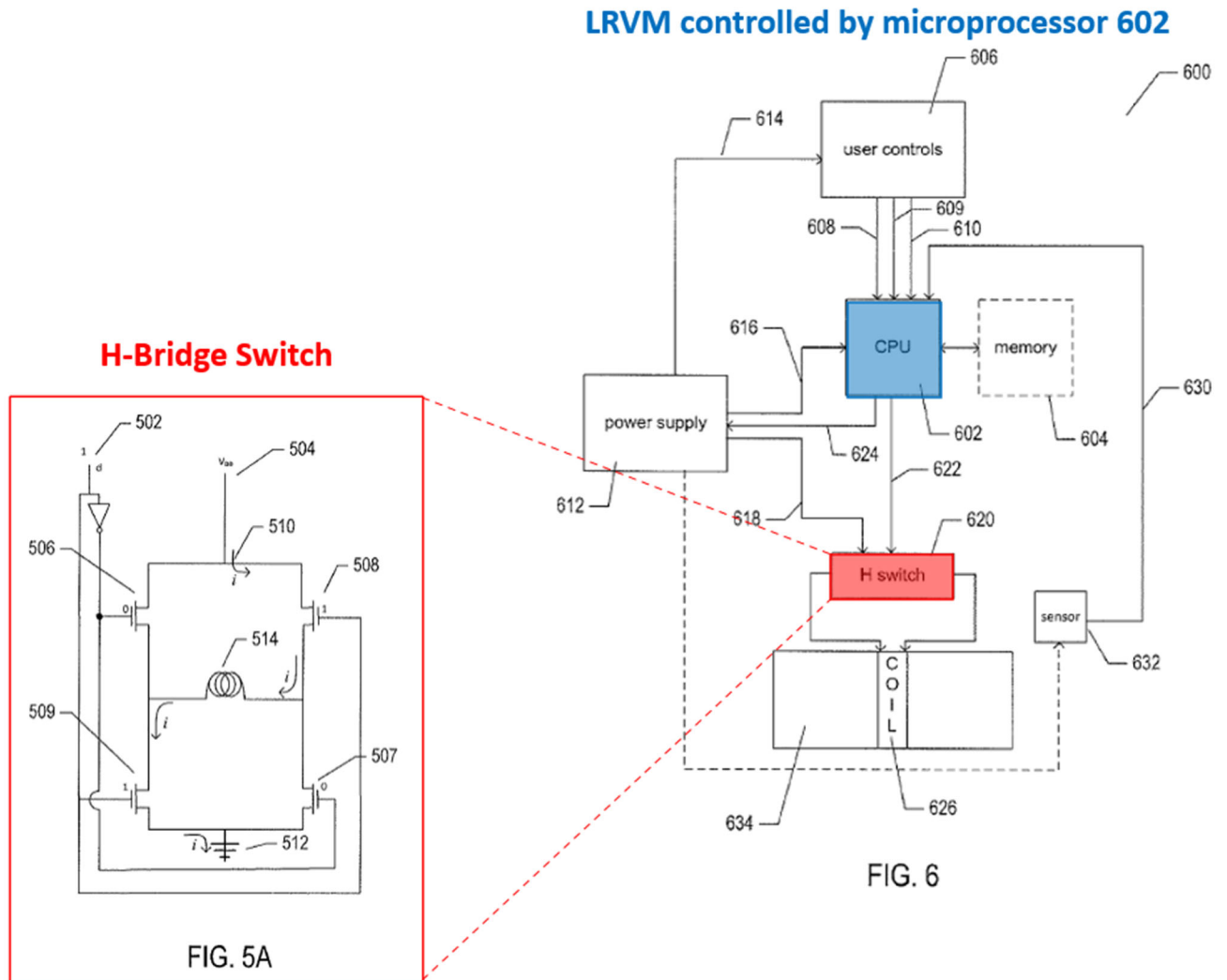
79. Figure 4A depicts one example of the '830 patent’s LVRM including a tubular housing (402), solid, cylindrical moving magnet (404) with opposing polarities on opposing sides (410, 412), capping end magnet disks of the tubular housing (414, 416), and a coil of conductive wire (420):



Id. at Fig. 4A (annotated to show associated components); 4:49–5:10.

80. During operation of the LRVM of Fig. 4A, current is applied in a first direction to coil 420, creating a magnetic force that accelerates weight 404 in a direction parallel to the axis of the housing. *Id.*, 5:11-16. Current is then applied in the opposite direction to coil 420, resulting in weight 404 accelerating in the opposite direction (i.e., “linearly oscillates back and forth”). *Id.*, 5:11-41. “Thus, by 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.* at 5:34–41.

81. The '830 patent explains that “[t]he 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.*, 5:50-6:5. Specifically, microprocessors and H-bridge circuitry can be used to control the application of current and changes in direction of current to the coil:

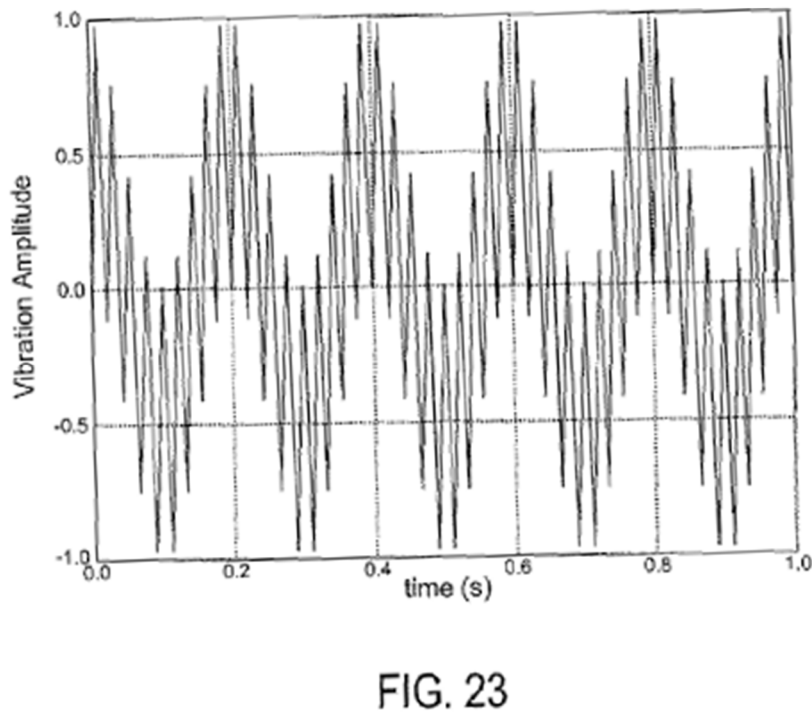
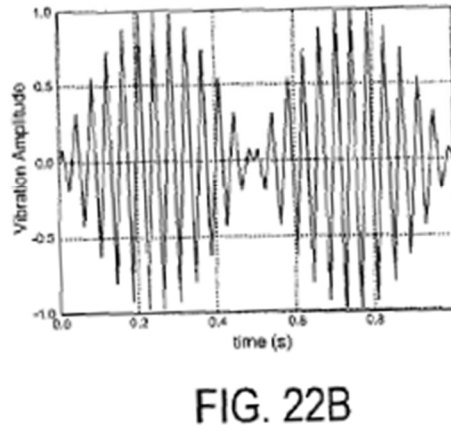
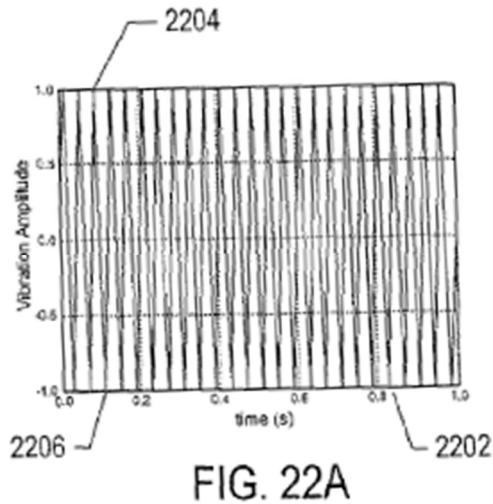


Id. at Figs. 5A, 6 (annotated and combined to show relationship between components); 5:50-6:5 (disclosing application of control signals 502 and 504 to the H-bridge switch to reverse current); 6:6-51 (disclosing CPU microprocessor control of the LRVM using H-bridge switch 618).

82. The '830 Patent discloses that a user may independently control the “vibration amplitude and vibration frequency” of the LRVM. *Id.* at 4:36-40 (describing user-input features as physical controls including “buttons, sliders, and

other types”), 6:27–29 (“controls may include any of various dials, pushbuttons, switches, or other electromechanical-control devices”). According to the ’830 patent, microprocessor control “allows for an essentially limitless number of different vibrational behaviors and modes to be configured by software or firmware design, by user input, or by a combination of software or firmware design and user input.” *Id.*, 13:20–31. Figures 22A-23 “illustrate interesting vibrational modes produced by driving a linear-resonant vibration module simultaneously at two different frequencies”:

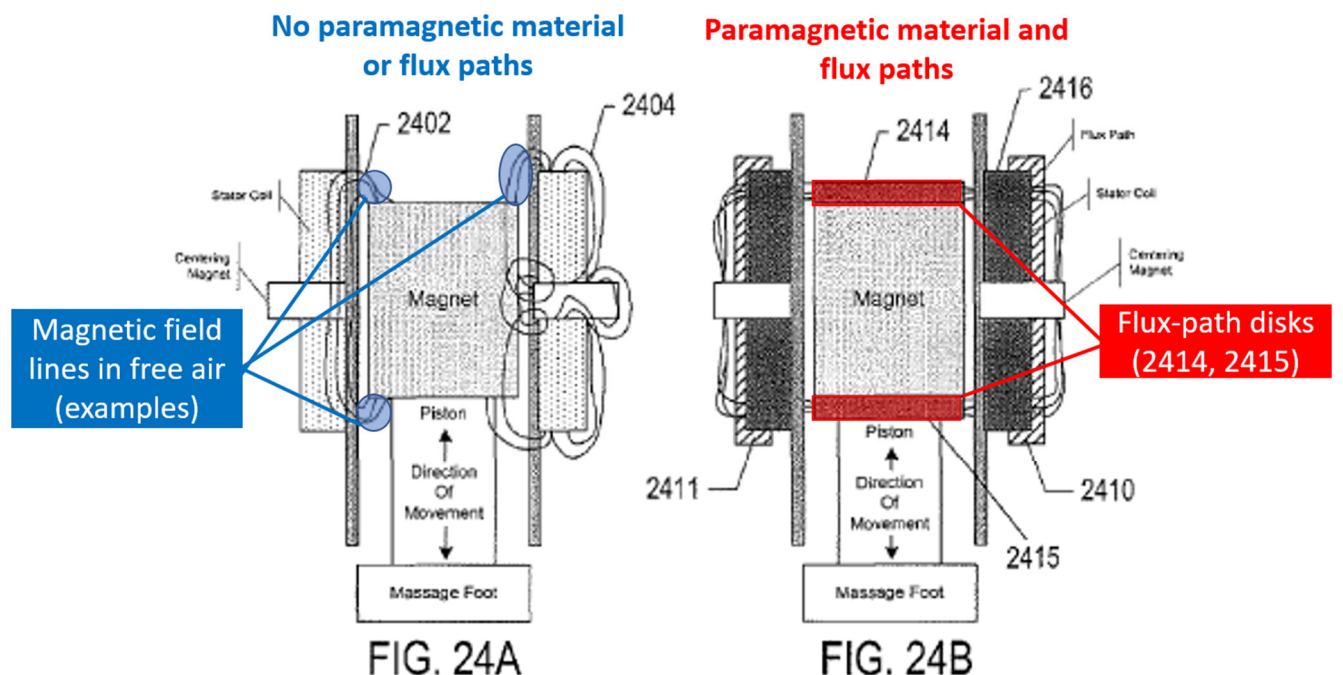
Complex vibrational patterns and modes



Id. at Figs. 22A–B, 23; 13:31–59. The '830 Patent further describes “different alternative implementations of LRVMs.” *Id.* at 3:62–64. Known applications for vibration-inducing motors at the relevant time included “consumer appliances,

toys . . . pagers . . . hair-trimming appliances, electric toothbrushes, electric toy football games” among others. *Id.* at 1:25–31. The ’830 patent also discusses incorporating “paramagnetic flux paths” into its LVM. *Id.*, 14:3-14:35. Specifically, the ’830 patent explains: “Free air can be considered to be analogous to a resistor in an electric circuit and increases the resistance, or magnetic reluctance, of a magnetic circuit and reduces and [sic] the flux of the magnetic field.” *Id.*, 14:7-10. Thus, the ’830 patent explains that “paramagnetic materials” can be introduced to “provide a lower-resistance path for magnetic flux.” *Id.*, 14:13-19.

83. The ’830 Patent distinguishes between an LVM embodiment with (Fig. 24A) and without (Fig. 24B) paramagnetic flux paths:



Id. Figs. 24A–B (annotated), 14:3–19. According to the ’830 Patent, paramagnetic flux paths are introduced to the LVM by including paramagnetic materials (“flux path disks”) that “decrease the portion of magnetic field lines passing through free air” and therefore providing “a more efficient linear vibration module.” *Id.* at 14:20–35.

B. Prosecution History

84. I understand the ’830 Patent issued on April 10, 2018. I also understand it claims priority through a chain of applications to May 18, 2009, when provisional application no. 61/179,109 (Ex. 1029) was filed.³

85. It is my understanding that during prosecution (Ex. 1002), the examiner issued one non-final office action containing multiple rejections, including:

³ I understand the earliest claimed priority date is May 18, 2009. I also understand the references in this Petition are all prior art even if the ’830 claims are entitled to that priority date under 35 U.S.C. § 102 because the filing and publication dates of all the references precede the effective priority dates for all the Challenged Claims as described with respect to each prior art reference.

- Rejection of claims 1–18 for nonstatutory double patenting over the '081Pat. (Ex. 1023) and U.S. Patent Application Publication (“USPub.”) 2007/0261185A1 (“Guney”) (Ex. 1032);
- Rejection of claims 19–20 for nonstatutory double patenting over U.S. Patent 8,860,337 (Ex. 1025) in view of Guney; and
- Rejection of claims 1–12 as obvious over the combination of USPub. 2011/0144426A1 (“Blenk”) (Ex. 1030) in view of USPub. 2011/0248817A1 (“Houston”) (Ex. 1031).

'830FH (Ex. 1002), 103–108. I understand then-Applicant responded with arguments rather than amendments to the claims, alleging a terminal disclaimer was unnecessary and that the Blenk-Houston combination failed to teach the independently-claimed invention because Houston's controller resides in a computer separate from Blenk's vibrating device rather than within one and the same “module.” *Id.*, 118–121. I understand Examiner responded with a notice of allowance lacking any rationale for issuance.⁴ *Id.*, 128–134.

⁴ Petitioners address the appropriate priority date for certain claims in the unpatentability challenges below. For all other claims, the references are prior art even assuming the earliest possible priority date (May 18, 2009). Petitioners reserve the right to further address priority in other proceedings.

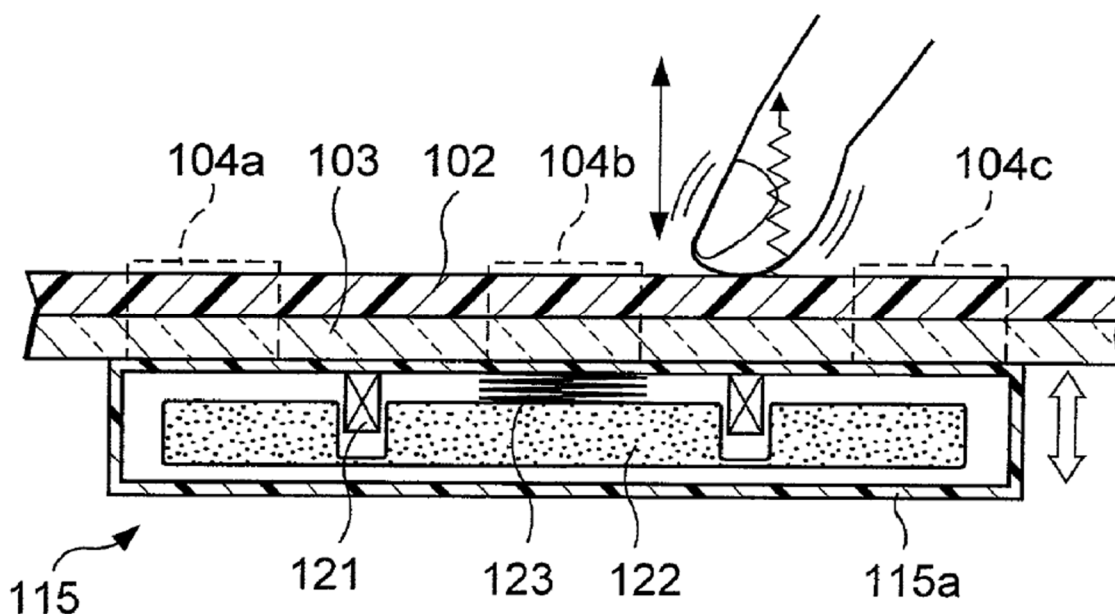
IX. OVERVIEW OF THE PRIOR ART REFERENCES

86. Below is an overview of the primary prior art references that I considered when analyzing the validity of the claims of the '830 Patent.

A. Fukumoto

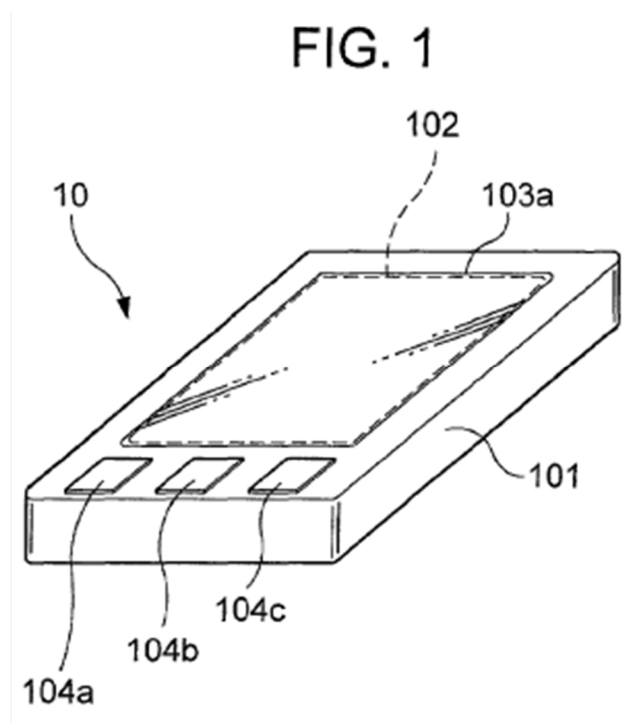
87. I understand Fukumoto (Ex. 1005) was filed as a Patent Cooperation Treaty ("PCT") application on August 2, 2001, published on February 14, 2002, and is therefore prior art under at least 35 U.S.C. § 102(b) under the statutes preceding the America Invents Act ("pre-AIA").

88. Fukumoto discloses an electronic device, such as a PDA or mobile phone, with an oscillatory actuator that generates vibration when an input to a touch panel or operation key is received. *Fukumoto*, Abstract, 1:13–19, 16:29–36. Figure 3 of Fukumoto shows a cross sectional view of an oscillatory actuator in a PDA.

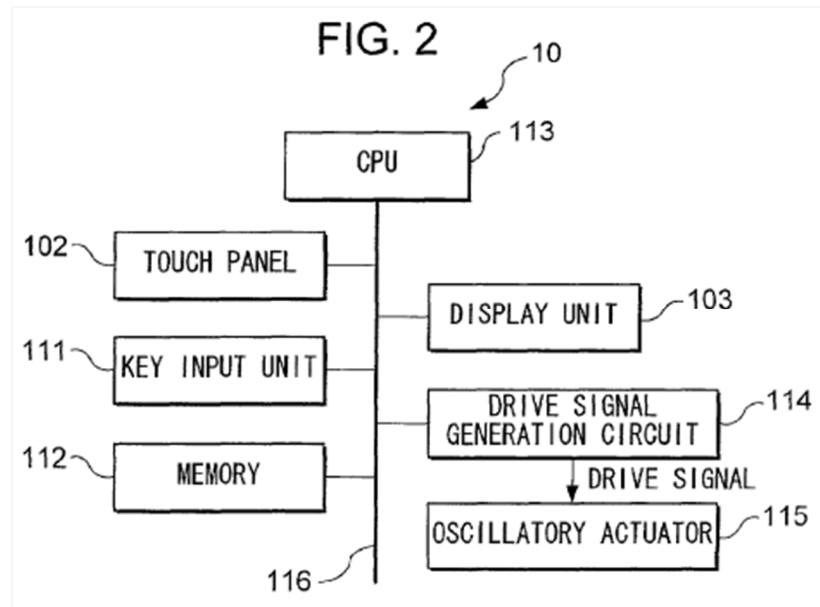


Id. at Fig. 3, 14:27–16:37 (describing the components and operation of the same). Fukumoto’s “oscillatory actuator” contains a case 115a, moveable weight (permanent magnet) 122 supported by a spring 123, and coil 121 that generates magnetic force and causes the moveable weight to vertically oscillate as shown by the arrow in Figure 3 to create vibrational acceleration. *Id.* at 14:38–15:4. Fukumoto further discloses “movable weight 122 linearly reciprocates in the vertical direction in the figure by the magnetic force generated from the coil 121 when an AC (alternating) current (drive signal) is applied to the coil 121.” *Id.* at 14:57–60.

89. Fukumoto further discloses user inputs in a device like the PDA in Figure 1 with the hardware depicted in Fig. 2, below. Specifically, Figure 1 depicts user input buttons 104a–c and touch panel 102:

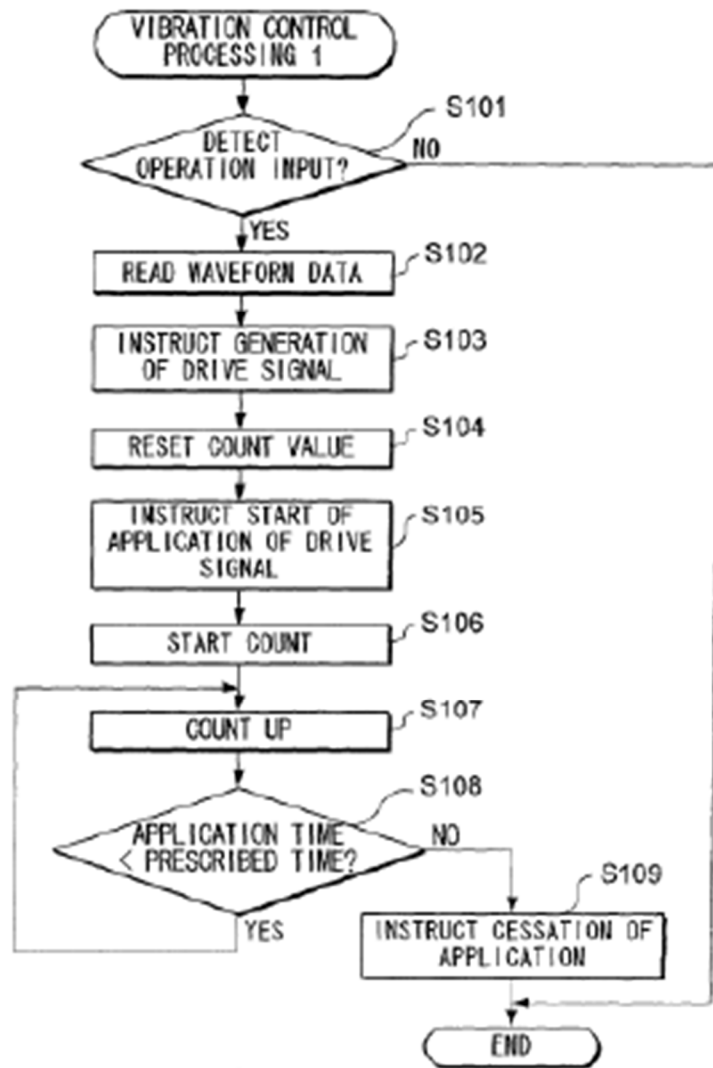


Id. at Fig. 1; 13:41–53. Figure 2 depicts the hardware of the PDA in Figure 1:



Id. at Fig. 2. The PDA hardware includes the touch panel 102 and key input unit 111 that send “operation signal[s]” to a CPU 113, which “executes a vibrational control processing” using a “drive signal generation circuit 114 [that] generates a drive signal for driving oscillatory actuator 115 in accordance with” waveform data corresponding to a drive signal stored in memory 112. *Id.* at 13:54–14:26. Figure 5 provides a flow chart illustrating Fukumoto’s operation:

FIG. 5



Id. at Fig. 5, 16:60–19:3 (describing the same). In Figure 5, CPU 113 executes the following steps (among others): step S101 (detects whether a touch signal or key operation signal has been input via the touch panel or key, respectively); step S102 (determines when “at least one of the touch signal or key operation signal has been input,” then “reads from the memory 112 the waveform data of the drive signal to be applied to the oscillatory actuator 115”); step S103 (“outputs the waveform data

read from the memory 112 to the drive signal generation circuit 114” then “instructs the drive signal generation circuit 114 to generate a drive signal,” and in response, “the drive signal generation circuit 114 generates a drive signal using the waveform data supplied from the CPU 113”); and step S105 (“instructs the drive signal generation circuit 114 to initiate applying the drive signal.”). *Id.* at 17:1–30. Fukumoto also teaches that its waveform data can be stored in a waveform data table:

FIG. 33

112a

TOUCH BUTTON	AREA DATA	WAVEFORM DATA
A		
B		
C		
⋮	⋮	⋮

Id. at Fig. 33 (112a). The table “stores the frequency data, amplitude data, and the like required for generating these drive signals as the waveform data.” *Id.* at 29:1–8.

90. Fukumoto is from the same field of endeavor as '830 patent. *Compare Fukumoto*, Abstract, 1:13–19, 14:20–26, 14:57–15:4, 16:38–50, with '830 Patent, Abstract. Thus, Fukumoto is analogous art.

B. Grant

91. I understand Grant (Ex. 1006) was filed as a PCT application on December 8, 2003; published December 21, 2006, and qualifies as prior art under at least pre-AIA 35 U.S.C. §§ 102(a), (b), and (e).

92. Grant discloses “methods and systems for providing customized ‘haptic messaging’ to users of handheld communication devices” including mobile phones, pagers, and personal digital assistants (PDAs). *Grant*, [0004]–[0005]. Each of Grant’s devices contains housing 110, user-interface 112, processor 120, and an actuator 130 and memory 140 both in communication with processor 120:

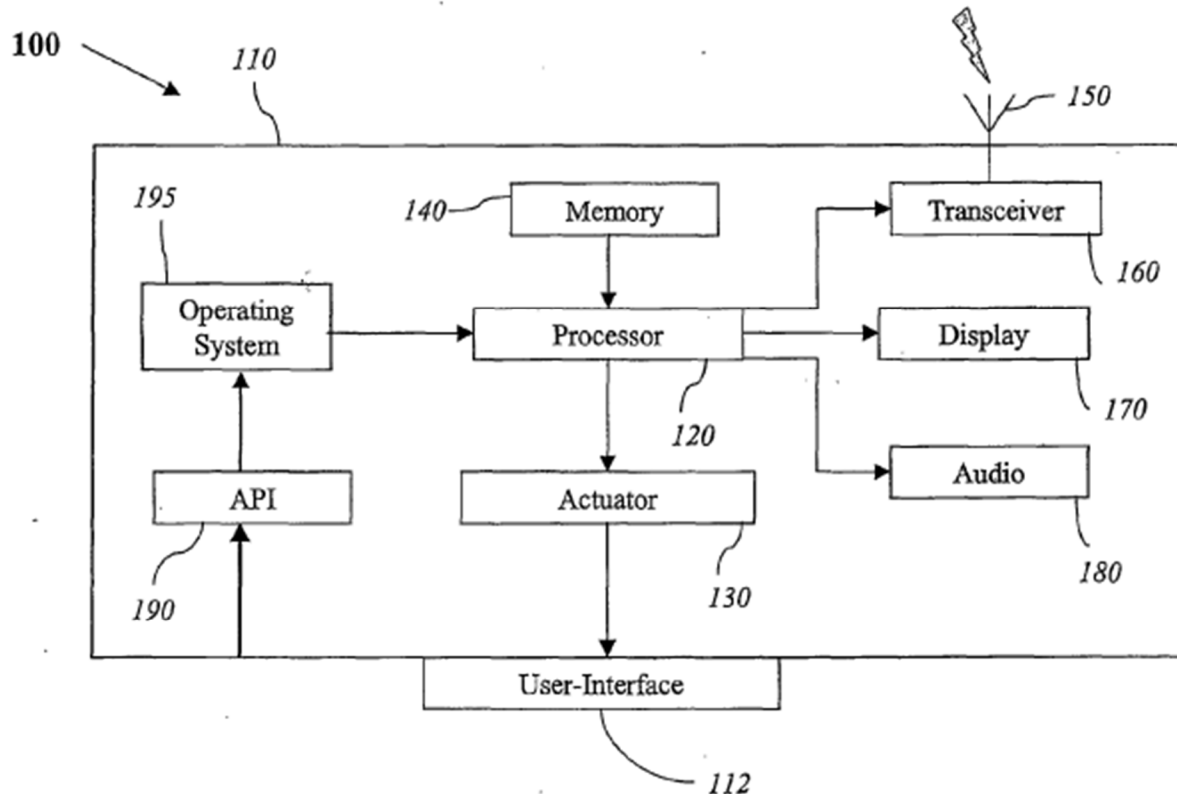


FIG. 1

Id., Fig. 1, [0021]. Grant's user-interface members are embodied as keys, buttons, a touch screen, and a touch pad. *Id.*, [0022]. An application programming interface (API) works in conjunction with the processor. *Id.*, [0023]–[0024]. A memory stores program code “that enables a user to map an event of interest to one of the haptic effects as provided, e.g., via user-interface 112 through API 190” in “one-to-one mappings” of events and haptic effects, which are “compiled into a haptic lookup table” stored in the memory table. *Id.*, [0026]. When an event occurs, the handheld communication device extracts a “haptic code” from a lookup table of haptic codes

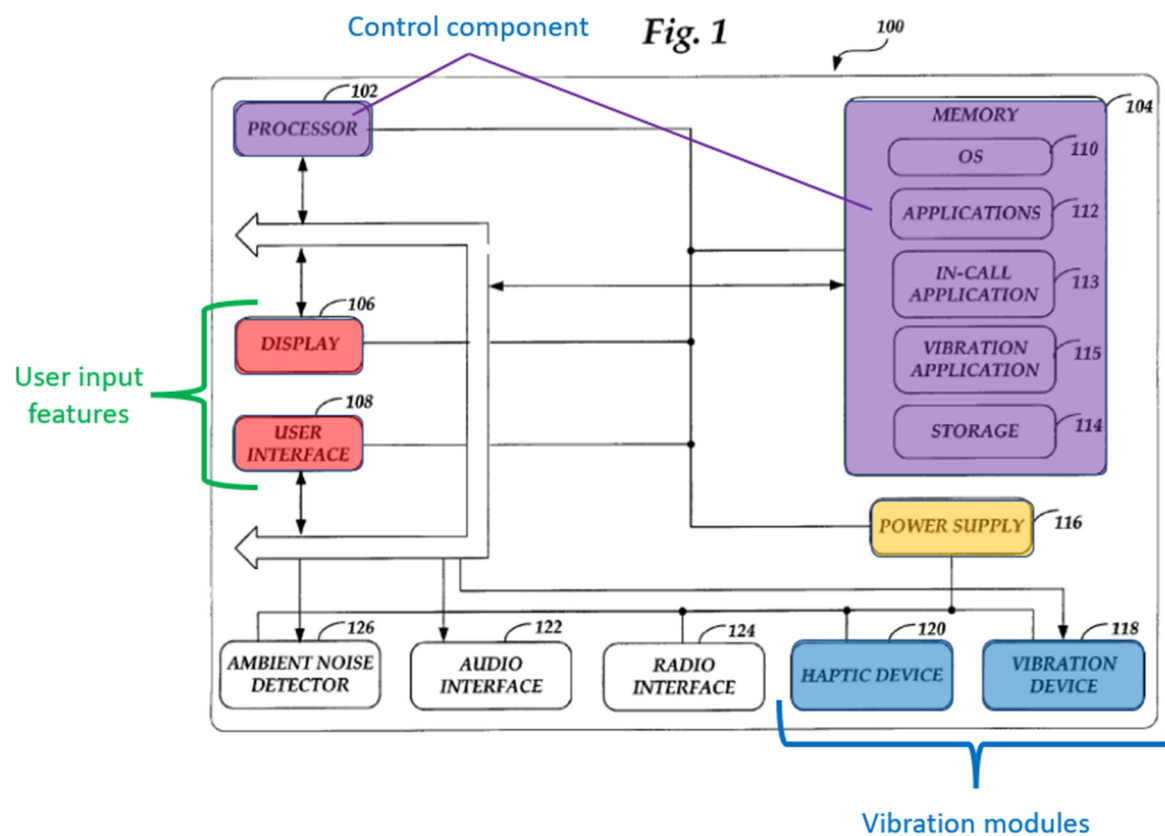
corresponding to such events, then outputs a “selected control signal to the actuator for rendering the desired haptic effect.” *Id.* [0037]–[0038], Fig. 3. By example, when a person receives a phone call from a loved one like a spouse, the handheld communication device looks up the respective “haptic ringer” associated with that remote, spouse-originated call event having unique “low-amplitude and high frequency vibrations” and imparts that haptic effect to the user’s phone. *Id.*, [0034]. Furthermore, Grant discloses the association of haptic feedback with user-interface members (e.g., keys and touch screen), where manipulating such keys and touch screen transmits a respective haptic code to a remote handheld communication device for that remote user to experience. *Id.*, [0040]. By example, husband “Bob” may experience certain vibrations at his phone when wife “Alice” presses a key on her phone corresponding to a haptic code mapped to a “‘laugh’ sensation” imparted to Bob’s phone. *Id.*, [0041]. Furthermore, a user (“Bob”) “can program the mobile phone . . . via user interface 112 through API 150” by “inputting various events of interest and associating each with a distinct haptic effect” such that a “different and distinct” haptic effect occurs for every different event programmed. *Id.*, [0057]–[0058].

93. Grant is from the same field of endeavor as ’830 patent. *Compare Grant*, [0004], [0021]–[0022], [0025], [0034], [0054], *with* ’830 Patent, Abstract. Thus, Grant is analogous art.

C. Barton

94. I understand Barton (Ex. 1007) was filed as a U.S. patent application on April 28, 2005; published November 2, 2006, and qualifies as prior art under at least pre-AIA 35 U.S.C. § 102(b).

95. Barton relates to user customization of alerts triggered by an event on a mobile device, such as a cellphone, PDA, or pager. *Barton*, [0014]. Specifically, “using the mobile device’s user interface, a user can select various alert settings according to the type of notification event,” including “vibrating feedback.” *Id.*, [0005], [0014]. Figure 1 of Barton is reproduced below:



Id., Fig. 1 (annotated). User interface 108 may include “buttons” or “soft keys,” and “a touch-sensitive display 106 can be used as an input device.” *Id.*, [0021]. Mobile device 100 further includes vibration application 115 loaded onto memory 104, storage 114, power supply 116, vibration device 118, and haptic device 120. *Id.*, [0022]-[0024]. Vibration device 118 “can be used to give feedback to the user such as for alerting the user of a newly arrived message and other information. *Id.*, [0024].

96. Figures 2A-2B of Barton show a flow diagram for a user creating an in-call profile using user interface 108. *Id.*, [0026]. Figure 2A is reproduced below:

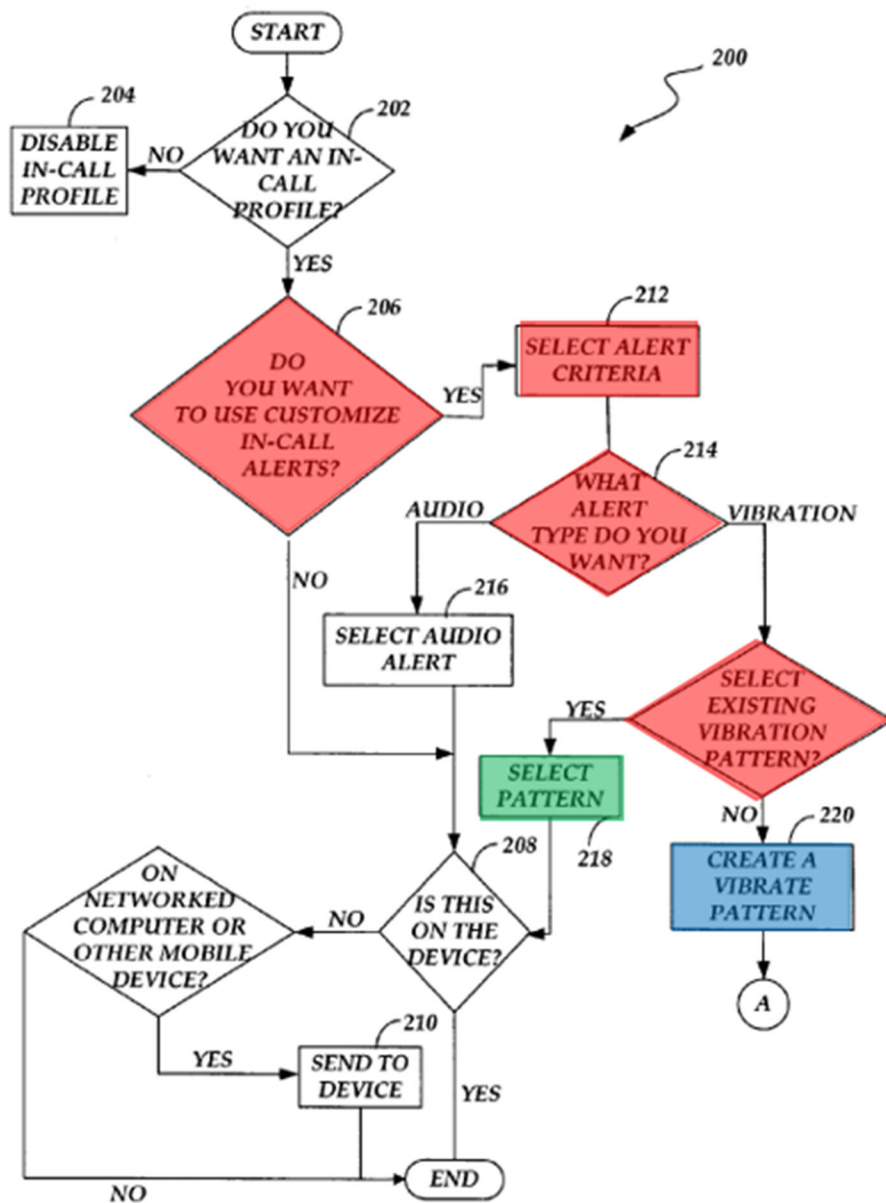
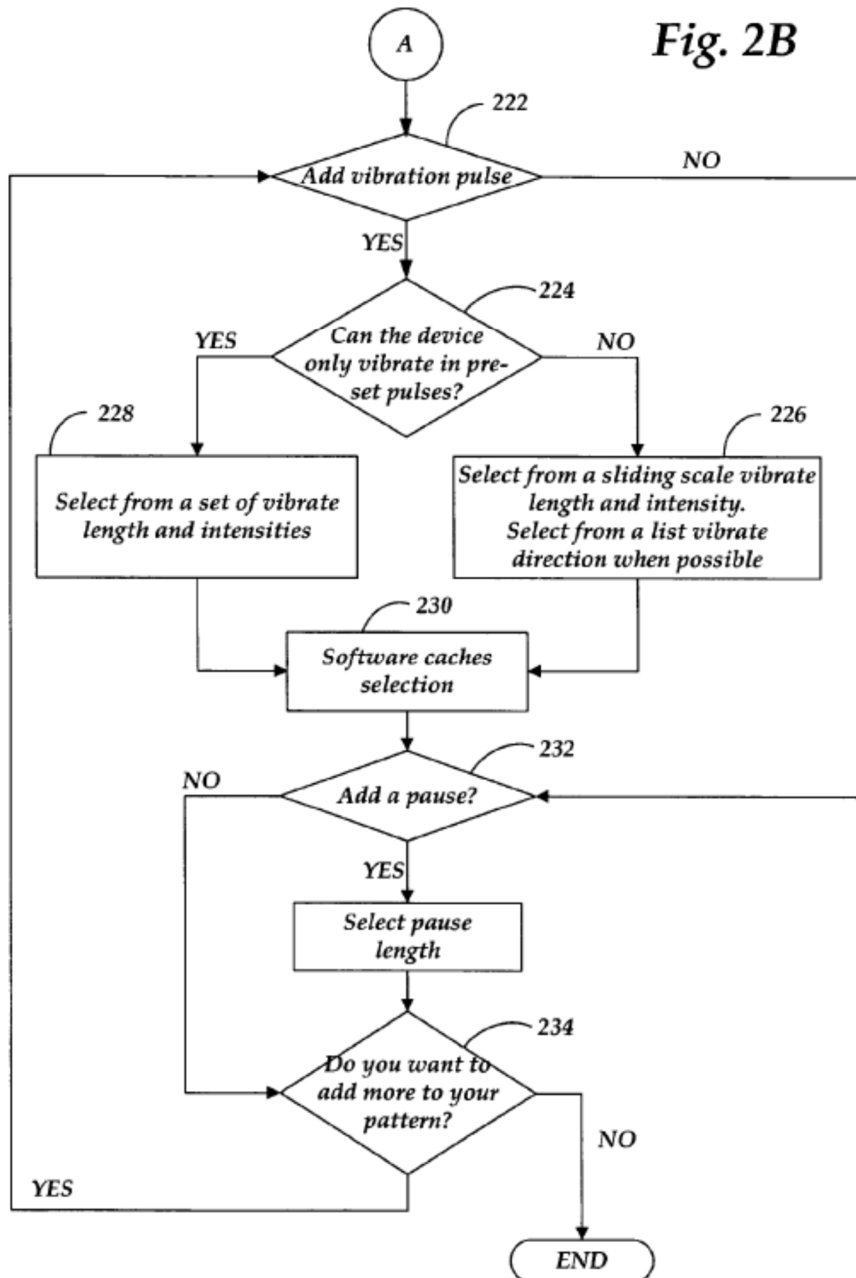


Fig. 2A

Id., Fig. 2A (annotated). As shown in that figure, if the user chooses to use an in-call profile (202) to use customized in-call vibration-type alerts (206, 212, 214) and the user selects an existing vibration pattern (218) (green), the in-call application 113 checks for a vibration pattern in storage location 114. *Id.*, [0033]. If the user

chooses not to use existing vibration patterns, the user can then create a vibration pattern (220) (blue). *Id.*, Fig. 2A, [0028]-[0033]. The flow diagram then proceeds to Figure 2B (reproduced below):



Id., Fig. 2B. This figure depicts the process for a user creating a vibration pattern, which can be made up of a series of vibration pulses and pauses, using vibration application 115. *Id.*, [0034]. In such a vibration pattern, “feedback can be set using a sliding scale of intensities, frequencies, and durations.” *Id.*, [0034]; *see also id.*, [0036]. “[T]he user using the vibration application 115 can create and/or edit vibrate patterns which are used by the mobile device 100 to control the operation of the vibration device 118... the user can use a sliding scale or other means to define various vibrate intensities, frequencies ... by sliding a slider along the scale or inputting numbers which correspond to a particular amount or level.” *Id.*, [0038].

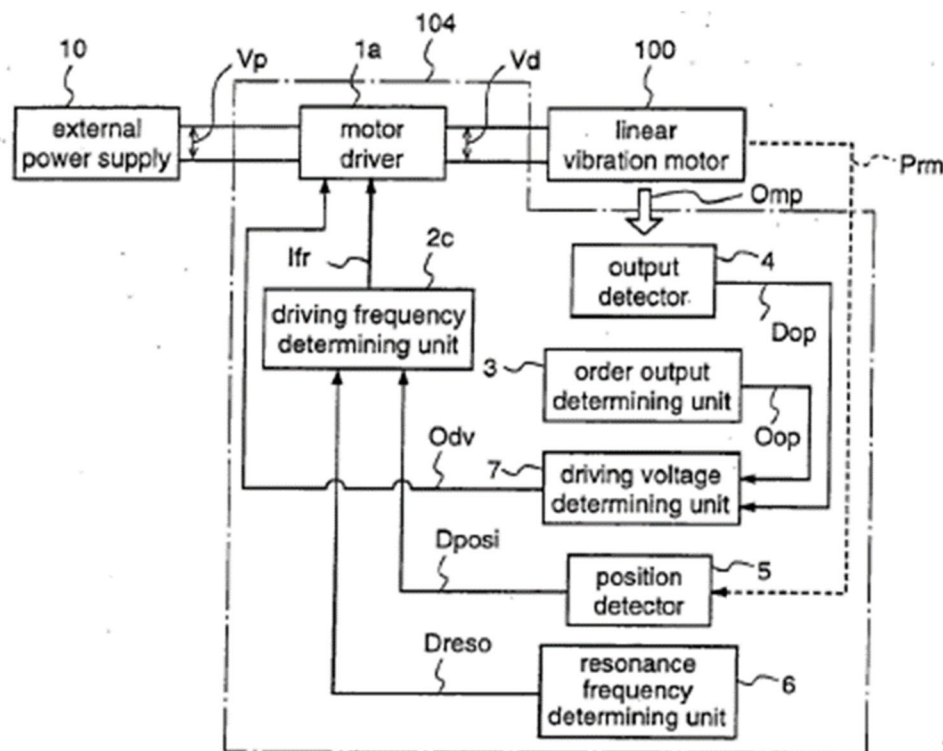
97. Barton is from the same field of endeavor as ’830 patent. *Compare Barton*, [0005], [0014], [0033], [0034], [0038] *with* ’830 Patent, Abstract. Thus, Barton is analogous art.

D. Ueda

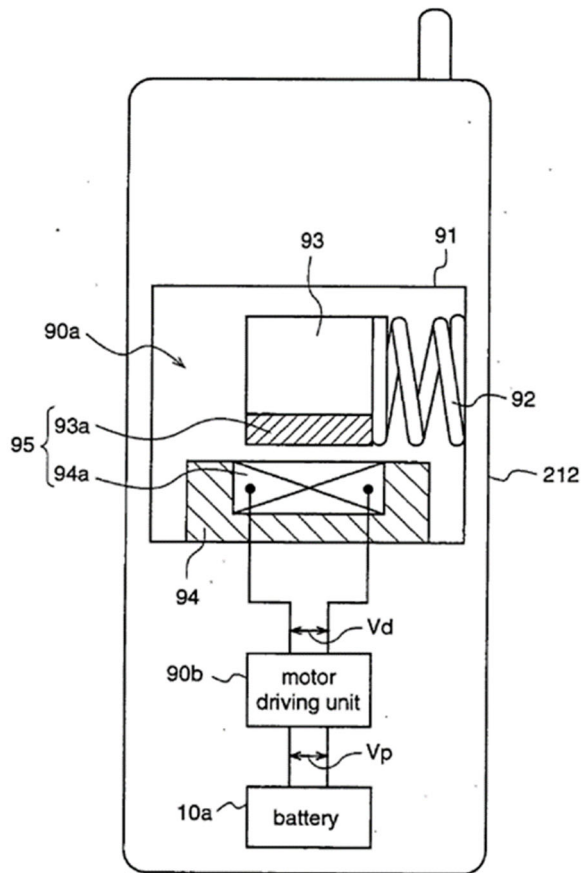
98. I understand Ueda (Ex. 1008) was filed as a PCT application on July 15, 2003, published September 4, 2004, and qualifies as prior art under at least pre-AIA 35 U.S.C. § 102(b).

99. Ueda discloses an apparatus for controlling the driving signal to a linear vibration motor from a power supply. *Ueda*, Abstract, [0141]-[0143]. The linear vibration motor of Ueda comprises a coil; a permanent magnet; and a spring for

linear movement of the permanent magnet. *Id.*, [0058], [0140]. Fig. 4(a) depicts Ueda's control apparatus:



Id., Fig. 4(a). Ueda's control apparatus uses feedback from sensors monitoring information about the linear vibration motor to determine the frequency and amplitude of the AC power that drives the linear vibration motor. *Id.*, [0141]-[0142]. Ueda uses the control apparatus and linear vibration motor to improve vibrations in a mobile phone, as depicted in Fig. 14:



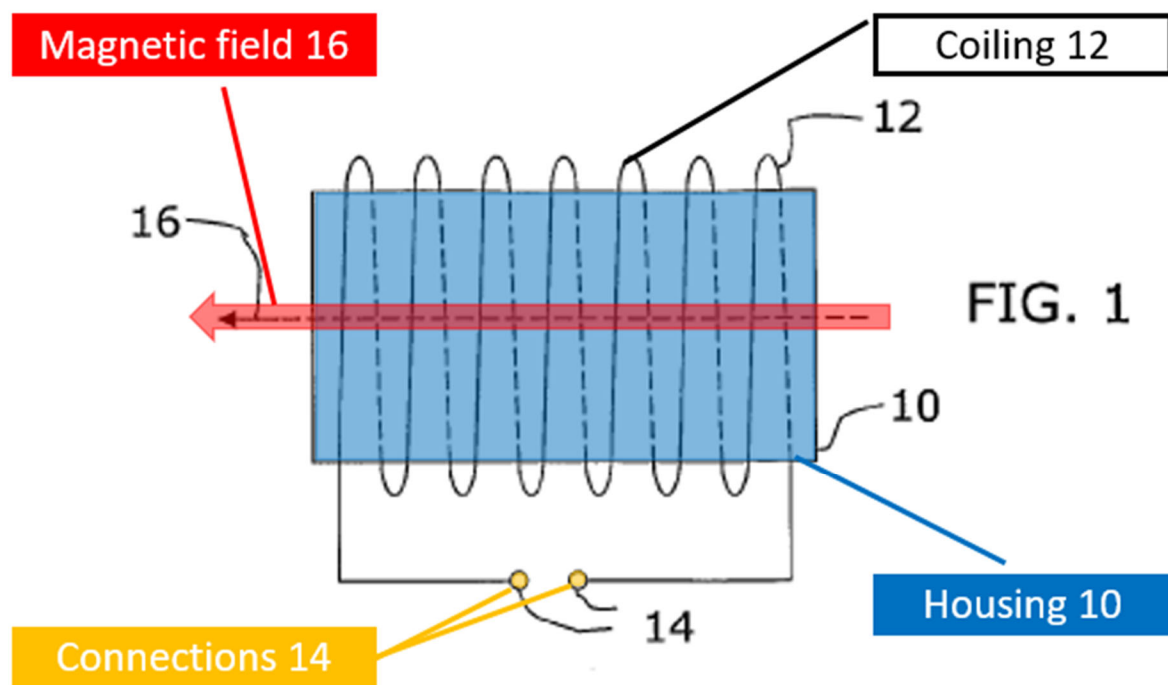
Id., [0340].

100. Ueda is from the same field of endeavor as the claimed invention of the '830 patent. *Compare* Ueda, Abstract (describing a “motor driving apparatus for driving a linear vibration motor”), [0097], [0107], [0340], *with* '830 Patent, Abstract (describing “linear vibration modules”). Thus, Ueda is analogous art.

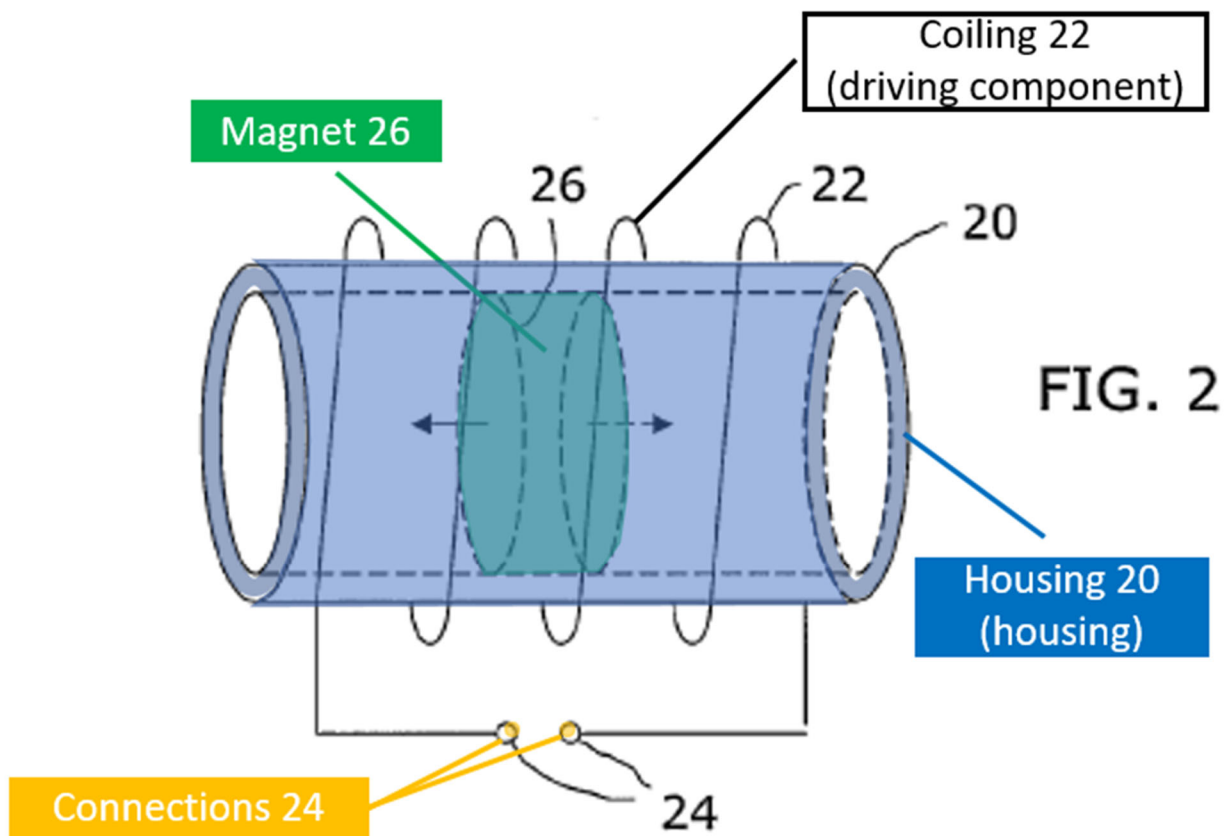
E. Erixon

101. I understand Erixon was filed as a PCT application on March 15, 2006, published July 24, 2008, and qualifies as prior art under at least pre-AIA 35 U.S.C. § 102(e).

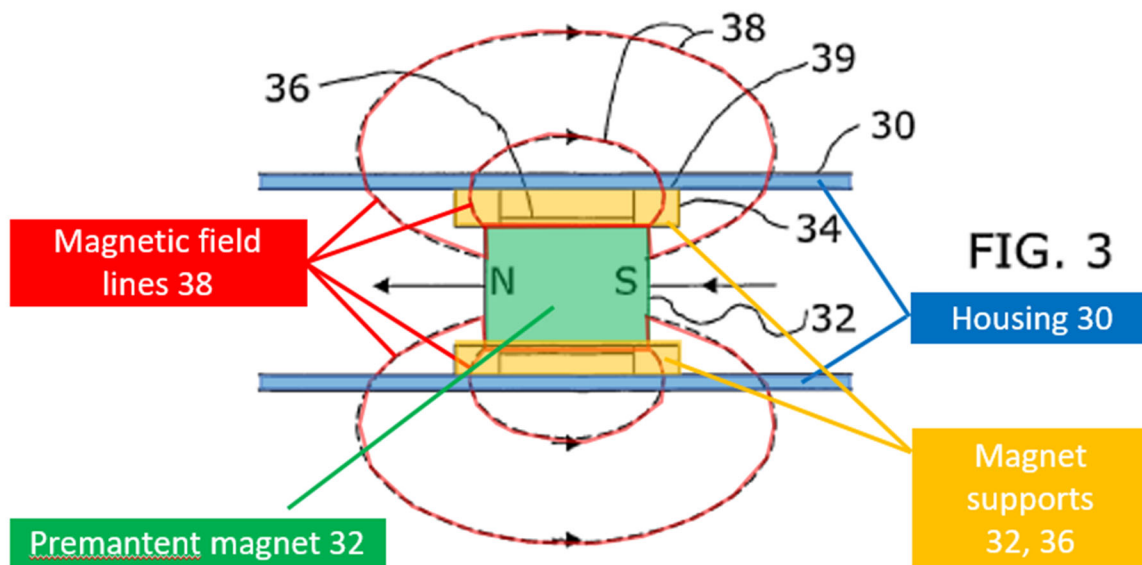
102. Erixon relates to an electromagnetic vibrator used in a portable communication device like a mobile phone that includes a housing, coiling, permanent magnet assembly “arranged for motion along [a] track,” and ferrofluid mixture. *Erixon*, Abstract, [0011]–[0015], [0037], [0102]. The track is a “tubular cavity” that may be circular or “any other shape.” *Id.*, [0059]. Voltage is supplied to the coiling via connections 14, “creating a magnetic field 16 that is directed along the long axis of the housing.” *Id.*, [0055]. That magnetic field (created by electric current flowing through the coiling) and another (formed by the permanent magnet itself) “interact with each other and create relative attracting or repelling forces.” *Id.*, [0056]–[0057].



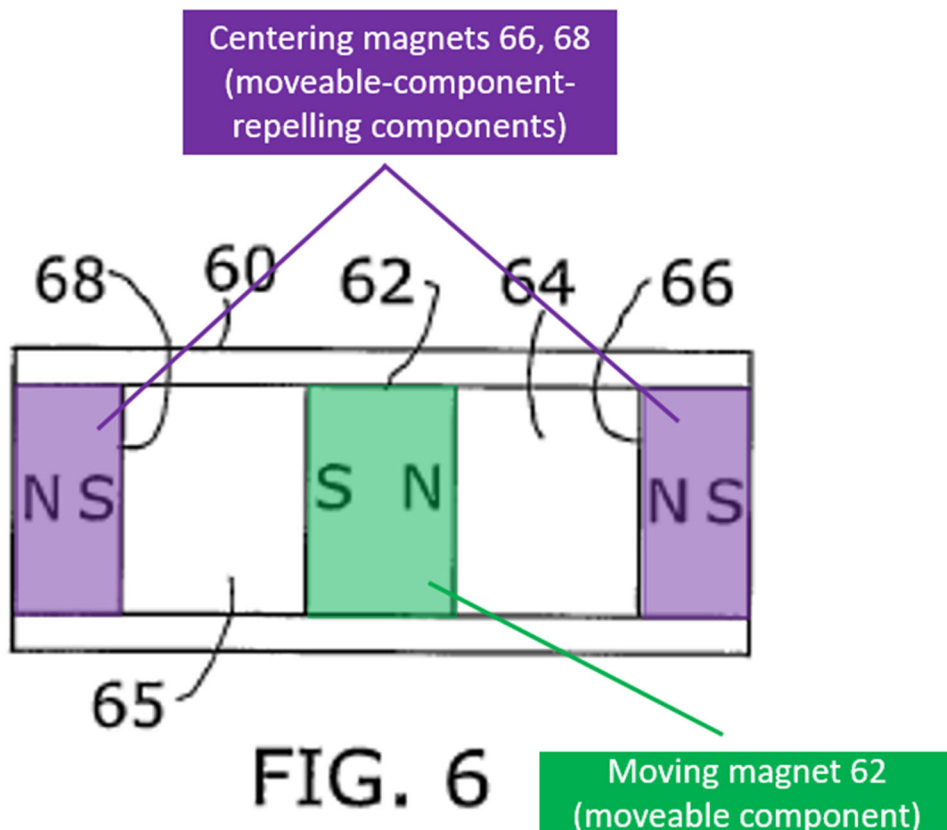
Id., Fig. 1 (annotated). Erixon discloses a three-dimensional embodiment where coiling 22 is wound around housing 20 and supplied with electric voltage at connectors 24 and magnet 26 is “oriented so that the magnetic axis of the magnet is parallel with the symmetry axis of the cylindrical housing” such that “the directions of the magnetic axis and the center of the magnetic field, created by the coiling, coincide.” *Id.*, [0056].



Id., Fig. 2. Magnet 26 is “preferably oriented so that the magnetic axis of the magnet is parallel with the symmetry axis of [a] cylindrical housing.” *Id.*, [0056]. Erixon’s electromagnetic vibrator further includes a ferrofluid located in a “sliding surface interface 29” between a magnet assembly—comprising permanent magnet 32 and magnet supports 34, 36—and a track. *Id.*, [0063]–[0065]. Magnetic field lines 38 are “approximately parallel with the normal to the surface of the interface 39.” *Id.*, [0072].



Id., Fig. 3 (annotated). [0063]–[0064]. The ferrofluid and its placement creates a low-friction sliding environment between the magnetic assembly and housing that enables efficient back and forth movement. *Id.*, [0066]–[0075]. In one embodiment, centering magnets are placed at the ends of the housing to repel the moving magnet.



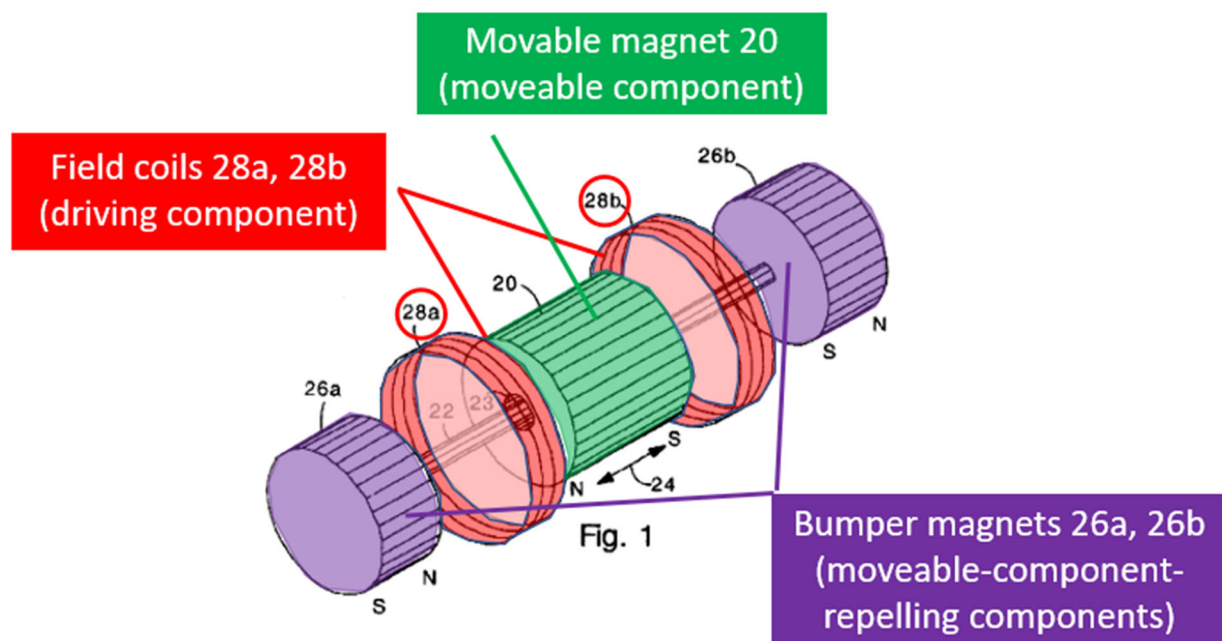
Id., Fig. 6 (annotated), [0091]–[0093].

103. Erixon is from the same field of endeavor as the claimed invention of the '830 patent. *Compare Erixon*, Abstract (disclosing an “electromagnetic vibrator for use in a portable communication device” including a track and coiling that, when supplied with electric voltage, causes a permanent magnet assembly to move along the track) *with '830 Patent*, Abstract (describing “linear vibrational modules” used “in a wide variety of appliances, devices, and systems to provide vibrational forces”). Thus, Erixon is analogous art.

F. Fuller

104. I understand Fuller was filed July 3, 2006, published January 3, 2008, and qualifies as prior art under at least pre-AIA 35 U.S.C. § 102(b).

105. Fuller relates to an “electromagnetic vibrator” containing a movable magnet that moves along an axis when alternating current is provided to a “field coil,” oscillating linearly between two “magnetic bumpers...oriented to repel the movable magnet.” *Fuller*, Abstract.



Id., Fig. 1 (annotated), [0027]. Fuller’s vibrator is designed to provide an “inexpensive, simple, and energy efficient miniature vibrator” for use in “cellular telephones and portable electronics.” *Id.*, [0002]–[0004]. Fuller’s field coils cause the movable magnet to oscillate at the alternating current frequencies applied to them

and are oriented to “to provide push and pull forces” using “anti-parallel magnetic fields.” *Id.*, [0036]. The movable magnet further “rebounds from the magnetic field of the bumper magnet.” *Id.* Fuller’s electromagnetic vibrator further includes an “electrical control compensator” that can adjust applied power to achieve specific amplitudes and frequencies as informed by a sensor feedback signal. *Id.*, [0038].

106. Fuller is from the same field of endeavor as the claimed invention of the ’830 patent. *Compare Fuller*, Abstract (disclosing an “electromagnetic vibrator” including two field coils that push and pull on a movable magnet to cause it to oscillate linearly in portable electronic devices including cell phones), *with ’830 Patent*, Abstract (describing “linear vibrational modules” used “in a wide variety of appliances, devices, and systems to provide vibrational forces”). Thus, Fuller is analogous art.

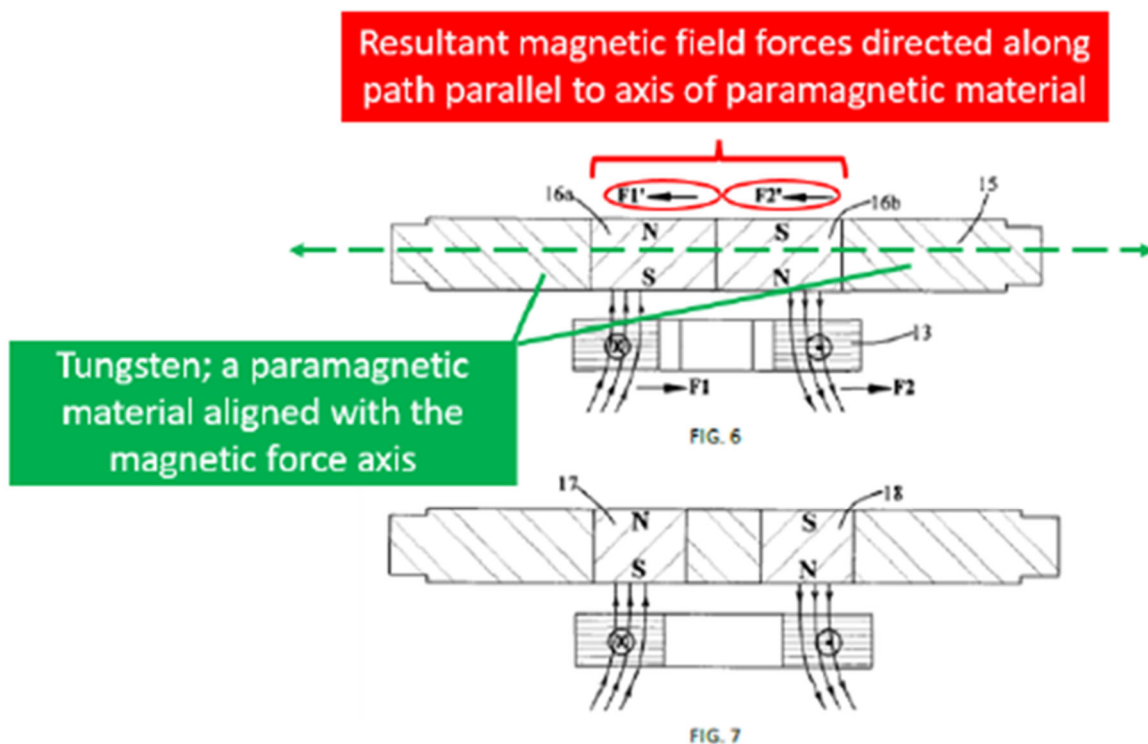
G. Dong

107. I understand Dong (Ex. 1011) published on July 22, 2009, and qualifies as prior art under at least pre-AIA 35 USC § 102(a). I understand the English translation of Dong I studied is certifiably accurate. *See* (Ex. 1012).

108. I understand that in the ’830 patent, Figures 24A, 24B, and 25 as well as their associated description (’830Pat., 14:3-14:58) appear to be the only written description support for the added limitations in dependent claim 14 and independent claim 19. In the ’830 patent’s priority chain, these figures and associated description

were not present in the May 18, 2009 provisional or May 18, 2010 non-provisional; instead, they first appeared in the January 6, 2012 continuation-in-part application. Thus, claim 14's priority date is no earlier than January 6, 2012, and Dong qualifies as prior art to claim 14.

109. Dong generally relates to a flat linear vibration motor that can be used in, for example, mobile phones. *Dong*, 3. Dong's movable component includes a counterweight 15 and a permanent magnet 16 that is driven by an electromagnetic coil 13. *Id.*, 5. Additionally, Dong discloses that the counterweight 15 is made tungsten and directs current paths to create magnetic forces "F1," "F2," "F1'" and "F2'" as shown in Figures 6 and 7 below:



Id., 10 (annotated).

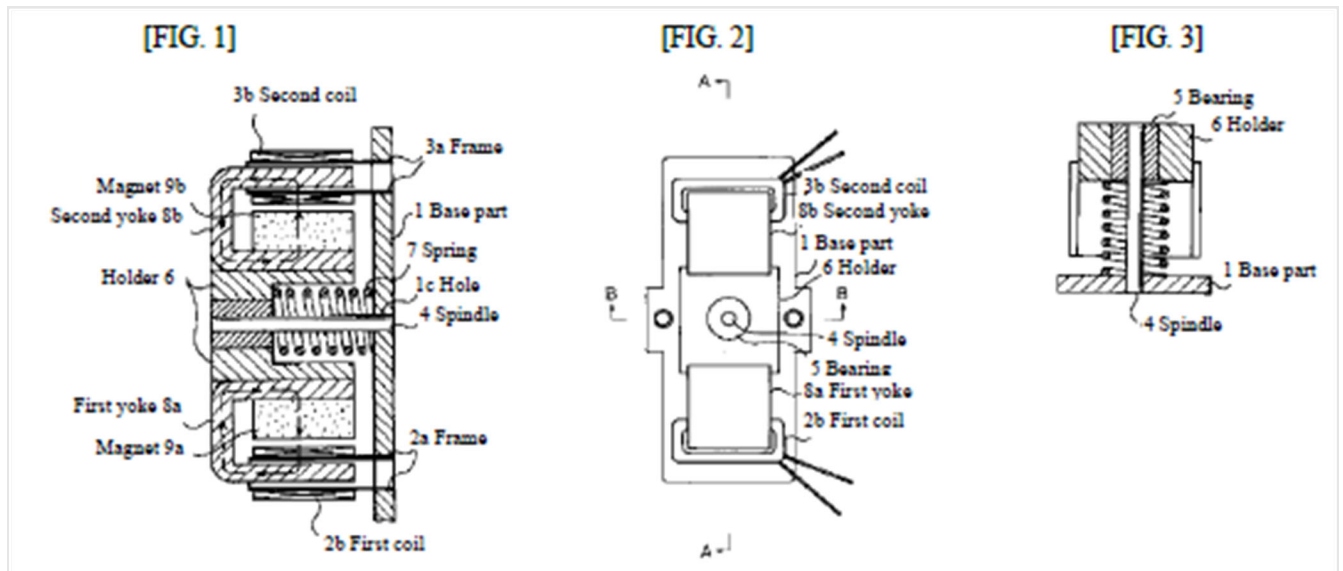
110. Dong is from the same field of endeavor as the claimed invention of the '830 patent. *Compare Dong*, Abstract (disclosing a “flat linear vibration motor” requiring a coil and permanent magnet polarized in opposite directions), *with '830 Patent*, Abstract (describing “linear vibrational modules” used “in a wide variety of appliances, devices, and systems to provide vibrational forces”). Thus, Dong is analogous art.

H. Ogusu

111. I understand Ogusu (Ex. 1015) was filed as a China patent application on January 12, 1995, published on July 30, 1996, and qualifies as prior art under at least pre-AIA 35 USC § 102(a). I understand the English translation of Ogusu I studied is certifiably accurate. *See* (Ex. 1016).

112. Ogusu relates to a “moving magnet type vibration actuator” and specifically discusses the application of such an actuator in pagers. *Ogusu*, [0002–3], [0059]. Like the common specification of the asserted patents, Ogusu distinguishes its invention from prior art vibration modules that generate vibration “by rotating an unbalanced weight attached to the tip of the rotor,” and explicitly identifies problems with such unbalanced motor vibration modules. *Id.* at [0004–9]. Figures 1-3 of Ogusu are reproduced below, with Figure 2 being the front view of

Ogusu's vibration actuator, Figure 1 showing a cross-sectional view of A-A, and Figure 3 showing a cross-sectional view of B-B.

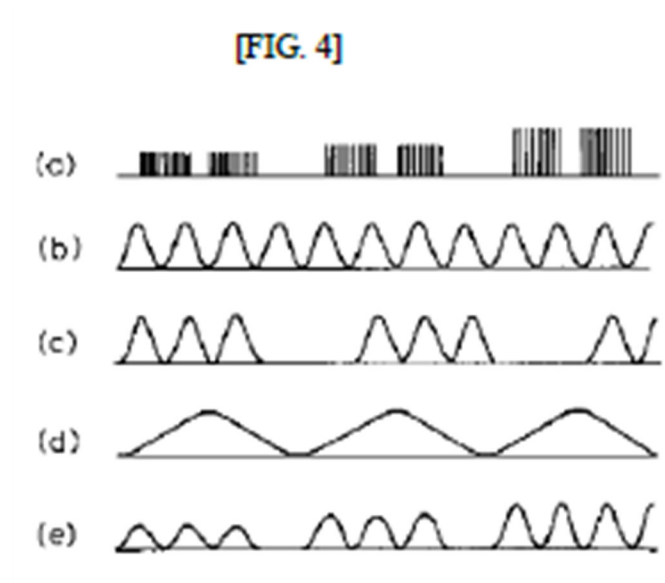


Id., Figs. 1–3. In Figures 1-3, Ogusu depicts a moving component including holder 6, bearing 5, yokes 8a and 8b, magnets 9a and 9b that slides along a spindle 4 when magnets 9a and 9b are driven by coils 2a and 2b. *Id.*, Fig. 1, [0024–30]. Ogusu further discloses:

When a current in a predetermined direction is sent to the first coil 2b and the second coil 3b, thrust is generated according to Fleming's left-hand rule in the first coil 2b and second coil 3b arranged in the magnetic circuit described above. Then, as a reaction to the thrust, the movable elements (the holder 6, the bearing 5, the yokes 8a and 8b, and the magnets 9a and 9b) try to move. Therefore, when an alternating current is sent to the first coil 2b and the second coil 3b, the movable elements generate vibration according to a current waveform. Furthermore, since the movable elements have magnets and a certain amount of weight, the base part 1 side also generates vibration in a direction opposite to that of the movable elements.

Id., [0032–3].

113. Ogusu's magnet and yoke are "suitable for generating various sounds and vibrations by changing the frequency and an amplitude thereof, or by intermittently generating an electric current, and the like." *Id.*, [0036]. Specifically, Ogusu's vibration actuator generates several types of waveforms:



Id., Figs. 4(a–d), [0035], [0037]. Ogusu discloses these waveforms result from changes to the frequency of vibration and amplitude, and Ogusu contemplates combining the waveforms disclosed in Figure 4. *Id.*, [0042]. In Ogusu, a user can manipulate the pager's vibrational operation: "various vibrations can be switched at the user's choice by a selection in the pager's control unit." *Id.*, [0043]. The vibration can also be configured to be selected arbitrarily according to settings from the caller side. *Id.*

114. Ogusu is from the same field of endeavor as the claimed invention of the '830 patent. *Compare Ogusu*, Abstract (describing a “vibration actuator” that is “capable of generating vibration at an arbitrary frequency and at an accurate amplitude” using two coils and a magnet), [0002] (“vibration actuator . . . used as vibration generation means for a pager”), *with '830 Patent*, Abstract (describing “linear vibrational modules” used “in a wide variety of appliances, devices, and systems to provide vibrational forces . . . produced by linear oscillation” requiring “rapidly alternating the polarity of one or more driving electromagnets” according to “amplitude/frequency combinations”). Thus, Ogusu is analogous art.

I. Saiki

115. I understand Saiki (Ex. 1013) was filed as a U.S. patent application on April 12, 2000, issued as a U.S. patent on February 28, 2006, and qualifies as prior art under at least pre-AIA 35 USC § 102 (b).

116. Saiki relates to a transducer for generating vibration, for example, in a portable phone or pager, and more specifically, to “a driving circuit for driving a vibrator having a mechanical vibration system which resonates at a resonance frequency.” *Saiki*, (57), 1:9-13. In Saiki, that driving circuit “outputs to the vibrator at least two signals of different frequencies which are included in a frequency range including the resonance frequency.” *Id.*

117. Saiki illustrates various complex vibration modes generated when its movable component is driven to oscillate at two or more frequencies. For example, Figures 17A and 17B are reproduced below.

FIG. 17A

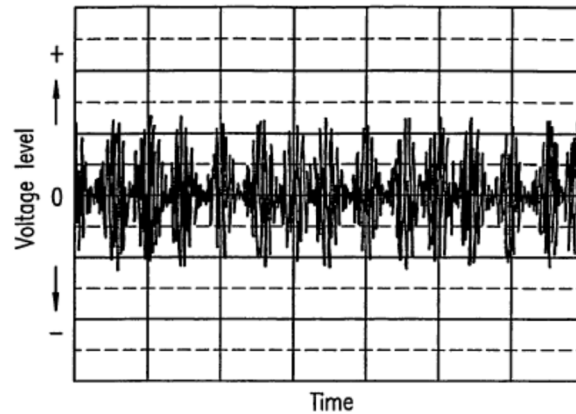
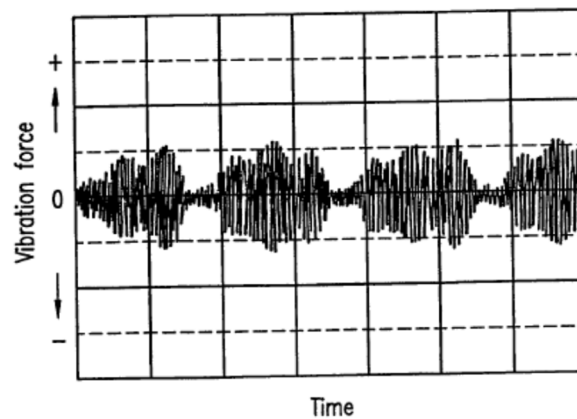


FIG. 17B



Id., Figs. 17A–B. Figure 17A illustrates a waveform of an electric signal obtained by adding together multiple frequencies, and Figure 17B illustrates the waveform of

the output vibration obtained from the electrical signal of Figure 17A. *Id.*, 5:66–6:3, 24:17–21.

118. Saiki is from the same field of endeavor as the '830 patent. *Compare Saiki*, 1:9–13 (disclosing an “electro-mechanical-acoustic transducer for generating a ringing tone or a ringing vibration for a portable terminal apparatus” including a “telephone, a pager or a PHS (personal handy phone set)”), 4:1–11, 12:8–14, 12:47–60, *with '830 Patent*, Abstract (describing “linear vibrational modules” used “in a wide variety of appliances, devices, and systems to provide vibrational forces”). Thus, Saiki is analogous art.

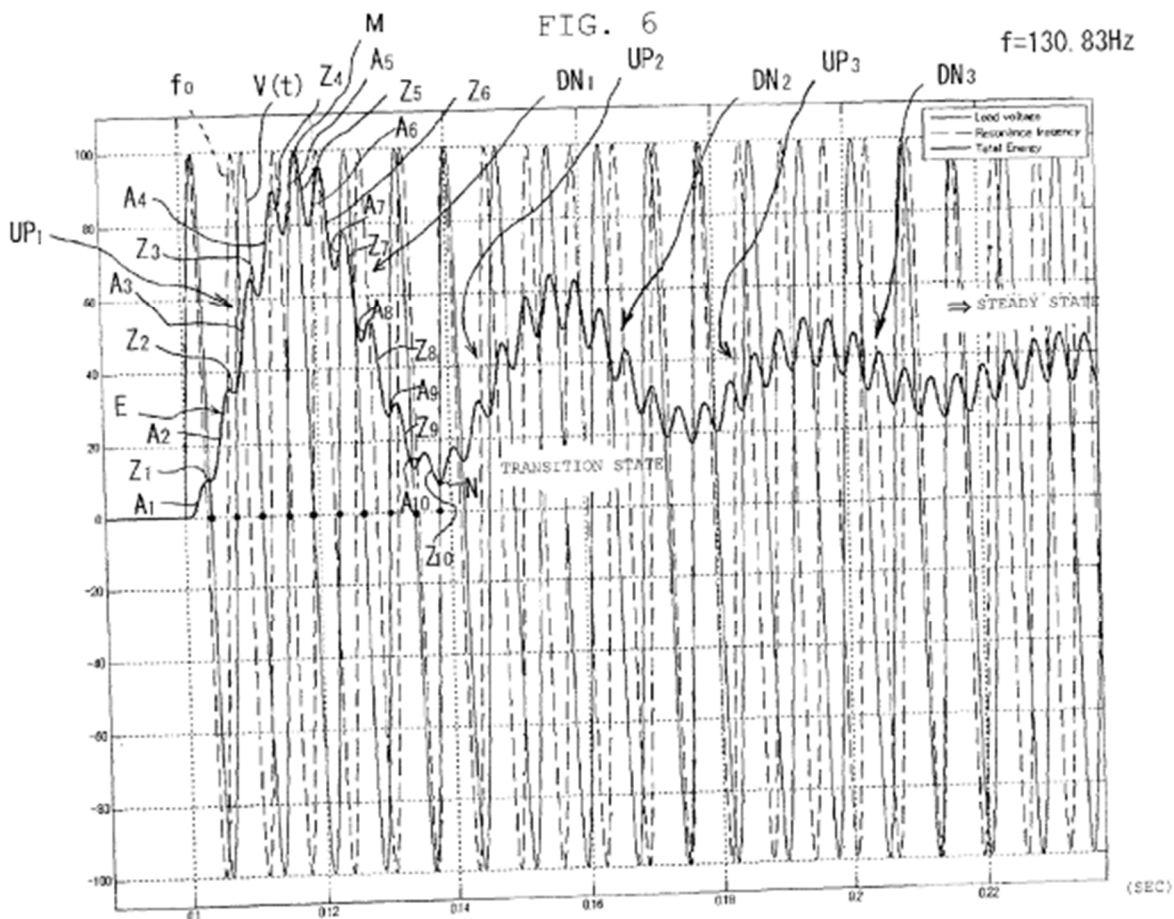
J. Masahiko

119. I understand Masahiko (Ex. 1014) was filed as a U.S. patent application on July 26, 2011, issued as a U.S. patent on February 2, 2012, and qualifies as prior art under at least pre-AIA 35 USC §§ 102(a) and (e). Further, I understand Masahiko qualifies as prior art under at least pre-AIA 35 U.S.C. §102(e) for claim 16 because that claim is entitled to a priority date no earlier than January 6, 2012.

120. In the '830 patent, Figures 22B and 23 and the description at 13:34-59 appear to be the only written description support for the added limitation in claim 16. In the '830 patent's priority chain, this figure and associated description was not present in the May 18, 2009 provisional or May 18, 2010 non-provisional; instead, they first appeared in the January 6, 2012 continuation-in-part application. Thus,

claim 16's priority date is no earlier than January 6, 2012, and Masahiko qualifies as prior art for claim 16.

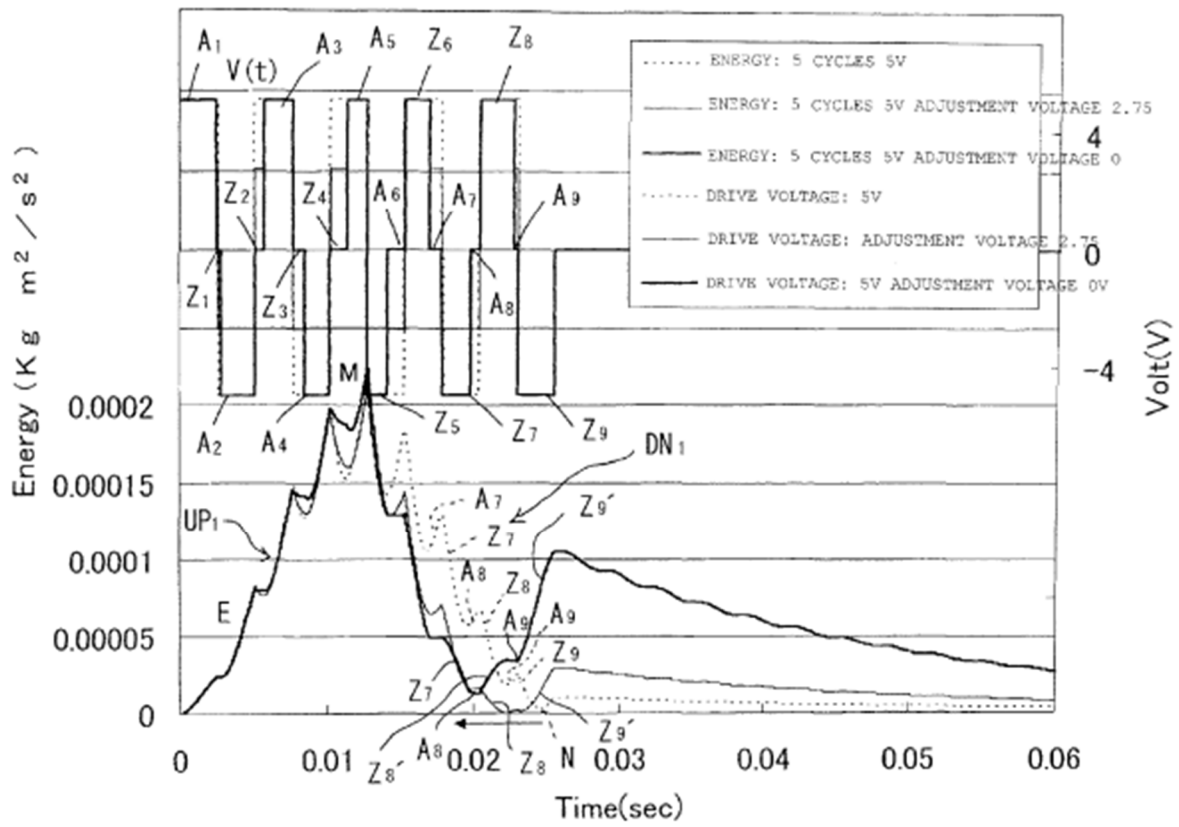
121. Masahiko is titled "Vibration Generating Apparatus," and relates to such an apparatus built into, for example, a mobile phone. *Masahiko*, (57), 1:17-21. Masahiko aims to provide "vibration tactile haptic effects with a good feel of damping of the mechanical vibrator." *Id.*, 1:60-64. To do this, Masahiko makes use of "beat vibration" (beat frequency or f_B). *E.g., id.*, 4:40-46, 12:55-56 ("Conversely, when $f_d < f$, for example, when $f = 196.25$ Hz at $f_o = 157$ Hz, the beat vibration f_g is 39.25 Hz."), Fig. 5. When the drive voltage is applied as a sine wave of "predetermined amplitude at the force vibration frequency," the "excitation periods A appear in [a] descending order of time" and the "damping periods z conversely appear in the ascending order of time." *Id.*, 14:26-53. When these conditions are controlled and "[a]fter considerable time passes," the "periodic spikes" reach a steady state. *Id.* Figure 6 shows these changes:

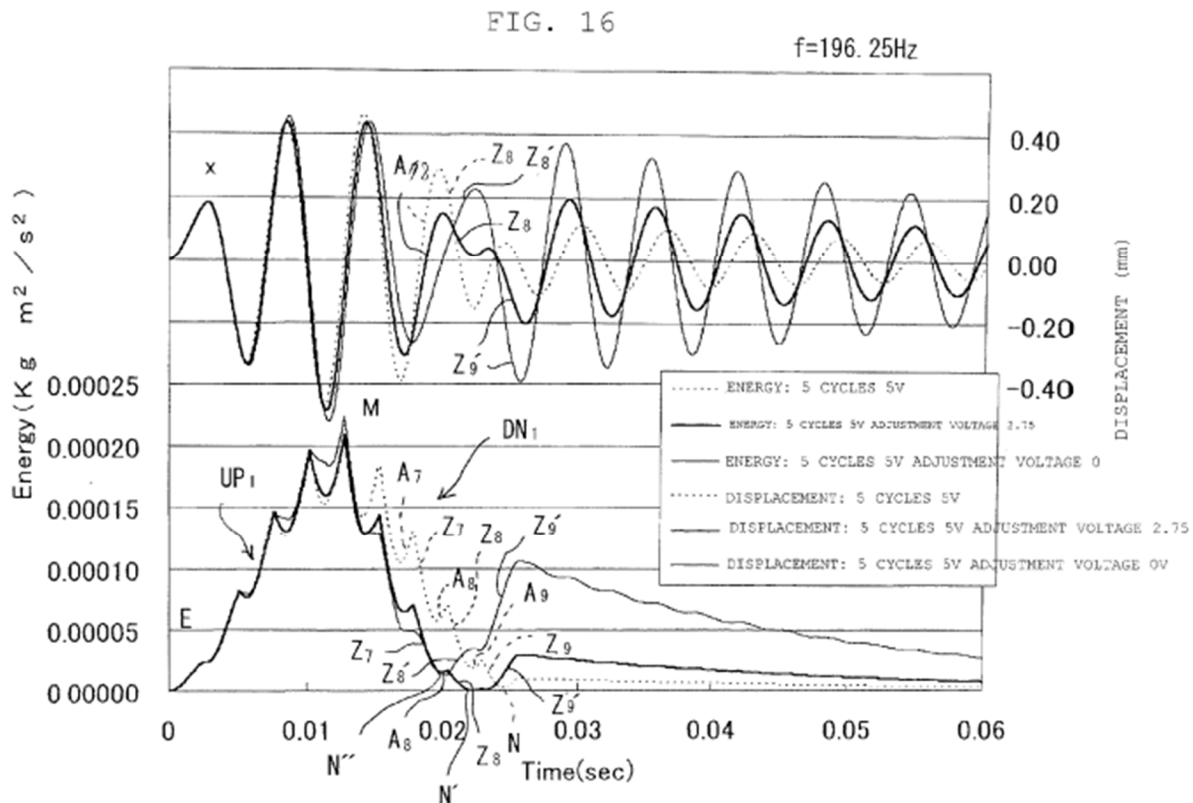


Id., Fig. 6. However, when the pure sine wave is changed to other types of waves like a bipolar square wave, the total energy of the system changes differently and causes excitations and dampening phases to change in a non-repetitive, gradual manner:

FIG. 15

f=196.25Hz





Id., Figs. 15, 16, 22:56–23:59.

122. Masahiko is from the same field of endeavor as the '830 patent. *Compare Masahiko*, 1:17–21 (disclosing a “vibration generating apparatus which can be built into a mobile phone, touch panel, or other device”), 8:19–42, 11:61–12:15, *with '830 Patent*, Abstract (describing “linear vibrational modules” used “in a wide variety of appliances, devices, and systems to provide vibrational forces”). Thus, Masahiko is analogous art.

X. CLAIM CONSTRUCTION

123. I have given all the claim terms of the Challenged Claims their plain and

ordinary meaning, as would have been understood by a person of ordinary skill in the art, at the time of the alleged invention. In IPR2023-00992 (filed concurrently), I explain that the claims of the '830 Patent are entitled to a priority date no earlier than June 13, 2016 based on a priority chain break. For purposes of this Petition and assuming no priority chain break, I understand that earliest priority date is May 18, 2009 for claims 1–8, 11, 15, 17, and 20 and January 6, 2012 (the filing date of U.S. Application No. 13/345,607) for claims 9, 14, 16, and 19, having taken into consideration the language of the claims, the specification, and the prosecution history of record. *See* Exs. 1029, 1026.

124. Additionally, I have noted that several claim limitations appear to be expressed in means-plus-function form. I have identified means-plus-function constructions of several terms and have considered the function and corresponding disclosed structure in forming my opinions where applicable. The terms, function achieved, and corresponding structure of each function that I considered are as follows:

A. “moveable component”

Limitation (Function Underlined)	Corresponding Structure
Claims 1, 19, 20: “ <u>moveable component</u> ” (i.e., a component that <u>moves</u>)	A moving weight. <i>E.g.</i> , Ex. 1001, Figs. 4A-4G (weight 404), Fig. 6 (oscillating mass 634).

B. “driving component”

Limitation (Function Underlined)	Corresponding Structure
Claim 1, 19, 20: “a driving component that <u>drives the moveable component to oscillate within the housing</u> ”	One or more electromagnetic coils. <i>E.g.</i> , Ex. 1001, Figs. 4A-4G (coil 420); Fig. 6 (coil 626); Fig. 13 (first coil 1302 and second coil 1304).

C. “control component”

Limitation (Function (or Additional Function for Dependent Claims) Underlined)	Corresponding Structure
Claim 1, 19, 20: “a control component that <u>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</u> ”	Processor and H Bridge Switch, where processor is programmed with an algorithm to perform the following steps: (1) set the mode and strength to default values or values represented by selections made by user input to the user input features, (2) provide a corresponding output to the power supply, and (3) provide a corresponding output to the H-bridge switch. Ex. 1001, 7:20-29, 7:29-34, 8:20-30, Fig. 7A, Fig. 7C.
Claim 3: “wherein the control component <u>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</u> ”	Claim 1 structure with the processor further programmed with an algorithm to perform the following steps: (1) convert the received output signal into an integer, (2) compare that integer to a specific value, (3) adjust one or more operational control outputs based on that comparison. Ex. 1001, 7:24-29, 7:42-8:19, Figs. 7A, 7B.
Claim 4: “wherein the control component <u>adjusts the one or more operational control outputs of the control component according to the received output signals from the sensors</u> ”	Claim 1 structure with the processor further programmed with the same claim 3 algorithm.

<u>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”⁵</u>	
--	--

125. Additionally, I note that in claims 4–6, “the one or more operational control outputs of the control component,” “the sensors,” and “the one or more sensors” do not appear to have proper antecedent basis. Specifically, Claim 4 recites: “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**[.]” Claims 5 and 6 depend from claim 4.

126. For this issue, I understand multiple possible interpretations exist: (1) the first two terms should be “~~the~~ one or more operational control outputs of the control component” and “~~the~~ sensors,” and (2) this claim should depend from claim 3 rather than claim 1. In my opinion that follows, I address both possibilities and discuss why the prior art reads on claims 4-6 under either possibility.

⁵ Claims 5 and 6 depend from claim 4 and recite additional limitations related to “the one or more operational control parameters” and “the one of more operational control outputs.”

XI. SPECIFIC GROUNDS FOR CHALLENGE

A. Grounds Challenging Claims 1–9, 11, 14–17, and 19–20 of the '830 Patent

127. Ground 1A challenges claims 1–3, 7–9, 15, 17, and 20 as obvious by Fukumoto under pre-AIA 35 U.S.C. § 103.

128. Ground 1B challenges Claims 1–3, 7–9, 15, 17, and 20 as obvious by Fukumoto in view of Grant under pre-AIA 35 U.S.C. § 103.

129. Ground 1C challenges Claims 1–3, 7–9, 15, 17, and 20 as obvious by Fukumoto in view of Barton under pre-AIA 35 U.S.C. § 103.

130. Ground 1D challenges Claims 3–6 as obvious by Fukumoto in view of Ueda under pre-AIA 35 U.S.C. § 103.

131. Ground 1E challenges Claims 3–6 as obvious by Fukumoto in view Grant in view of Ueda under pre-AIA 35 U.S.C. § 103.

132. Ground 1F challenges Claims 3–6 as obvious by Fukumoto in view of Barton in view of Ueda under pre-AIA 35 U.S.C. § 103.

133. Ground 1G challenges Claims 7–8 as obvious by Fukumoto and Erixon under pre-AIA 35 U.S.C. § 103.

134. Ground 1H challenges Claims 7–8 as obvious by Fukumoto, Grant, and Erixon under pre-AIA 35 U.S.C. § 103.

135. Ground 1I challenges Claims 7–8 as obvious by Fukumoto, Barton, and Erixon under pre-AIA 35 U.S.C. § 103.

136. Ground 1J challenges Claim 8 as obvious by Fukumoto, and Fuller under pre-AIA 35 U.S.C. § 103.

137. Ground 1K challenges Claim 8 as obvious by Fukumoto, Grant, and Fuller under pre-AIA 35 U.S.C. § 103.

138. Ground 1L challenges Claim 8 as obvious by Fukumoto, Barton, and Fuller under pre-AIA 35 U.S.C. § 103.

139. Ground 1M challenges Claims 14 and 19 as obvious by Fukumoto in view of Dong and further in view of Ogusu under pre-AIA 35 U.S.C. § 103.

140. Ground 1N challenges Claims 14 and 19 as obvious by Fukumoto, Grant, Dong, and Ogusu under pre-AIA 35 U.S.C. § 103.

141. Ground 1O challenges Claims 14 and 19 as obvious by Fukumoto, Barton, Dong, and Ogusu under pre-AIA 35 U.S.C. § 103.

142. Ground 1P challenges Claims 15 and 20 as obvious by Fukumoto in view of Saiki under pre-AIA 35 U.S.C. § 103.

143. Ground 1Q challenges Claims 15 and 20 as obvious by Fukumoto in view of Grant in view of Saiki under pre-AIA 35 U.S.C. § 103.

144. Ground 1R challenges Claims 15 and 20 as obvious by Fukumoto in view of Barton in view of Saiki under pre-AIA 35 U.S.C. § 103.

145. Ground 1S challenges Claim 16 as obvious by Fukumoto in view of Saiki and further in view of Masahiko under pre-AIA 35 U.S.C. § 103.

146. Ground 1T challenges Claim 16 as obvious by Fukumoto in view of Grant, Saiki, and further in view of Masahiko under pre-AIA 35 U.S.C. § 103.

147. Ground 1U challenges Claim 16 as obvious by Fukumoto in view of Barton, Saiki, and Masahiko under pre-AIA 35 U.S.C. § 103.

148. Ground 2A challenges Claims 1, 2, 7, 11, 15, 17, and 20 as obvious by Ogusu in view Fukumoto under pre-AIA 35 U.S.C. § 103.

149. Ground 2B challenges Claims 1, 2, 7, 11, 15, 17, and 20 as obvious by Ogusu in view Fukumoto in view of Grant under pre-AIA 35 U.S.C. § 103.

150. Ground 2C challenges Claims 1, 2, 7, 11, 15, 17, and 20 as obvious by Ogusu in view Fukumoto in view of Barton under pre-AIA 35 U.S.C. § 103.

151. Ground 2D challenges Claims 3–6 as obvious by Ogusu in view of Fukumoto and further in view of Ueda under pre-AIA 35 U.S.C. § 103.

152. Ground 2E challenges Claims 3–6 as obvious by the combination of Ogusu-Fukumoto-Grant further in view of Ueda under pre-AIA 35 U.S.C. § 103.

153. Ground 2F challenges Claims 3–6 as obvious by the combination of Ogusu-Fukumoto-Barton further in view of Ueda under pre-AIA 35 U.S.C. § 103.

154. Ground 2G challenges Claims 7–8 as obvious by the combination of Ogusu-Fukumoto further in view of Erixon under pre-AIA 35 U.S.C. § 103.

155. Ground 2H challenges Claims 7–8 as obvious by the combination of Ogusu-Fukumoto-Grant further in view of Erixon under pre-AIA 35 U.S.C. § 103.

156. Ground 2I challenges Claims 7–8 as obvious by the combination of Ogusu-Fukumoto-Barton further in view of Erixon under pre-AIA 35 U.S.C. § 103.

B. Ground 1A: Fukumoto Renders Obvious Claims 1–3, 7–9, 15, 17, and 20

1. Claim 1

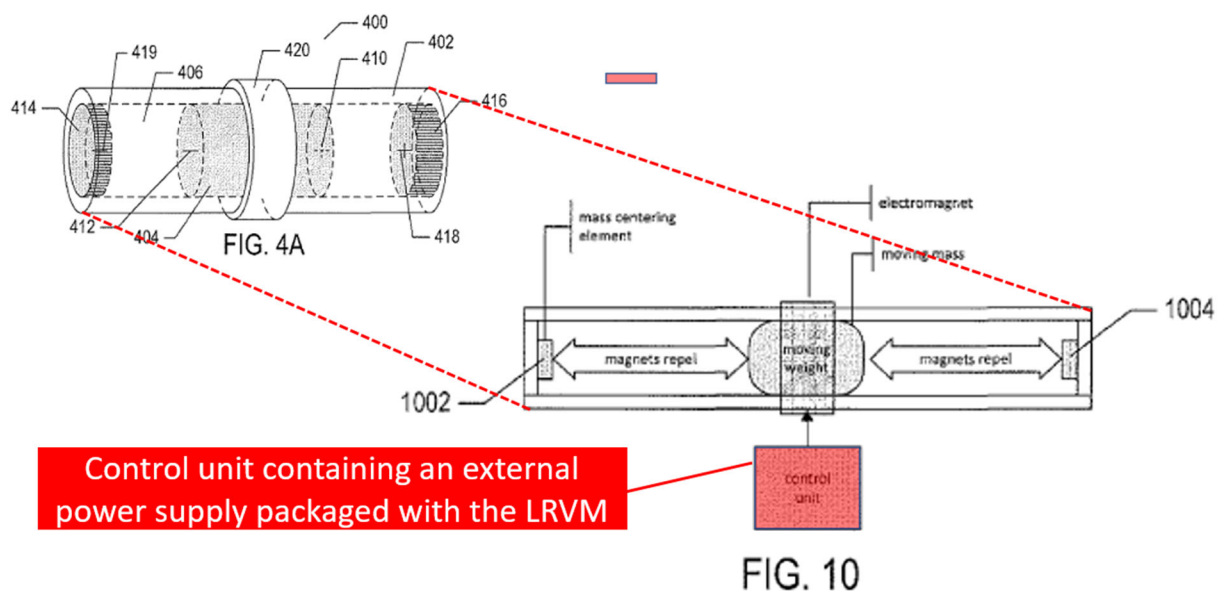
a) 1[pre]: “A vibration module comprising”:

157. To the extent the preamble is limiting, it is my opinion that Fukumoto discloses or suggests it. Fukumoto discloses “[a]n electronic device drives an oscillatory actuator to cause generation of vibration . . . in a direction perpendicular to their respective front surfaces.” *Fukumoto*, Abstract. Fukumoto’s vibration actuator is linear in the same way as the ’830 patent. *Id.*, 14:20-24 (“oscillatory actuator 115 is a linear oscillatory actuator”), Fig. 3; ’830*Pat.*, 4:21-27. As discussed below, Fukumoto’s controller and vibrating device are contained in the same overall module.

158. First, I understand that in its infringement contentions in district court, PO asserts an entire mobile phone can be a “vibration module.” EX1022, 70–75. As discussed below, Fukumoto’s PDA contains both its controller and vibrating device. To the extent PO argues its statements in the ’830 prosecution history require the

recited “vibration module” to include a controller and vibrating device in the same structure, Fukumoto discloses such an arrangement.

159. Second, a POSITA would have understood that Fukumoto’s oscillatory actuator falls clearly within the scope of the ’830 patent’s claimed vibration module because the ’830 Patent broadly discloses the term. Disclosing an example, the ’830 patent discloses Fig. 10, which is a “schematic illustration of an LRVM [linear resonance vibration module] similar to that discussed above with reference to Fig. 4A”:



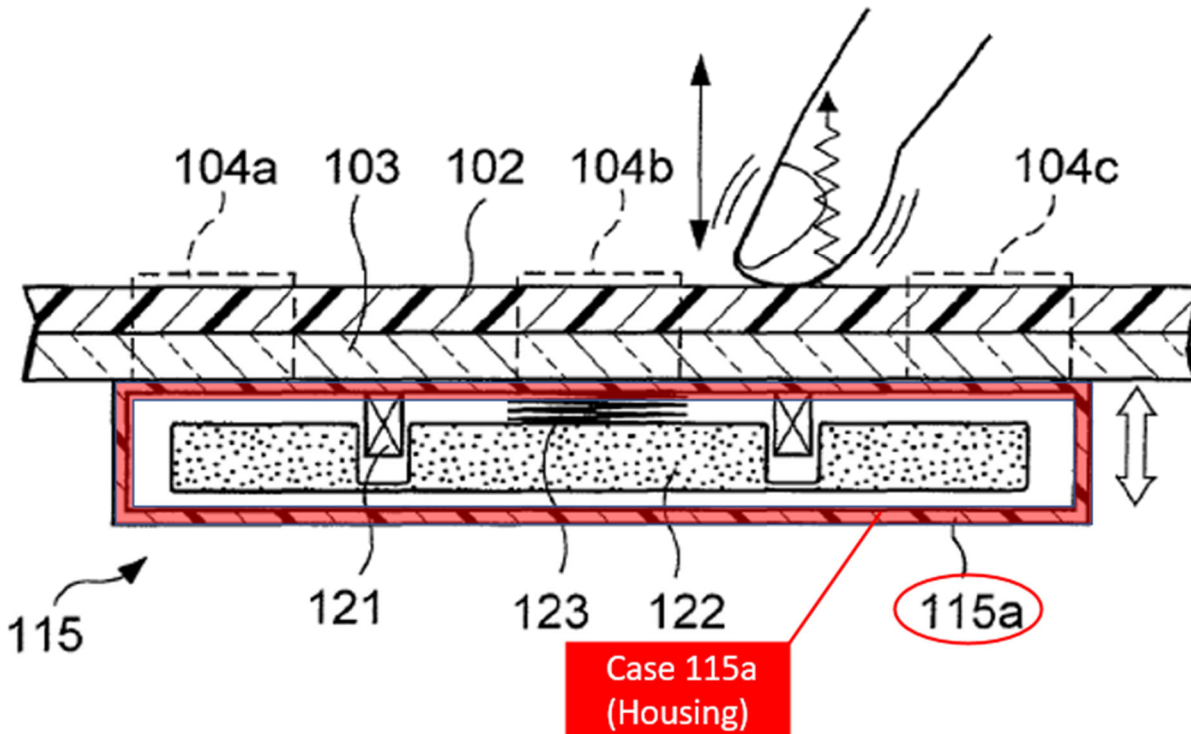
’830 Patent, 9:20–24, Figs. 4A, 10 (combined and annotated). Fig. 10 replicates the components and configuration of Fig. 4A, but expressly depicts a “control unit” Fig. 4A only describes: “the LRVM, in addition to the cylindrical housing, coil, and internal components shown in Fig. 4A, includes a power supply” and other circuitry,

CPU, and sensor-type components “packaged together as an LRVM within a vibration-based appliance, device, or system.” *Id.* at 6:9–18 (emphases added). It is my opinion, therefore, that a POSITA would have understood from the ’830 Patent’s disclosure that a vibration module, or LRVM, encompasses components both internal or external to the housing as long as they are considered to be “packaged” with those and other components with respect to a greater appliance, device, or system as shown by the difference in Figs. 4 and 10.

160. Therefore, Fukumoto discloses or suggests “a vibration module”.

b) 1[a]: “a housing”

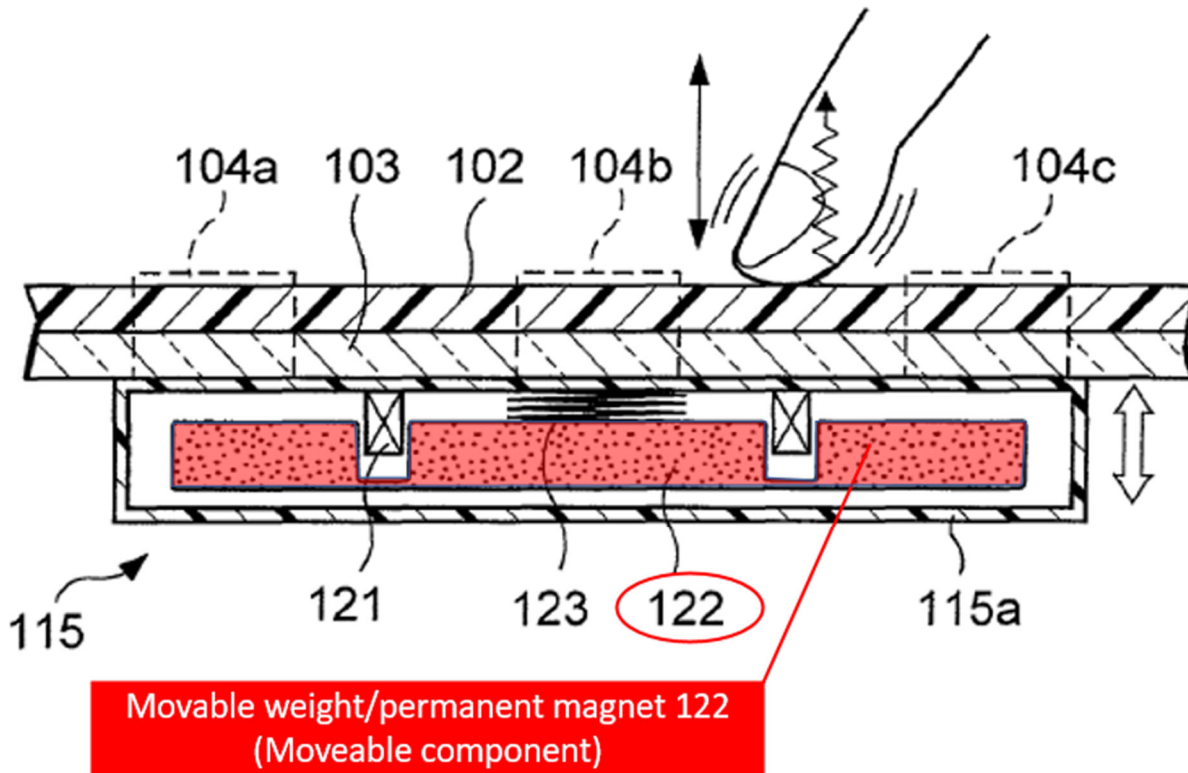
161. It is my opinion that Fukumoto discloses or suggests this limitation. Fukumoto discloses the components of the oscillatory actuator are “housed inside the case 115a,” depicted in Figure 3. *Fukumoto*, 15:56–59.



Id., Fig. 3 (annotated). Therefore, Fukumoto’s case 115a discloses or suggests a “housing.” Alternatively, it is my opinion Figure 1 (above) shows Fukumoto’s PDA has main case 101 which also discloses or suggests a “housing” as Patent Owner has apparently asserted in its district court infringement contentions. EX1022, 70–75.

c) 1[b]: “a moveable component”

162. It is my opinion that Fukumoto discloses or suggests this limitation under a non-MPF or MPF construction. For non-MPF, Fukumoto discloses a “columnar movable weight 122 made of permanent magnet,” depicted in Figure 3. *Fukumoto*, 14:32–37.



Id., Fig. 3 (annotated). Fukumoto discloses “[t]he movable weight 122 linearly reciprocates in the vertical direction in the figure.” *Id.*, 14:57–60. Thus, Fukumoto’s movable weight 122 discloses or suggests a “moveable component.” See ¶124.

163. Under an MPF construction, Fukumoto discloses or suggests the recited function (“moves”) for the reasons discussed above. As I discussed above in ¶ 124, the corresponding structure for this limitation is a moving weight. Fukumoto discloses this corresponding structure (movable weight 122) that performs the recited function for the same reasons discussed above.

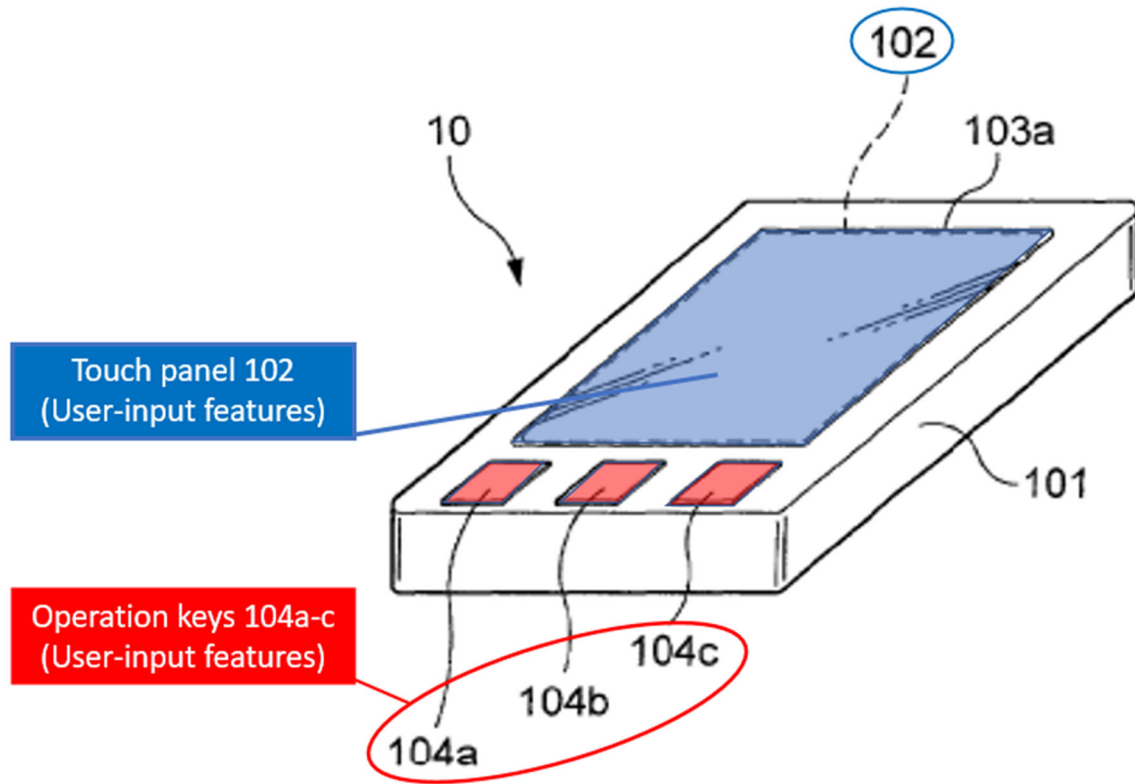
164. In sum, it is my opinion that Fukumoto discloses or suggests this limitation under either a non-MPF or MPF construction.

d) 1[c]: “a power supply”

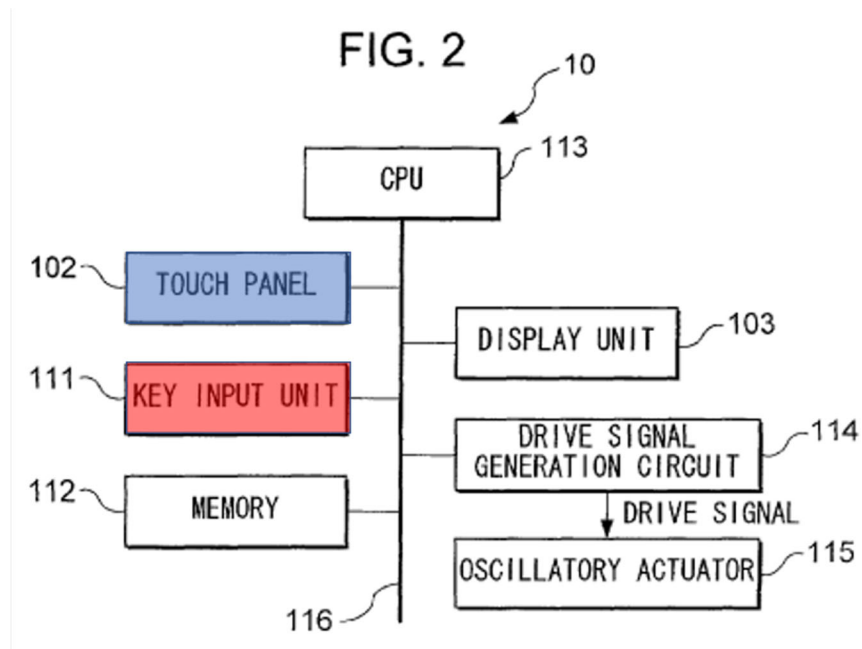
165. It is my opinion that Fukumoto discloses or suggests this limitation. Fukumoto discloses “[t]he movable weight 122 linearly reciprocates in the vertical direction in the figure by the magnetic force generated from the coil 121 when an AC (alternating) current (drive signal) is applied to the coil 121.” *Fukumoto*, 14:57–60. For oscillatory actuator 115 to vibrate at a resonant frequency, it requires “small drive power,” which “reduce[s] the power consumption.” *Id.*, 16:44–50. A POSITA would have understood and found it at least obvious that the “small power” is supplied to the coil as alternating current using a power supply. Therefore, Fukumoto discloses or suggests a “power supply.”

e) 1[d]: “user-input features”

166. It is my opinion that Fukumoto discloses or suggests this limitation. Fukumoto discloses a PDA with a “touch panel” and “push-button type operation keys” for a user to “input[] operation instructions to the PDA 101.” *Fukumoto*, 13:40–14:13.

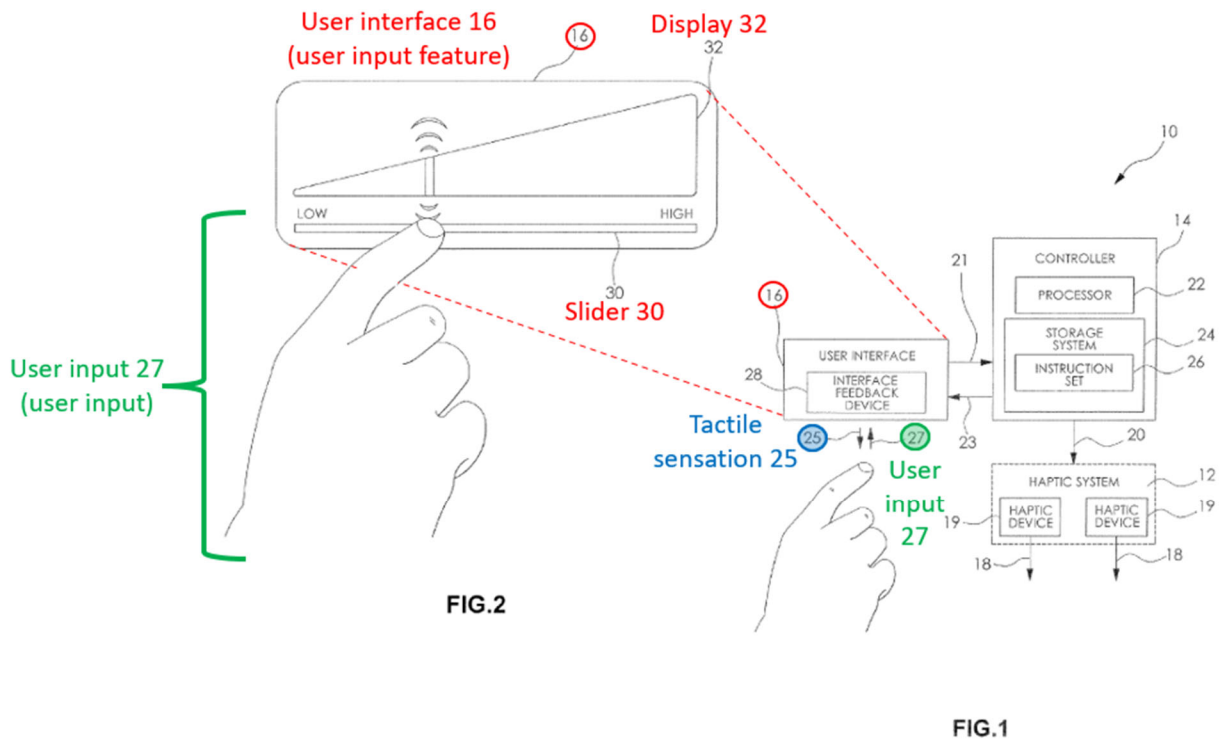


Id., Fig. 1 (annotated).



Id., Fig. 2 (annotated). In this embodiment, “[t]he CPU 113 executes a program stored in the memory 112” including a “vibration control processing” where “[u]pon detection of an operation input from the touch panel 102 or any one of operation keys 103 to 104c, it drives the oscillatory actuator 115 through the drive signal generation circuit 114 to cause the touch panel 102 or one of the operation keys 104a to 104c to vibrate.” *Id.*, 14:8–13, 30:48–53, 31:27–29, Fig. 41.

167. While Fukumoto clearly describes how a user manipulates, e.g., a hardware touch panel (“user input feature”) to run processor-driven, software instruction steps of controlling oscillatory actuator vibrations using drive signals, a POSITA would have recognized U.S. Patent Application 2009/0295739 (“Nagara,” Ex. 1034) depicts how a user manipulates Fukumoto’s screen-based interface to achieve the oscillatory control Fukumoto describes because it likewise comprises a user interface 16 controlled by processor-driven software instruction steps:



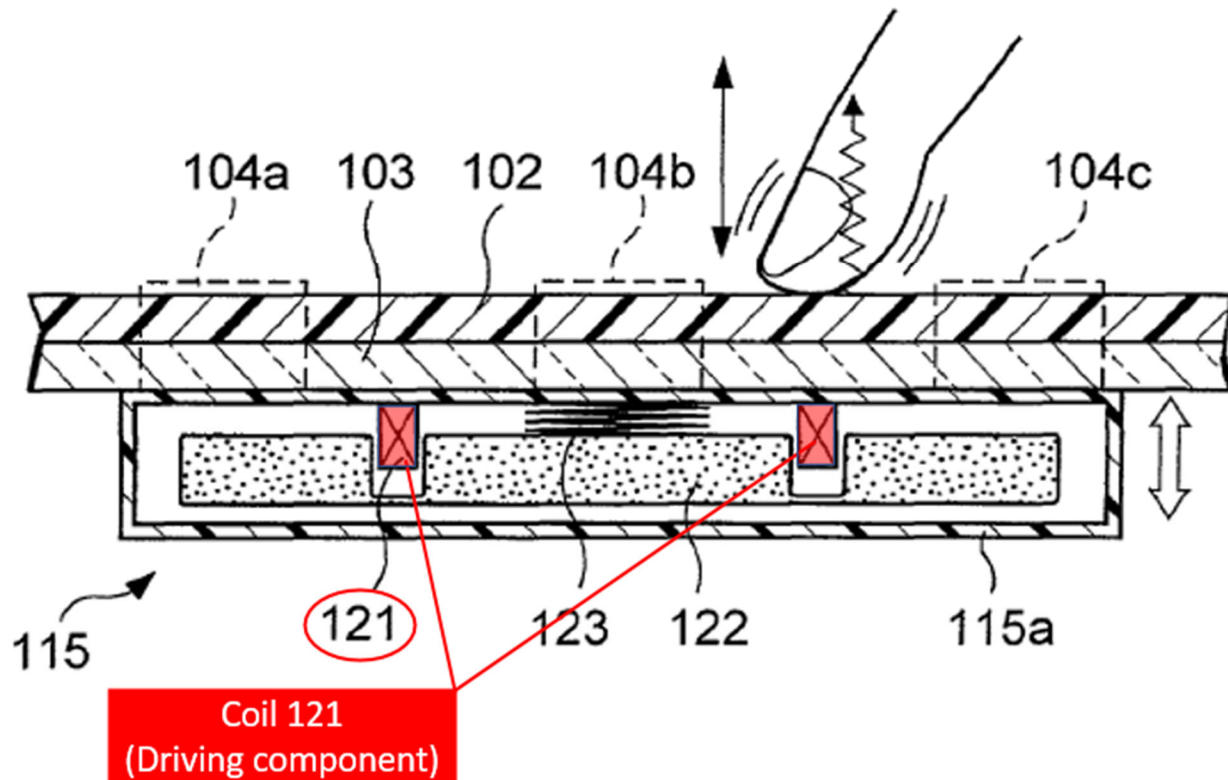
Nagara, Figs. 1–2 (combined and annotated). These steps allow user control of “the desired ‘feeling’ they would like to receive” as a “tactile sensation 25” by providing a user input 27 (Fig. 1, the act of which is depicted in the exploded view of Fig. 2) to the user interface 16. *Id.*, [0020]–[0021].

168. Therefore, Fukumoto’s touch panel, push button keys, and slider disclose or suggest “user-input features.”

f) 1[e]: “a driving component that drives the moveable component to oscillate within the housing”

169. It is my opinion that Fukumoto discloses or suggests this limitation under a non-MPF or MPF construction. For non-MPF, Fukumoto discloses a

“magnetic force [is] generated from the coil 121 when an AC (alternating current (drive signal) is applied to the coil 121.” *Fukumoto*, 14:57–60.



Id., Fig. 3 (annotated). “[M]ovable weight 122 linearly reciprocates in the vertical direction in the figure [3] by the magnetic force generated from the coil 121 when an AC (alternating) current (drive signal) is applied to the coil 121.” *Id.*, 14:57–60. Therefore, Fukumoto discloses or suggests a coil 121 (“driving component”) that causes movable weight 122 to linearly reciprocate in the vertical direction within housing 115a when alternating current is applied to coil 121 (“drives the moveable component to oscillate within the housing”). *See* ¶124.

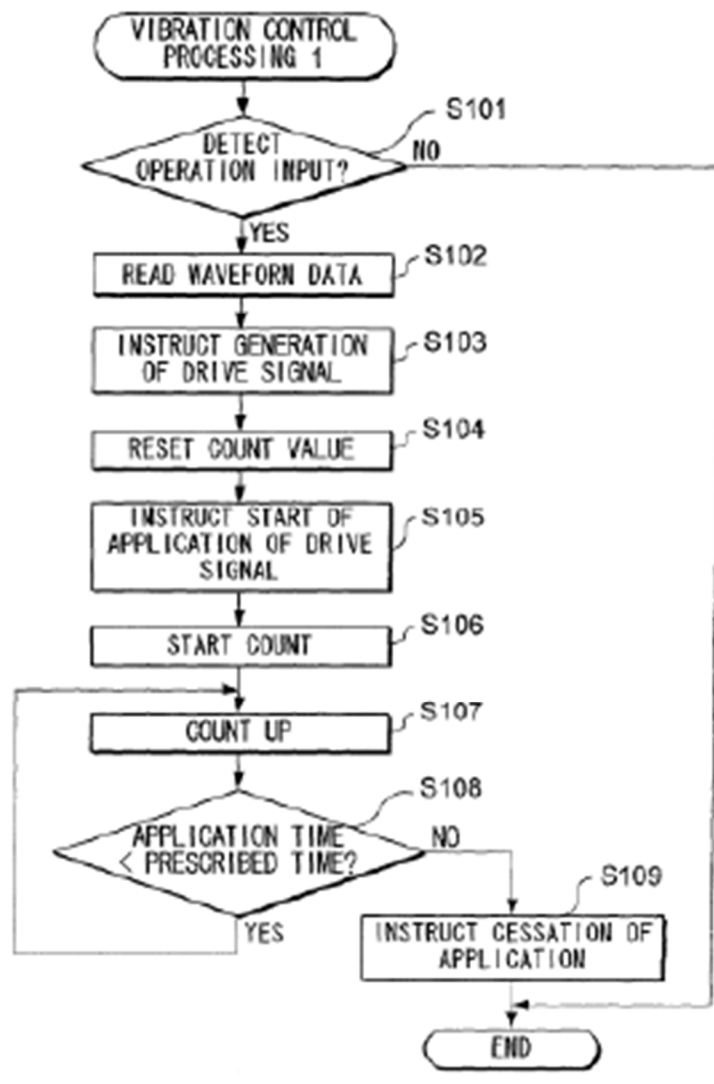
170. For MPF, Fukumoto discloses or suggests the recited function (“drives the moveable component to oscillate within the housing”) for the reasons discussed above. In addition, as discussed in ¶ 124, the corresponding structure for this limitation is one or more coils of conductive wire. Fukumoto discloses this corresponding structure (coil 121) that performs the recited function for the same reasons discussed above.

171. In sum, Fukumoto discloses or suggests this limitation under either a non-MPF or MPF construction.

- g) **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”**

172. It is my opinion that Fukumoto discloses or suggests this limitation under a non-MPF or MPF construction. For non-MPF, in Fukumoto, CPU 113 “executes a vibrational control processing” using drive signal generation circuit 114 that generates drive signals for driving oscillatory actuator 115 according to waveform data. *Fukumoto*, 13:54–14:26. Figure 5 illustrates this process:

FIG. 5



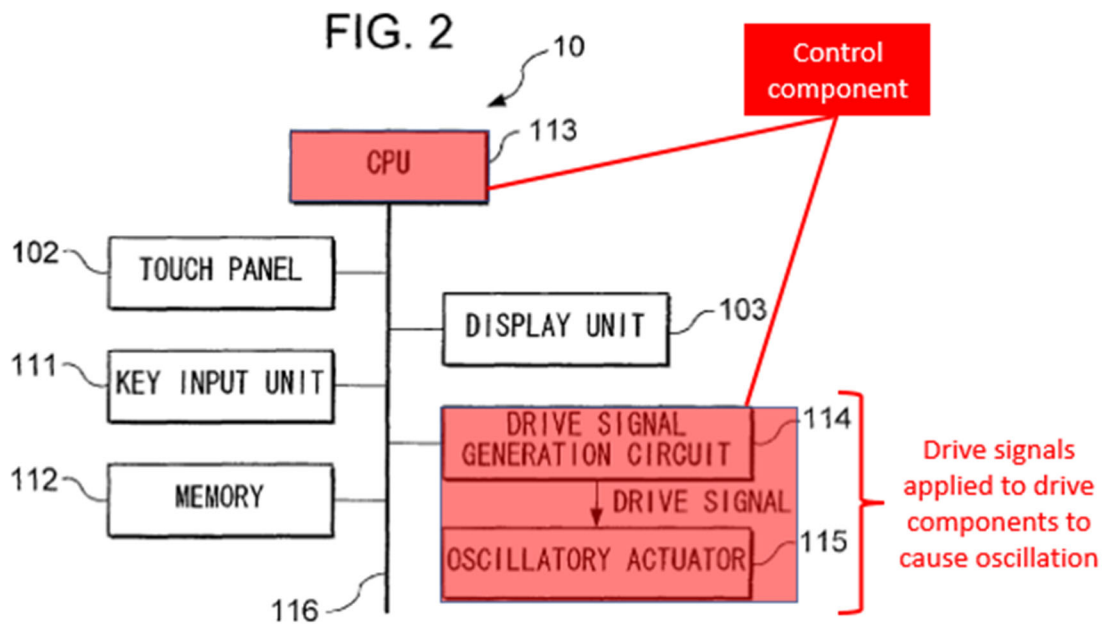
Id., Fig. 5, 16:60–19:3. Fukumoto’s waveform data is stored in a table:

FIG. 33

112a

TOUCH BUTTON	AREA DATA	WAVEFORM DATA
A		
B		
C		
⋮	⋮	⋮

Id., Fig. 33 (112a). CPU 113 uses this data to generate a drive signal at drive signal generation circuit 114 sent to oscillatory actuator 115:



Id., Fig. 2 (annotated). In other words, a user's input starts a sequence of CPU-driven events that results in vibration of certain amplitude and frequency: namely, a user

touches a button or location of the touch panel; the CPU detects the location/button of that touch, reads the waveform corresponding to that touch from data stored in a reference table and generates a drive signal sent to the oscillatory actuator to vibrate at the amplitude and frequency specified by the waveform stored in that table. *Id.*, 13:54–14:25, *see also* 29:15-18 (“The above-mentioned waveform data table 112a stores the frequency data, amplitude data, and the like required for generating these drive signals as the waveform data.”), 48:42-47 (“Further, the frequency of the drive signal applied to the oscillatory actuator is not limited to the frequency for causing resonance in the housing or touch panel of the electronic device or the liquid crystal display panel provided with the touch panel or the oscillatory actuator itself.”). Such technique and variants of the same were well known. *See, e.g.*, U.S. Patent Application Publication 2008/0153554A1 (“Yoon ’554”) (Ex. 1035), Fig. 2, [0081]–[0085] (describing a “control unit 280” in a mobile phone 200 that supplies a “control signal” to a “motor driving module 271 [that] generates a voltage form driving [a] vibration motor 273” and that the driving module 271 specifically “adjusts the size of current applied to the vibration motor 273 to differentiate the vibration pattern/level through again control of the vibration motor 273,” the adjustment of which—in parallel effect—adjusts the “frequency and strength level” of a vibration generated by the motor.”).

173. Further, as I noted above, a POSITA would have recognized that a user manipulates Fukumoto's touch panel according to the known technique disclosed by Nagara, where a fingertip is used to adjust a slider corresponding to at least "variable frequency [and] a variable amplitude." *Nagara*, [0015]. Specifically, "[a]s the user moves his/her finger across the slider 30, the tactile sensation 25 of the user interface 16 varies in response to the slider 30 motion." *Id.*, [0019].

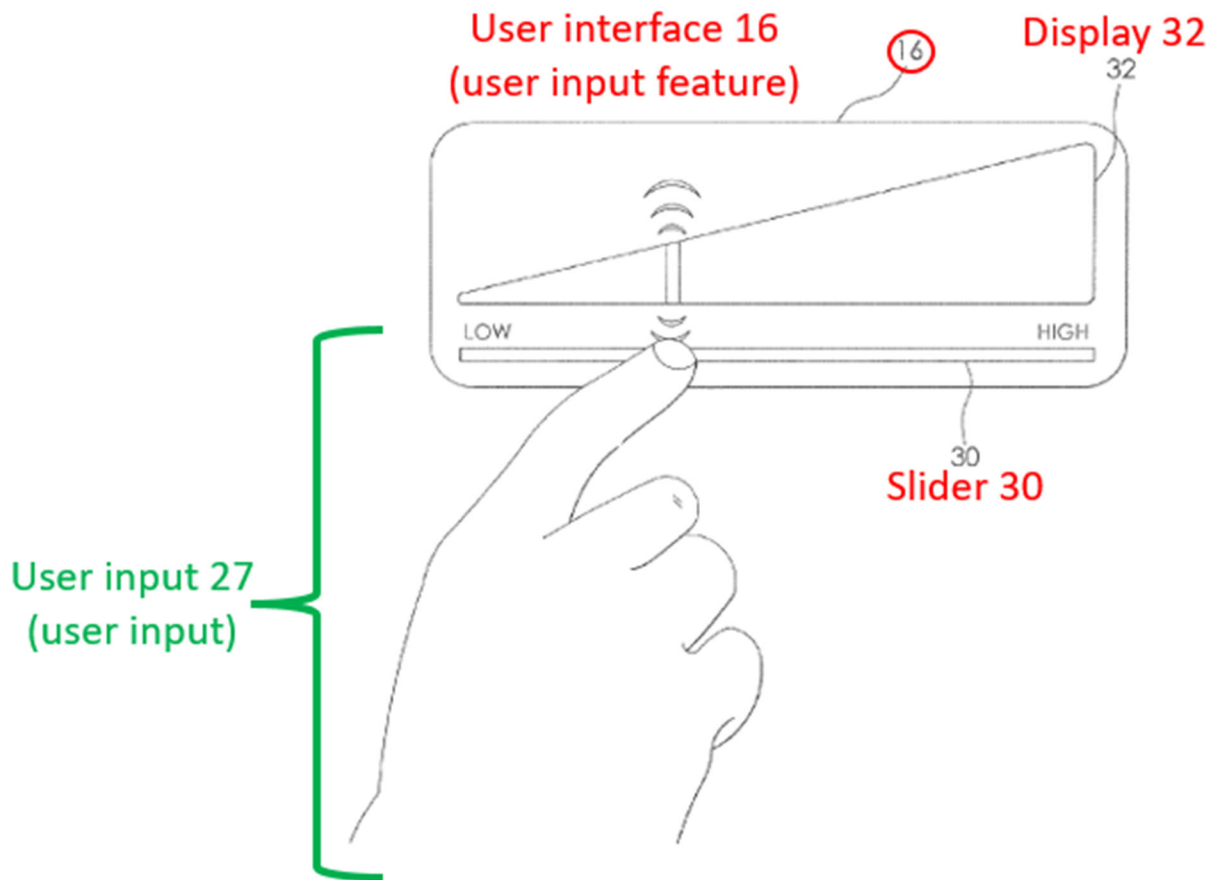


FIG.2

Id., Fig. 2 (annotated). Therefore, Fukumoto's CPU 113 and drive signal generation circuit 114 ("control component") generate a drive signal for the power to be applied

to coil 121 in oscillatory actuator 115 (“controls supply of power from the power supply to the driving component”) based on the stored waveform data, including frequency and amplitude, corresponding to the received user input (“to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values”).

174. For MPF, Fukumoto discloses or suggests the recited function (“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”) for the reasons I discussed above. In addition, as discussed in Section ¶ 124, the corresponding structure includes a processor and an H bridge switch, where the processor is programmed with an algorithm to perform the following steps: (1) set the mode and strength to values represented by selections made by user input to the user input features, (2) provide a corresponding output to the power supply, and (3) provide a corresponding output to the H-bridge switch.

175. Fukumoto discloses CPU 113 (“a processor”) but does not expressly disclose an H-bridge switch. Instead, Fukumoto discloses applying an AC drive signal to coil 121 (*Fukumoto*, 14:57–60), but does not provide details about the circuitry used in Fukumoto to convert power supplied from, for example, the battery in the electronic device to the AC drive signal. The components required to do so

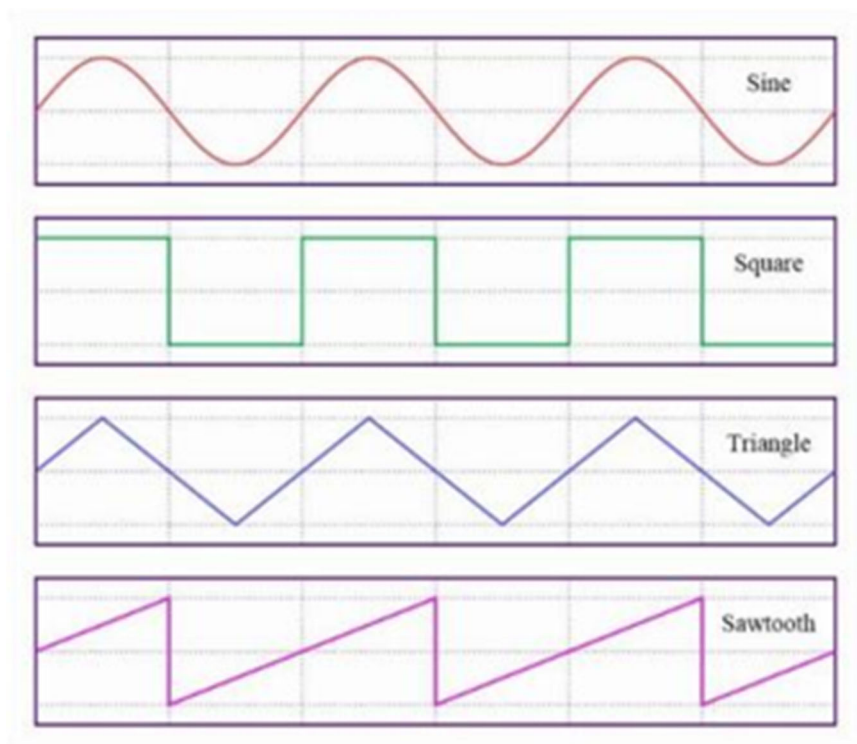
were well-known at the relevant time, including H-bridge switches, oscillator circuits, and inverters.

176. To elaborate, many people are familiar with the concept of AC power delivery in the form of utility-supplied power such as the 110V wall outlets in American homes. Many people are also familiar with DC power as provided by batteries such as in a flashlight or a cell phone. To a POSITA, these terms refer to a specific characteristic of the voltages provided by these power sources. A simple DC signal provides a voltage at an essentially constant value. A simple AC signal provides a voltage that oscillates between two voltage values. Both can be useful in electronic or electromagnetic circuits. *See, e.g.*, U.S. Patent Application Publication 2008/0155415A1 (“Yoon ’415”) (Ex. 1036) at Fig. 1, [0023]–[0025] (disclosing a mobile terminal comprising a battery module for supplying power and a power supply unit for “converting power of the battery module . . . to a level of voltage corresponding to a control signal and outputting the converted voltage to [a] vibration unit”).

177. In particular, an AC signal can be useful in creating an alternating magnetic field that can then be used to create motion and vibration in an electromagnetic transducer. One familiar device that does this is a battery-powered portable radio. An AC signal is created by the electronic circuits to

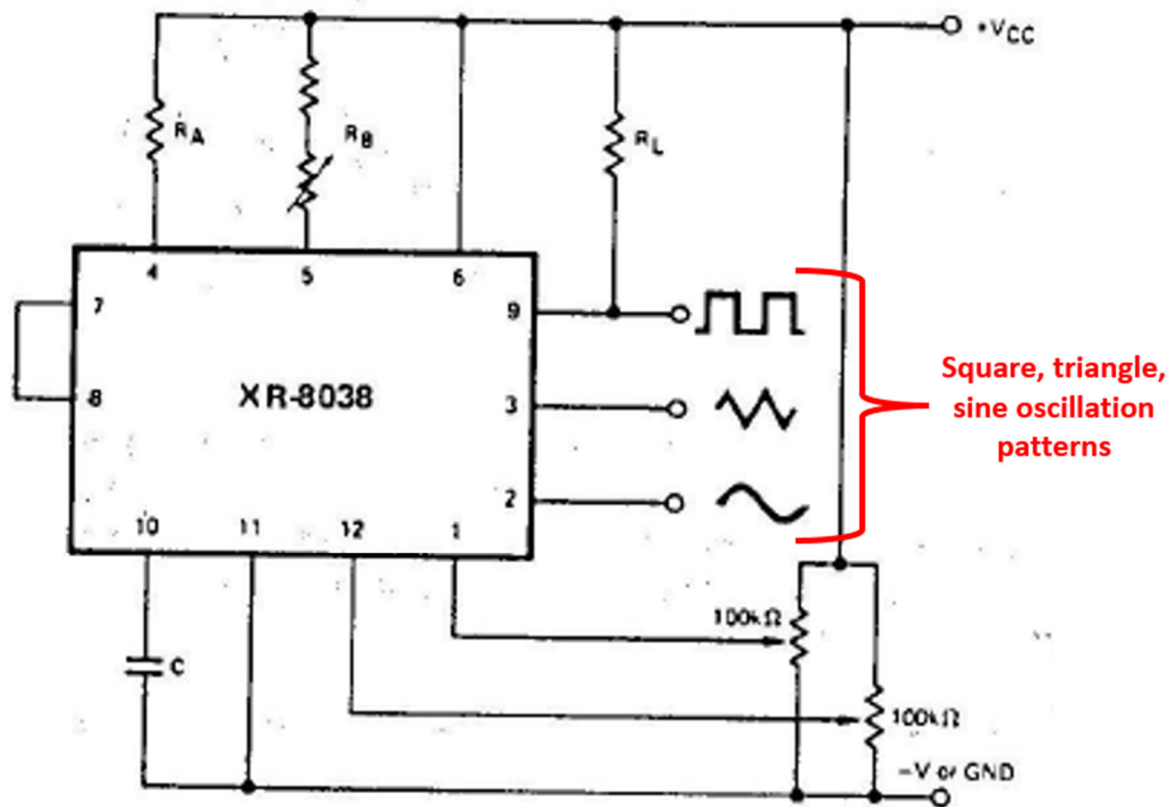
electromagnetically vibrate the speaker cone back and forth to produce audible sounds.

178. There are many ways to create an AC signal in an electronic system, but one of the most basic is a circuit called an oscillator. An oscillator produces an electronic signal that oscillates between two values—generally voltages. This oscillation can take several forms, corresponding to different methods of transitioning between the two peak values. The diagram below illustrates four different oscillation patterns: sine, square, triangle, and sawtooth. Each can be used to power an electromagnetic transducer.



179. Oscillators are a basic electronic building block that would be familiar to any POSITA. I personally used an oscillator chip called the Exar XR8038 in the

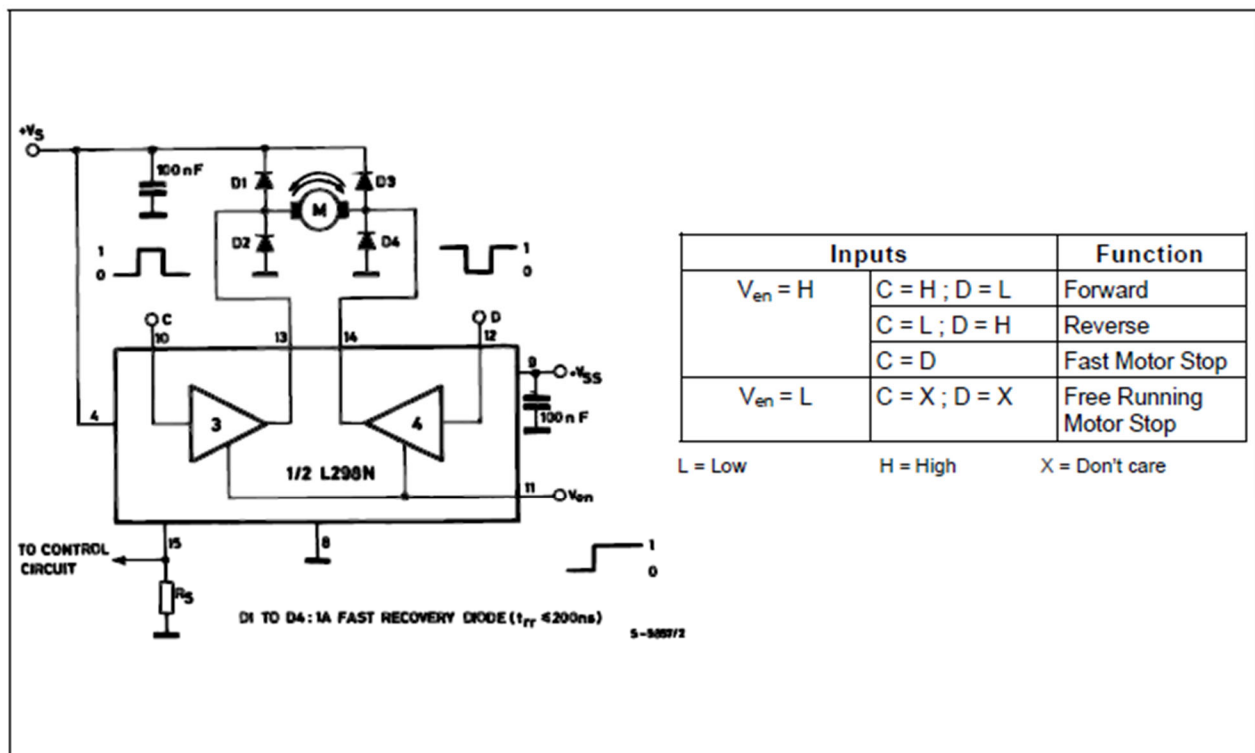
mid-1080s to produce AC signals for touch-sensitive displays. *See Exar* (Ex. 1037), 213–216.



Id., 216 (annotated).

180. A POSITA would have also learned how to build an oscillator from a basic textbook or design guide. I note that at least two electronic hobbyist books that I bought in Junior High School include complete instructions for designing an oscillator that can drive an electromagnetic device (for example a speaker or an electromagnetic resonator). *See Jung* (Ex. 1040), *Friedman* (Ex. 1038). Some of my textbooks from college also show oscillator designs suitable for audio-range or haptic vibration signals. *See Horowitz* (Ex. 1039), *Millman* (Ex. 1041).

181. Another technique for implementing an oscillator to drive an electromagnetic actuator is the use of an H-bridge. An H-bridge can use a signal from a microprocessor to switch the voltage of one actuator terminal with respect to another from one voltage level to another in order to make the actuator oscillate. The L298 H-bridge from ST Microelectronics is the particular component that I use for this purpose with my students. This component has been available and documented since at least 2000. *STMicroelectronics* (Ex. 1042), 1–13.



182. An AC signal, whether a sine wave or a square wave, will oscillate around its own average value and thus will drive an electromagnetic actuator (like a

speaker or linear resonator) back and forth at the oscillation frequency. This can be implemented from a single voltage supply or from a dual-polarity voltage supply with a separate ground. *See Exar*, 216. If, however, one chooses to provide a dual-polarity voltage supply with a separate ground from a single battery, the structure for doing so is well-known. A voltage inverter (often called a charge pump) is used to create a negative supply voltage from a positive supply voltage. I included one in a chip I designed in 1986. A basic design for a voltage inverter can be found in many textbooks, for example the circuit below is from “The Art of Electronics”:

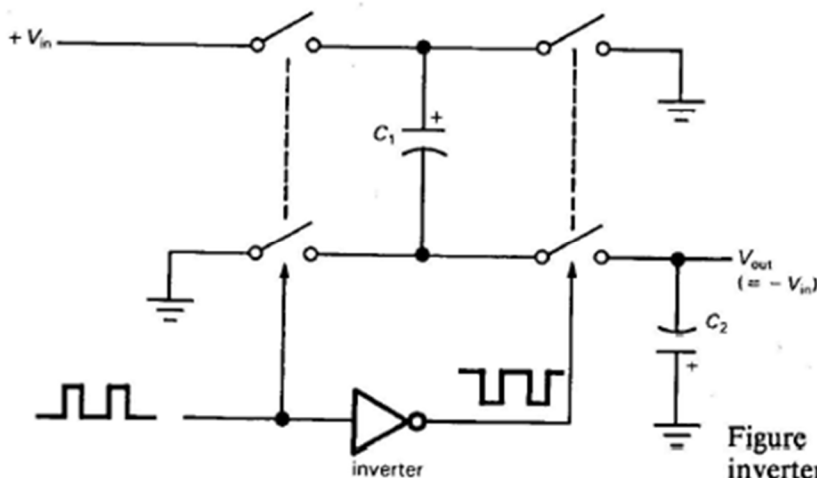


Figure 3.55. Flying-capacitor voltage inverter.

Horowitz, 153. It converts a positive supply voltage V_{in} to a corresponding negative supply voltage $-V_{in}$. *Id.*

183. Therefore, it is my opinion that a POSITA would have viewed any of these well-known options as equivalent because each would convert input power into the desired waveform (i.e., with two directions of current flow). Finally,

Fukumoto discloses an equivalent algorithm to the algorithm discussed above as corresponding structure. Specifically, in Fukumoto, when “at least one of the touch signal or key operation signal has been input,” the CPU “reads from the memory 112 the waveform data of the drive signal to be applied to the oscillatory actuator 115.” *Id.*, 17:7–11. Doing so would set the mode and strength to values represented by selections made by user input to the user input features. Additionally, Fukumoto’s CPU provides a corresponding output to the power supply when it “instructs the drive signal generation circuit 114 to generate a drive signal,” and in response, “the drive signal generation circuit 114 generates a drive signal using the waveform data supplied from the CPU 113.” *Id.*, 17:20–26. As I discussed above, a POSITA would have understood or found it obvious that because Fukumoto uses components to covert power from the battery into the desired waveform (i.e., Fukumoto’s AC drive signal), Fukumoto providing an output to such components is equivalent to the ’830 patent’s algorithm step of providing an output to an H-bridge switch.

184. For the reasons discussed above, it is my opinion that Fukumoto discloses or suggests a processor, circuitry to convert power supplied from, for example, the battery in the electronic device to the AC drive signal (equivalent to the ’830 patent’s disclosed H-bridge switch), and an algorithm to perform the claimed function with at least equivalent steps to those disclosed in the ’830 specification.

185. In sum, Fukumoto discloses or suggests this limitation under a non-MPF or MPF construction.

2. Claim 2

186. It is my understanding that Claim 2 depends from claim 1 and further recites that “the control component is one of an variable oscillator circuit with additional control circuitry; and a control component that includes a microprocessor, and 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 one or more stored values.”

187. In my opinion, Fukumoto discloses or suggests the latter option. *See* ¶¶ 172–185. Specifically, Fukumoto discloses CPU 113 executes a vibration control processing program. *Fukumoto*, 14:5–13. Further, Fukumoto teaches “the memory 112 stores waveform data of the drive signal for driving the oscillatory actuator 115.” *Fukumoto*, 14:2–4. Thus, for the reasons discussed in Section ¶¶ 172–185, Fukumoto’s CPU 113 (“microprocessor”) executes vibration control processing program (“control program”), and a POSITA would have understood that program would be “stored in an electronic memory within, or separate from, the microprocessor” so that CPU 113 could execute it. For the reasons discussed in ¶¶

172–185, that control program “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.”

3. Claim 3

188. It is my understanding that Claim 3 depends from claim 1 and further recites: “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.” As context, Figure 6 of the ’830 patent illustrates an embodiment with one or more electromechanical sensors 632:

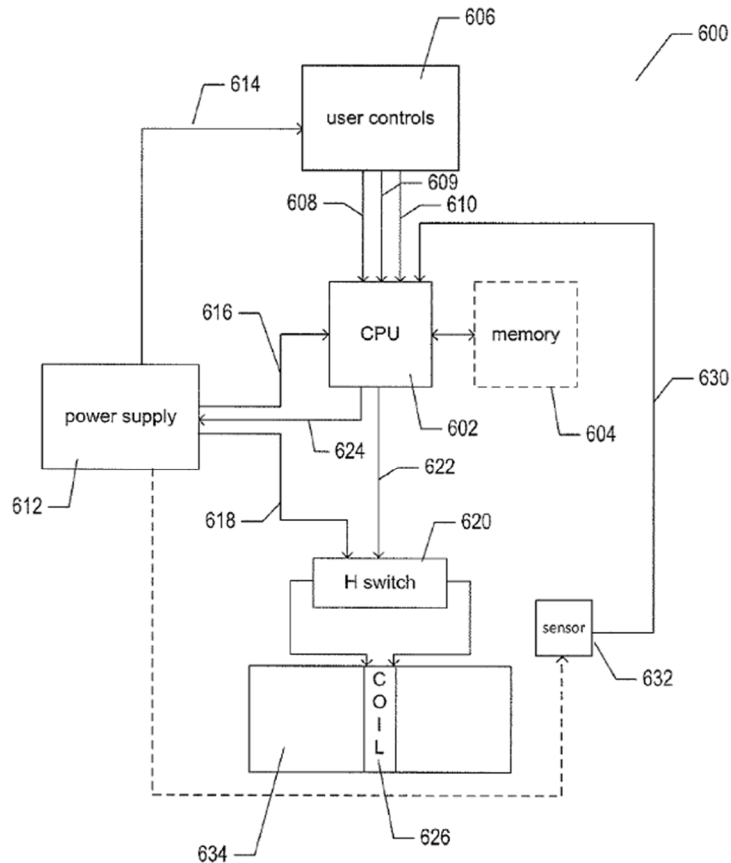
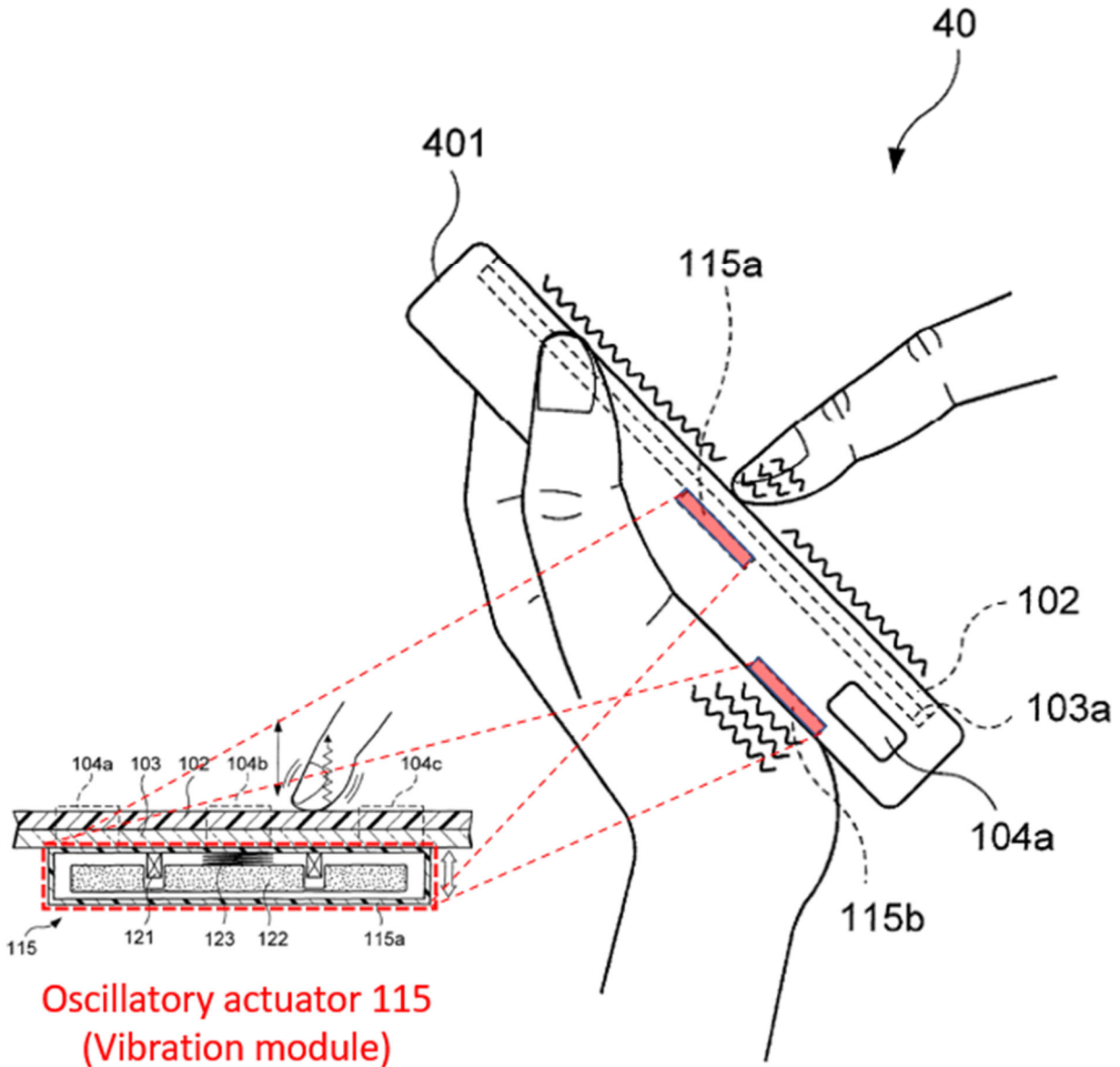


FIG. 6

'830*Pat.*, Fig. 6, 6:44-51. The '830 patent further states: "Sensors may include one or more of accelerometers, piezoelectric devices, pressure-sensing devices, or other types of sensors that can generate signals corresponding to the strength of desired vibrational forces." *Id.*, 6:47-51. Thus, a POSITA would have understood that, in the context of the '830 patent, "sensors" generate signals.

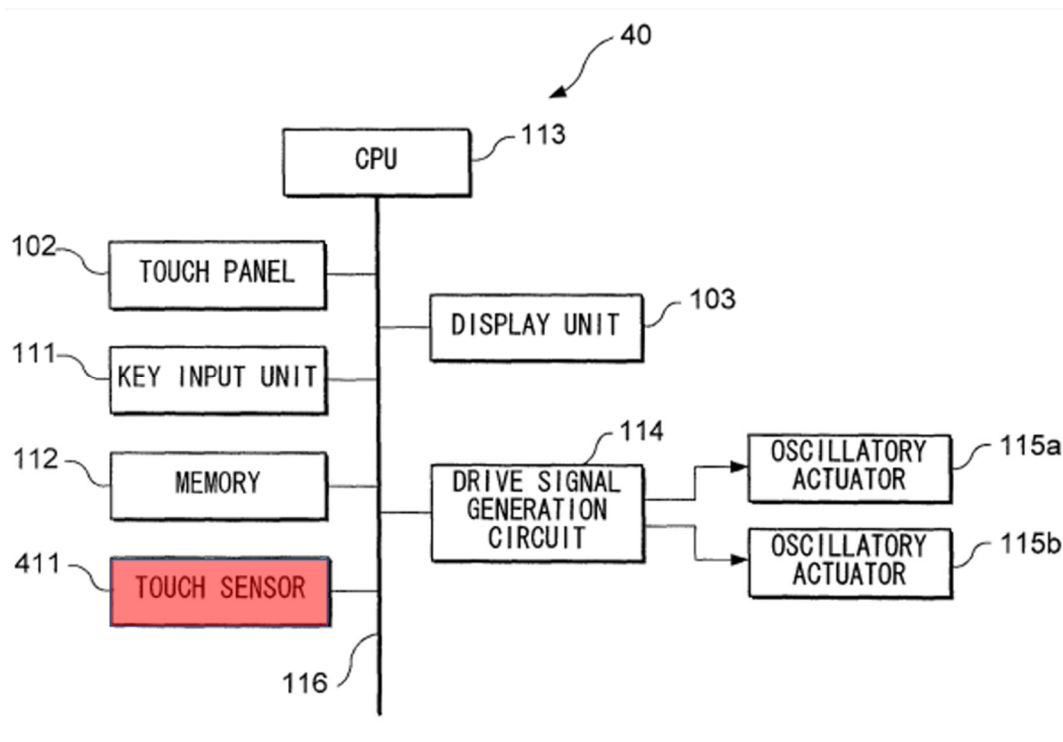
189. It is my opinion that Fukumoto discloses or suggests the additional limitations of claim 3 under a non-MPF construction.⁶ For example, in Figure 16 (reproduced below), Fukumoto discloses an embodiment incorporating the hardware of Figure 3 and further including two oscillatory actuators 115a and 115b, which provide vibration to both touch panel 102 and a user's palm:

⁶ If this limitation is construed as MPF as I have suggested, claim 3 is unpatentable as obvious over the combination of Fukumoto and Ueda as I describe in Ground 1D below.



Id., Figs. 3, 16 (combined and annotated), 23:52–55. The oscillatory actuators provide vibration to both touch panel 102 and user palm through PDA case 401. *Id.*, 23:63–24:8. The Figure 16 embodiment also incorporates a touch sensor, which senses whether a user is holding the PDA to prevent vibration when the user is not,

mitigating the “unpleasant buzzing sound” that occurs when vibration is otherwise allowed when the PDA is placed on a desktop (*id.*, 24:32–40):



Id., Fig. 17 (annotated). Like the Figure 3 embodiment, CPU 113 executes vibration control processing, but “drives only one of the two oscillatory actuators 115a and 115b to generate vibration in accordance with the results of detection of the touch sensor 411.” *Id.*, 24:52–58, 25:16–33.

190. A POSITA would have understood Fukumoto’s touch panel 102 and touch sensor 411 are two separate, touch-based sensors associated with two separate oscillatory actuators within the same PDA. Further, a POSITA would have found it obvious to combine the separate oscillatory actuator hardware elements into one that

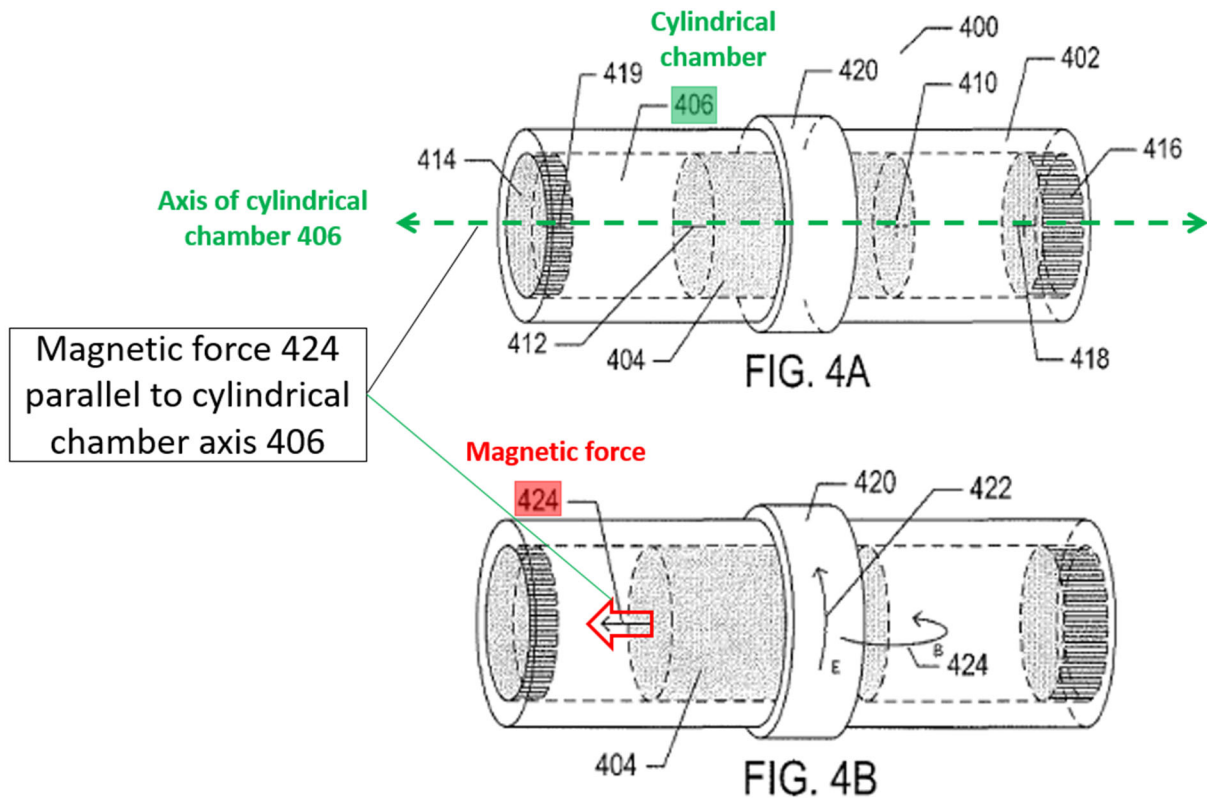
works with both sensors as a simple modification of existing hardware and software elements. *Id.*

191. Thus, in Fukumoto, CPU 113 and drive signal generation circuit 114 (“control component”) receive output signals from touch panel 102 and touch sensor 411 (“receives output signals from sensors within the linear vibration module during operation of the linear vibration module”) and causes vibration of either linear oscillator 115a or 115b depending on whether a user is holding the PDA (“adjusts one or more operational control outputs of the control component according to the received output signals from the sensors”). *Fukumoto*, 25:42-48.

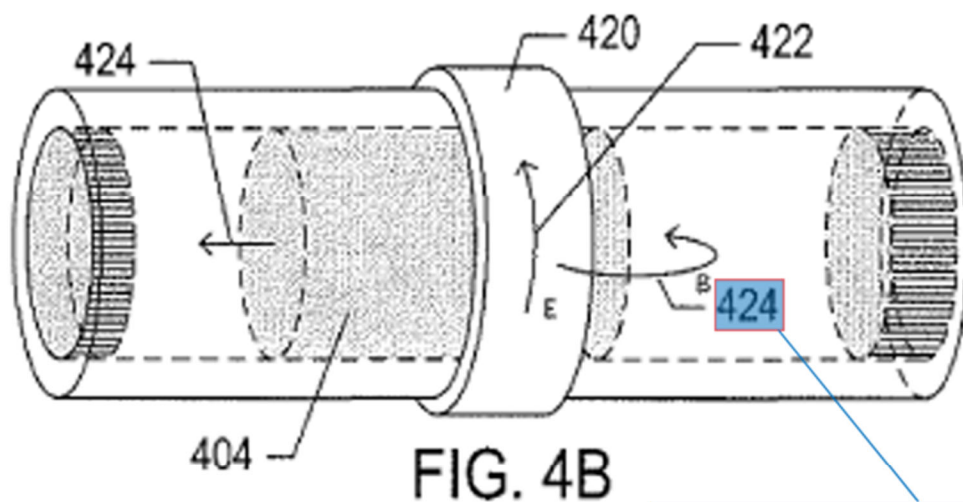
4. Claim 7

192. It is my understanding that Claim 7 depends from claim 1 and further recites “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.” The ’830 Patent discloses “a corresponding magnetic **force** 424 is generated in a direction parallel to the axis of the cylindrical chamber.”’830 *Patent*, 5:9–16) (emphasis added). Referring to the linear resonance vibration module (LRVM) of Figs. 4A and 4B, the ’830 Patent depicts the disclosed magnetic force 424 parallel to the axis of cylindrical chamber

406:



Id., Figs. 4A–B (annotated). A POSITA would have recognized the figure discloses a second element number “424” relative to an arc portion, “B”:



Magnetic field line B
(with redundant
identifier 424)

Id., Fig. 4B (annotated). However, a POSITA would have understood this second, arc-shaped 424 as a description of a radially-shaped magnetic field line consistent with those the '830 Patent discloses as “magnetic field lines 2402” that “radiate outwards in arcs from the north pole to the south pole of a magnet” as depicted in Fig. 24A:

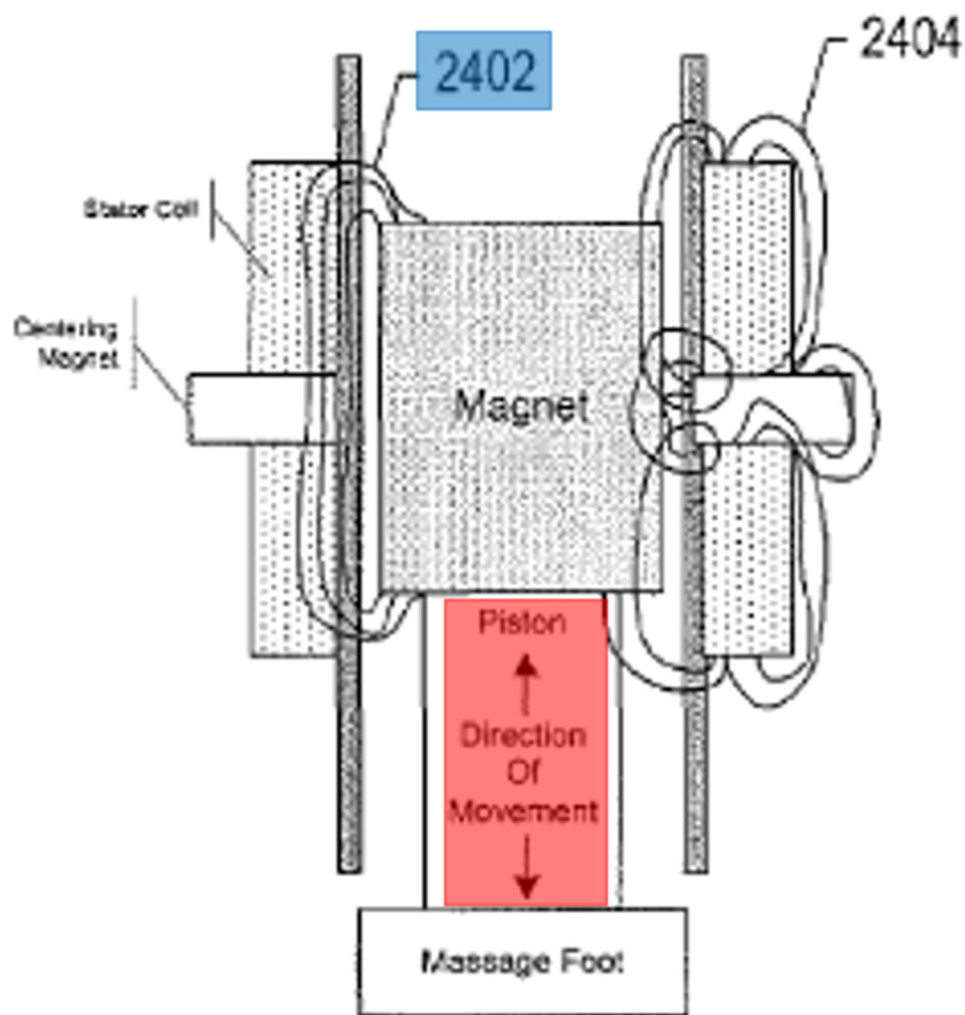
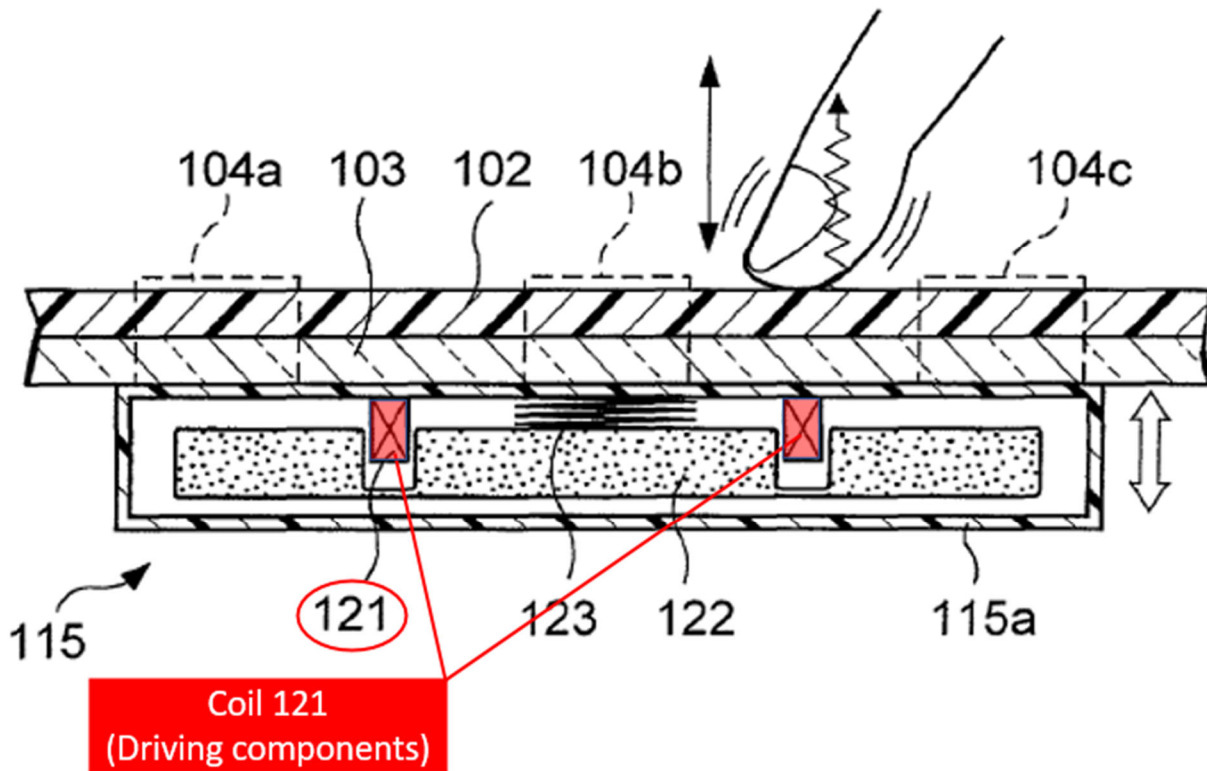


FIG. 24A

'830 Patent, Figs. 24A–B, 14:3–35. A POSITA would have recognized that the '830 patent discloses a linear magnetic force and movement of a moveable component that are parallel to an arced magnetic field for that finite portion of the magnetic field that is parallel to that linear direction.

193. It is my opinion, therefore, that Fukumoto discloses or suggests this limitation. See ¶¶169–171. Specifically, Fukumoto discloses coil 121 used to drive movable weight 122:



Fukumoto., Fig. 3 (annotated), 14:57–60. A POSITA would have recognized the magnetic fields are generated parallel to the direction of movable weight 112’s vibrational movement (i.e., so that moveable weight 112 moves up and down). In my opinion, Fukumoto teaches this limitation in the same way that the ’830 patent describes the limitation.

194. Therefore, Fukumoto discloses or suggests coil 121 (“the driving component comprises one or more electromagnetic coils”) “generate[s] magnetic

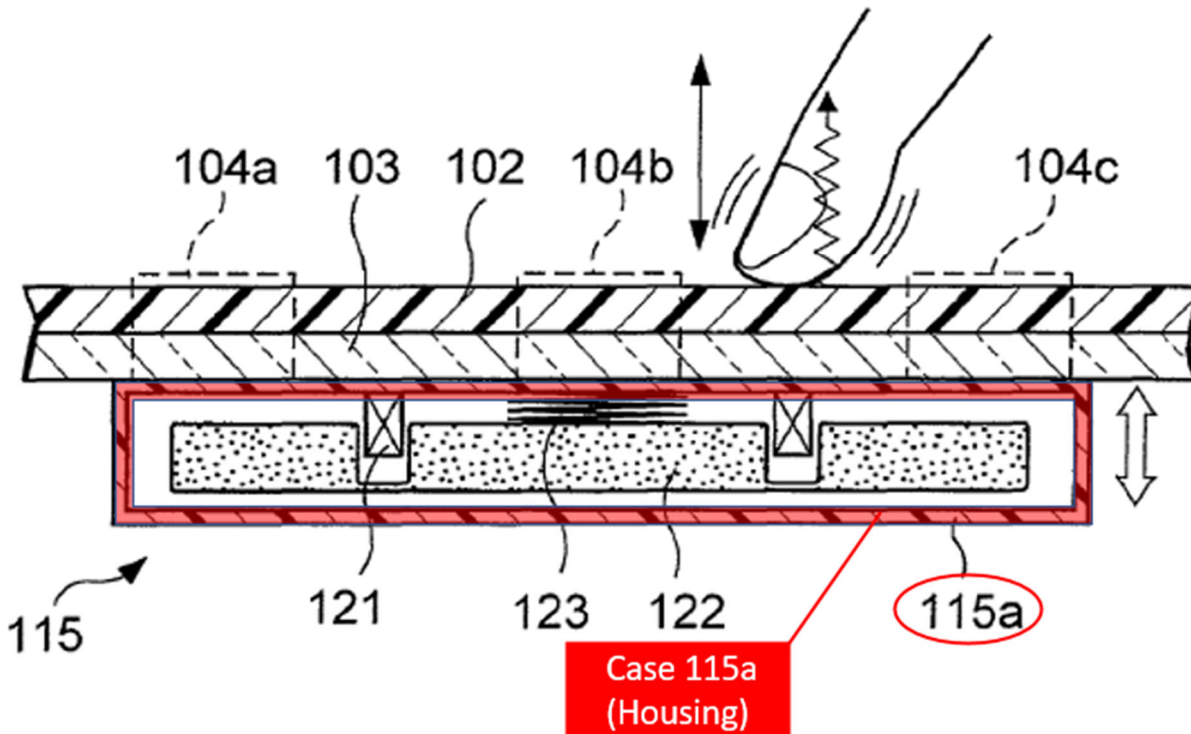
fields parallel to the directions in which the moveable component is driven by the driving component.”

5. Claim 8

195. It is my understanding that Claim 8 depends from claim 1 and further recites: “wherein the housing is a tube, capped at both ends by movable-component-repelling components selected from one of mechanical springs and magnets; wherein the movable component is a magnet shaped to slide within the tube; and wherein the driving component is an electromagnetic coil.” In my opinion, Fukumoto discloses or suggests these additional limitations.

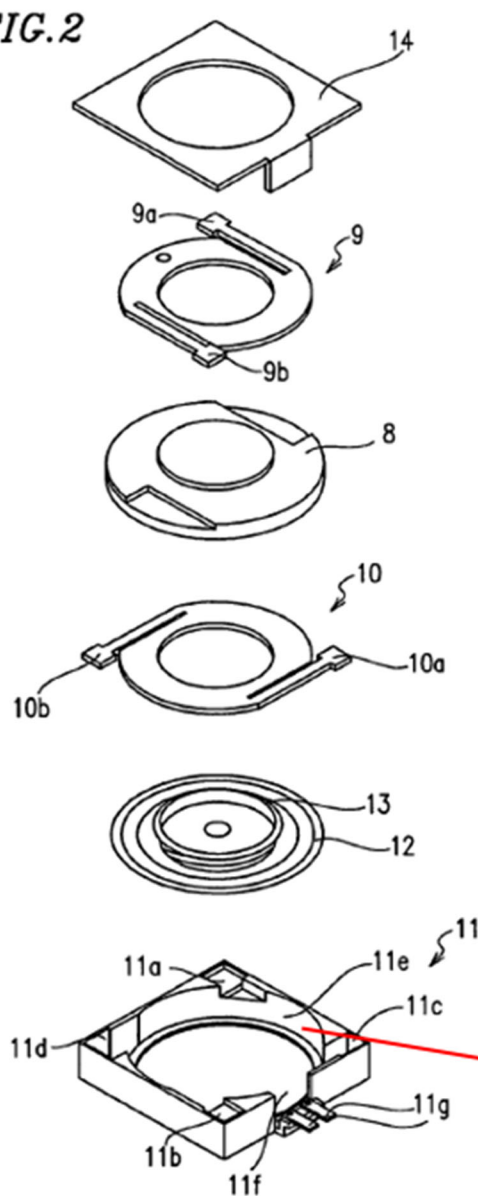
196. I understand PO contends in district court that a “tube” can have a rectangular cross-section: “the housing of the LVM in the Galaxy S22 Ultra is a linear tube, rectangular in cross-section.” EX1022, 61. To the extent this is correct,⁷ it is my opinion that Fukumoto’s case 115a teaches a housing that is a tube:

⁷ I understand Petitioners reserve the right to argue that a “linear tube” does not encompass a rectangular cross-section in other proceedings involving the challenged patent.



Id., Fig. 3 (annotated), 14:26–44. A POSITA would have recognized the cross-section of the housing as a design choice because the purpose of the housing, as claimed in the '830 patent, is to allow a magnet to “slide within the tube,” the magnet of which is further “shaped” to do so. '830*Pat.*, Claim 8. Saiki proves this by disclosing a housing that adopts *two* cross-sections: first, a circular “upper aperture 11e” of an overall square “plastic supporting member 11” making up a total “vibrator” depicted in the following exploded view of an “electro-mechanical-acoustic transducer”:

FIG. 2



**Vibrator 6
(Vibration module)**

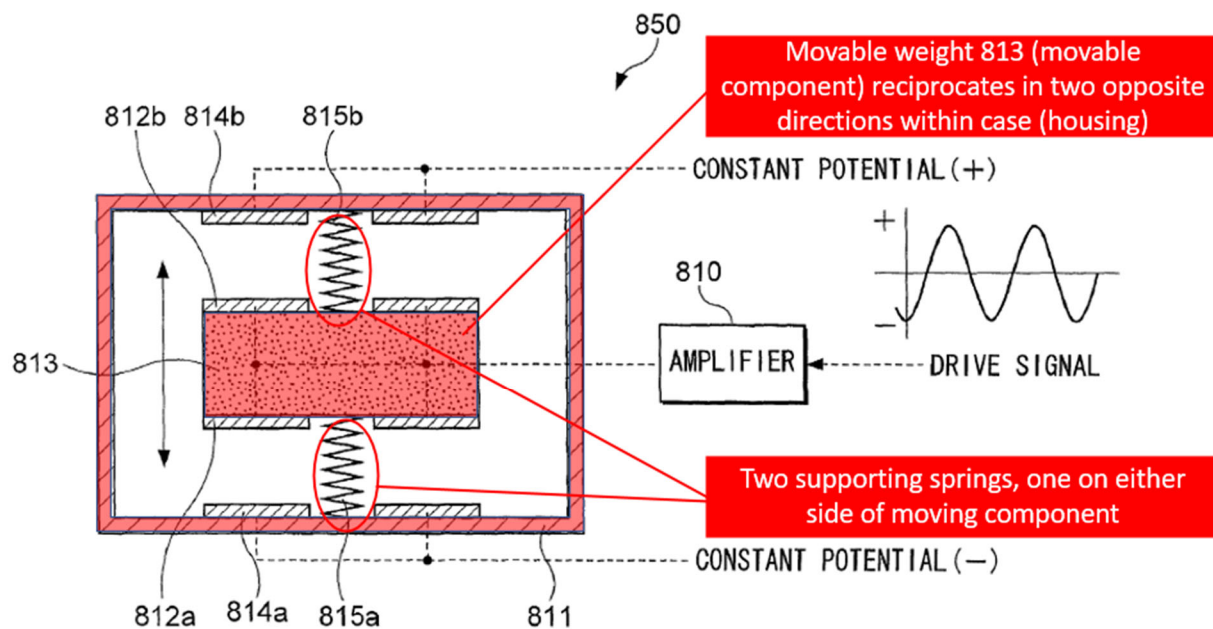
**Upper aperture 11e
(Housing is a tube)**

Saiki, Fig. 2 (annotated), 8:47–9:28. Thus, it is my opinion Fukumoto’s housing 115a discloses a housing that is a linear tube.

197. Additionally, a POSITA would have found it obvious for Fukumoto’s case 115a to be “capped at both ends by movable-component-repelling components selected from one of mechanical springs and magnets” as recited in ’830 Patent,

claim 8. As depicted in Fukumoto's Figure 3 above, one end of case 115a (the end attached to the electronic device) is capped by spring 123. *Fukumoto*, Fig. 3. A POSITA would have been motivated to modify oscillatory actuator 115 to accommodate two springs—one above and one below moveable weight 122—because Fukumoto expressly contemplates a variation using multiple springs. A POSITA would have been motivated to make such a modification to dampen the vibration forces without damage to other components such as the screen. A POSITA would have been motivated to modify the Figure 3 embodiment by placing a spring on the other end of the moveable weight to double the force of vibration created for greater effect while requiring less power as Fukumoto depicts in Figure 83:

FIG. 83



Id., Fig. 83 (annotated), 50:1–13.

198. Furthermore, when the “movable-component-repelling components” are mechanical springs, a POSITA would not have understood “capped” to require the springs to act as end caps; in other words, because mechanical coil springs ordinarily include open space, a POSITA would have understood that such springs would have been attached to a surface of the housing.

199. Next, Fukumoto discloses “the movable component is a magnet shaped to slide within the linear tube” because Fukumoto’s moveable weight 122 (“moveable component”) is a permanent magnet. *Id.*, 14:20-26, 34-35. In addition, moveable weight 122 slides within rectangular case 115a. *Id.*, 14:32-37. As discussed above, PO contends in district court that a “linear tube” can have a rectangular cross-section.

200. Finally, Fukumoto’s coil 121 (“driving component”) is an electromagnetic coil, as discussed in ¶¶ 169–171.

201. Therefore, Fukumoto discloses or suggests claim 8’s additional limitations.

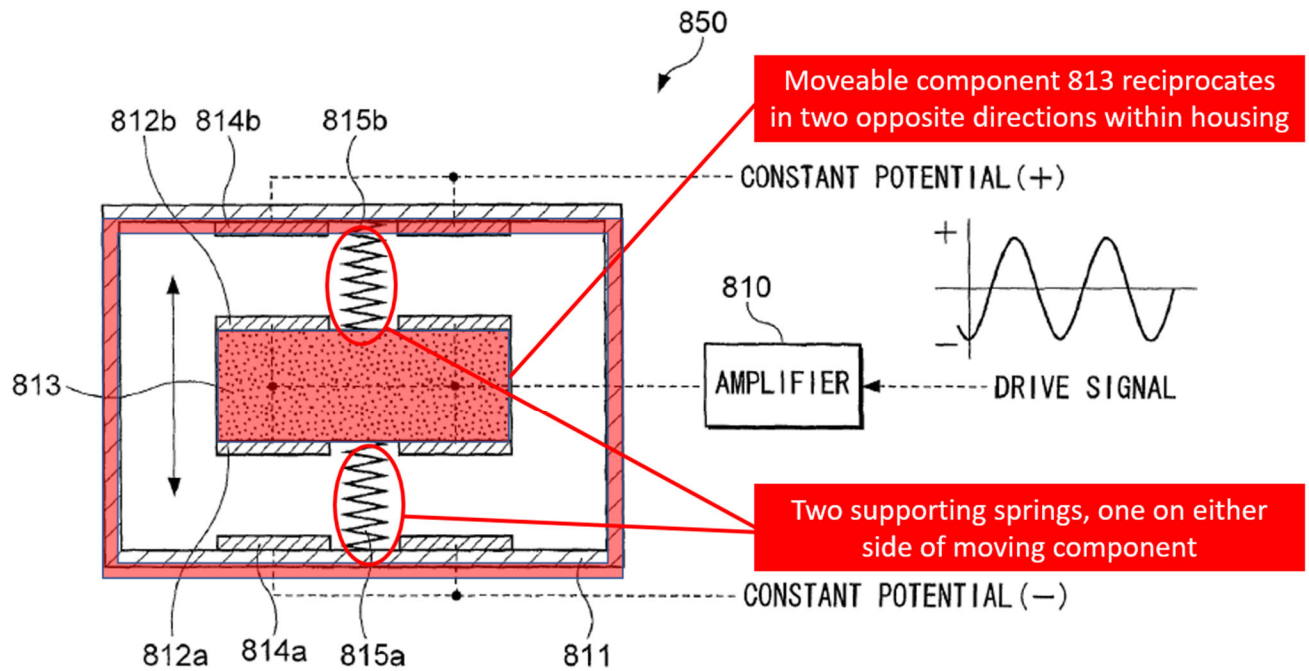
6. Claim 9

202. It is my understanding that Claim 9 depends from claim 1 and further recites “wherein the housing is a tube, capped at both ends by movable-component-repelling components; and wherein the moveable component includes an

electromagnetic-coil driving component and microprocessor.” In my opinion, the combination of Fukumoto and Dong teach the additional limitations of claim 9.

203. As discussed in ¶¶ 157–185 and 195–201, Fukumoto discloses or suggests the limitations of claim 1, as well as “the housing is a tube, capped at both ends by movable-component-repelling components.” For the limitation “the moveable component includes an electromagnetic-coil driving component,” Fukumoto discloses “a permanent magnet may be fixed in the case of the linear oscillatory actuator and a coil used as the movable weight.” *Fukumoto*, 49:1-3. In light of that disclosure, a POSITA would have been motivated to move the coils into the moving portion in Fukumoto’s Figure 3 embodiment discussed above for claim 1. Specifically, a POSITA would have been motivated to modify oscillatory actuator 115 to accommodate two springs—one above and one below moveable weight 122—because Fukumoto expressly contemplates a variation using multiple springs. A POSITA would have been motivated to make such a modification to dampen the vibration forces without damage to other components such as the screen. A POSITA would have been motivated to modify Fukumoto’s Figure 3 embodiment by placing a spring on the other end of the moveable weight to double the force of vibration created for greater effect while requiring less power as Fukumoto depicts in its Figure 83 embodiment:

FIG. 83



Id., Fig. 83 (annotated), 50:1–13.

204. Finally, regarding “the moveable component includes ... [a] microprocessor,” a POSITA would have recognized that in a linear vibration module a driving component may be in the moveable component, and further would have been motivated to also include the microprocessor in the moveable component to: (1) increase the mass of the moveable component and (2) eliminate the need for connections (e.g., wires) between the moveable component and the fixed components of the vibration module.

205. First, a POSITA would have recognized that adding components to the moveable weight would be a predictable way to increase its mass and that increasing

the mass of the moveable component would produce stronger vibrations. *Id.* Fukumoto itself supports this: “when the coil used as the movable weight does not have a sufficient mass, it is sufficient to use the coil as part of the weight having a suitable mass.” *Fukumoto*, 49:3-7. Consistently, Dong teaches that additional mass in the movable component can beneficially increase the vibration strength while adhering to strict size requirements for the portable electronic device. *See* Dong, 6 (explaining that the additional mass of “counterweight 15 functions to strengthen the vibrating force, making the vibration stronger”), 7 (“In practical applications, consumer electronics products are strictly required in thickness, that is, the thickness is required to be as small as possible”).⁸ Thus, in light of the teachings in Fukumoto as further supported by Dong, a POSITA would have been motivated to move

⁸ In this ground, I refer to Dong as support for the motivation to combine and not as an additional reference in this combination. I understand that Dong qualifies as prior art for claim 9 because that claim is entitled to a priority date no earlier than May 18, 2010. *See* Ex. 1028. Specifically, in the ’830 patent’s priority chain, certain limitations of claim 1 (“user-input features” and “frequency and amplitude specified by one or more stored values”) do not have support in the May 18, 2009 provisional. *See* Ex. 1029.

additional components of Fukumoto, including the processor, to increase the mass of the moveable component.

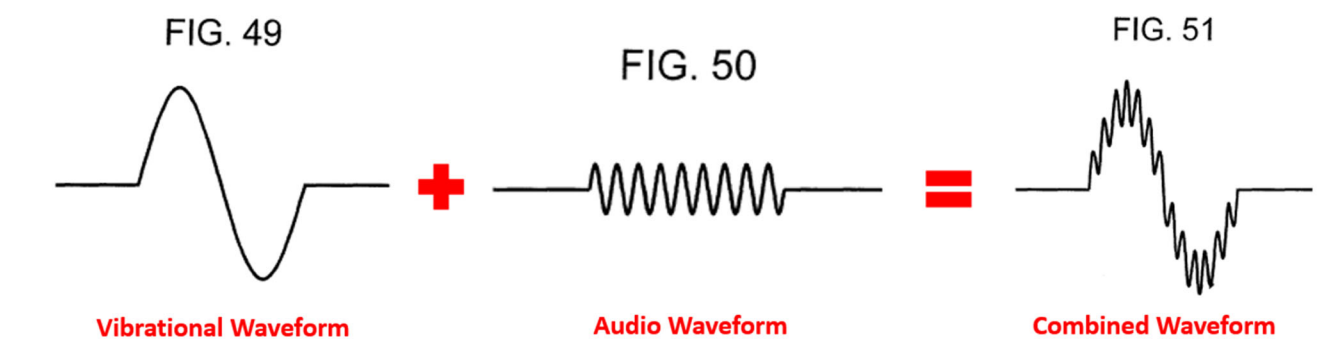
206. Second, when the coil is included in the moveable component, a POSITA would have recognized that coil would need to be connected through a wire to other components (e.g., processor, power supply) in the stationary portion of the vibration module, and would have recognized the drawbacks of such a wire (potential for breakage from repeated motion, possibility to interfere with the moveable component, etc.). Because of those drawbacks, a POSITA would have been motivated to eliminate wires connecting the moveable component to the stationary components, and a POSITA would have understood a predictable way to do this would be to move the components necessitating the wire(s) into the moveable component as well. Thus, a POSITA would have found it obvious to include the microprocessor in the moveable component when the electromagnetic-coil driving component is in the moveable component, to eliminate the need for wire(s) external to the moveable component. A POSITA would have had a reasonable expectation of success in making this modification which would require only changed to hardware layout within the skill of a POSITA.

207. Therefore, Fukumoto discloses or suggests the additional limitations of claim 9.

7. Claims 15 and 20

208. It is my understanding that Claim 15 depends from claim 1 and further recites “the control component drives simultaneous oscillation of the moveable component at two or more frequencies to generate complex vibration modes.” Claim 20 recites the same limitations as claim 1 along with the additional limitations of dependent claim 15. Fukumoto discloses or suggests this limitation.

209. For example, Fukumoto discloses that “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 also as a sound source.” *Fukumoto*, 18:15–17. In this embodiment, the oscillatory actuator 115 can be used as a speaker and vibrate the PDA simultaneously by combining both a vibration-causing waveform (Fig. 49) and a sound-causing waveform (Fig. 50) into one waveform used as a drive signal for the oscillatory actuator (Fig. 51):



Id., Figs. 49–51 (combined and annotated), 34:38–35:9. Specifically, “FIG. 51 is an example of the waveform of the drive signal for causing the oscillatory actuator 115

to generate vibration and sound simultaneously. The waveform shown in the figure is a combination of the waveform for generating vibration shown in FIG. 49 and the waveform for generating sound shown in FIG. 50.” *Id.*, 34:51–53. A POSITA would have recognized the different frequency and amplitude characteristics of the vibrational and audio waveforms (Figures 49 and 50, respectively) and that their combination into one would create a complex vibration mode driving Fukumoto’s moveable at the plurality of different frequencies depicted in Figure 51.

210. Therefore, Fukumoto discloses or suggests the additional limitation of claim 15 as well as claim 20.

8. Claim 17

211. It is my understanding that Claim 17 depends from claim 1 and further recites “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.” Fukumoto discloses or suggests this limitation. *See* ¶¶ 172–185. Specifically, a user’s input starts a sequence of CPU-driven events which results in a vibration of certain amplitude and frequency: a user touches a button or location of the touch panel; the CPU detects the touch location/button, reads the corresponding waveform data containing frequency and amplitude attributes from memory, and generates a drive signal sent to the oscillator actuator to vibrate

according to the prescribed amplitude and frequency of the specified waveform. *Id.*, Fig. 5, 13:54–14:25.

212. Thus, Fukumoto supplies power to the driving component to cause the moving portion to oscillate at the frequency and amplitude based on the waveform corresponding to the touch panel or key press (“at a frequency and an amplitude that are independently specified by user input received from the user-input features”).

C. Ground 1B: Fukumoto and Grant Renders Obvious Claims 1–3, 7–9, 15, 17, 20

1. Combination of Fukumoto and Grant

213. A POSITA would have found it obvious to implement Grant’s user-programmed haptic codes in Fukumoto’s mobile device. First, a POSITA would have recognized that Fukumoto and Grant are combinable because both are directed to electromagnetic vibration generation in mobile devices. *Fukumoto*, 14:38–15:4, 50:48–59, *Grant*, [0004], [0021], [0033].

214. Further, a POSITA would have been motivated to use Grant’s user-programmed haptic codes in Fukumoto’s mobile device to allow for user-driven customization of haptic effects. A POSITA would have recognized that the proposed combination would have amounted to the application of known programming steps and hardware (Grant’s user-input to modify a haptic code lookup table) to a known device ready for improvement (Fukumoto’s PDA with user-input features and

waveform table) to attain a predictable result (increased user control of the haptic feedback for a particular event). *Fukumoto*, 4:31–65 (describing a vibration mode in which part of a mobile device housing vibrates according to a parameter), 29:45–51 (differentiating vibration modes by changing vibration time and number of vibrations); *Grant*, [0034], [0057]–[0059] (describing user ability to program a mobile phone by associating distinct haptic effects with different events to distinguish between inputs, e.g., the difference between a high magnitude and short duration vibration emulating a “high-five” from a received email rather than the low amplitude, high frequency vibrations associated with a call from a spouse).

215. Further, a POSITA would have been motivated to use Grant’s user-programmed haptic codes in Fukumoto’s mobile device to allow for user-driven customization of haptic effects.

2. 1[pre]–[e].

216. As discussed in Sections ¶¶ 157–171 above, Fukumoto discloses or suggests 1[pre]–1[e].

3. 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”

217. As described in ¶¶ 172–185 above, Fukumoto discloses or suggests this limitation under a non-MPF or MPF construction.

218. To the extent PO argues Fukumoto does not disclose or teach that frequency and amplitude are specified by one or more stored values, it is my opinion that Fukumoto in combination with Grant teaches it. As discussed above, in Grant, memory 140 stores program code “that enables a user to map an event of interest to one of the haptic effects as provided, e.g., via user-interface 112 through API 190” in “one-to-one mappings” of events and haptic effects, which are “compiled into a haptic lookup table.” *Grant*, [0026]. A user can program the haptic lookup table using a touch screen. *Id.*, [0022], [0031], [0057] (“Bob can program the mobile phone, for example, via user-interface 112 through API 150 shown in FIG. 1, by inputting various events of interest and associating each with a distinct haptic effect”). Each haptic effect is tied to a haptic code of specific amplitude and frequency imparted to a mobile device by the actuator. *Id.*, [0037]–[0038] (disclosing extraction of a haptic code responsive to an event and sending a control signal to the actuator), [0034] (disclosing a haptic effect comprising “low-amplitude and high frequency vibrations” imparted on a mobile device (Bob’s phone) upon occurrence of a discrete, mapped event (wife Alice calling)).

219. Thus, a POSITA would have recognized that Grant discloses or suggests programming a haptic lookup table (populating “stored value”) via user-interface members 112, such as a touch screen (“user-input features”) to map a unique haptic effect (“frequency and amplitude specified”) to an event. In the

combination, a user would utilize Fukumoto’s user-input features to create or update a mapping between a desired haptic effect (including frequency and amplitude) and an event (“frequency and an amplitude specified by one or more stored values”). As discussed in ¶¶ 172–185, when that event occurs (e.g., a key press in Fukumoto), Fukumoto’s control component would cause its moveable component to oscillate at that frequency and amplitude (that the user specified in the lookup table in the combination) under either a MPF or non-MPF construction. As discussed above, a POSITA would have been motivated to use Grant’s user-programmed haptic codes in Fukumoto’s mobile device, for example, to allow for user-driven customization of haptic effects.

4. Claims 2–3, 7–9, 15, and 20

220. As discussed in ¶¶ 186–210 above, Fukumoto discloses or suggests Claims 2–3, 7–9, 15, and 20. Because those claims depend from claim 1 or in the case of claim 20 recites the same limitations as claim 1 along with additional limitations, they would have also been obvious over the combination of Fukumoto and Grant.

5. Claim 17

221. Claim 17 depends from claim 1 and further recites “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.”

222. To the extent PO argues Fukumoto does not disclose or suggest this limitation, Fukumoto in combination with Grant teaches it. As discussed in ¶¶ 91–93, Grant teaches a handheld communication device “that enables a user to map an event of interest to one of the haptic effects as provided, e.g., via user-interface 112 through API 190” in “one-to-one mappings” of events and haptic effects, which are “compiled into a haptic lookup table.” *Grant*, [0026], [0022], [0031], [0037]–[0038], [0057] Grant discloses a user’s ability to customize haptic effects to include “low-amplitude and high frequency vibrations” when receiving a call from a spouse, or “jolt-like pulses” of different amplitude and frequency when associated with an emergency (e.g., 911 call) event. *Id.*, [0034]. A POSITA would have recognized Grant’s device enables a user, when programming haptic codes, to achieve desired haptic effects by independently varying amplitude and frequency attributes of the haptic effects (e.g., change one but not the other, lower one and increase the other, etc.).

223. Thus, Grant causes a mobile device to vibrate (“oscillate”) at a particular frequency and amplitude corresponding to the exact haptic code programmed by a user (“at a frequency and an amplitude that are independently specified by user input”) the user inputs into the device at a touch screen (“received

from user-input features”). The Fukumoto-Grant combination as well as motivation to combine discussed above in ¶¶213–215, 219 for limitation 1[f] apply equally to claim 17.

D. Ground 1C: Fukumoto and Barton Renders Obvious Claims 1–3, 7–9, 15, 17, and 20

1. Combination of Fukumoto and Barton

224. A POSITA would have found it obvious to implement Barton’s user-programmed vibration patterns in Fukumoto’s mobile device. First, a POSITA would have recognized that Fukumoto and Barton are combinable because both are directed to vibration generation in mobile devices. *Fukumoto*, 14:38–15:4, 50:48–59; *Barton*, [0005], [0014].

225. Further, a POSITA would have been motivated to use Barton’s user-programmed vibration patterns in Fukumoto’s mobile device to allow for user-driven customization of vibration effects. A POSITA would have recognized that the proposed combination would have amounted to the application of known programming steps and hardware (Barton’s user-input to modify a vibration or haptic pattern) to a known device ready for improvement (Fukumoto’s PDA with user-input features and waveform table) to obtain a predictable result (increased user control of vibrating or haptic feedback for a particular event). *Fukumoto*, 4:31–65, 29:45–51; *Barton*, [0005], [0014], [0026], [0028]–[0039].

2. 1[pre]–[e]

226. As discussed in ¶¶ 157–166 above, Fukumoto discloses or suggests 1[pre]–1[e].

3. 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”

227. As described in ¶¶ 172–185 above, Fukumoto discloses or suggests this limitation under a non-MPF or MPF construction.

228. To the extent PO argues Fukumoto does not disclose or teach that frequency and amplitude are specified by one or more stored values, Fukumoto in combination with Barton teaches it. As discussed above, in Barton, mobile device 100 includes vibration application 115 loaded onto memory 104 and vibration device 118. *Barton*, [0022]–[0024]. The vibration device 118 and haptic device 120 are “directly coupled to the power supply 116” so that each remains powered on “for a duration dictated by [a] notification mechanism or other control.” *Id.*, [0024]. As shown in Fig. 2A, if a user chooses to use an in-call profile (202) to use customized in-call vibration-type alerts (206, 212, 214) and the user selects an existing vibration pattern (218) (green), the in-call application 113 checks for a vibration pattern in storage location 114:

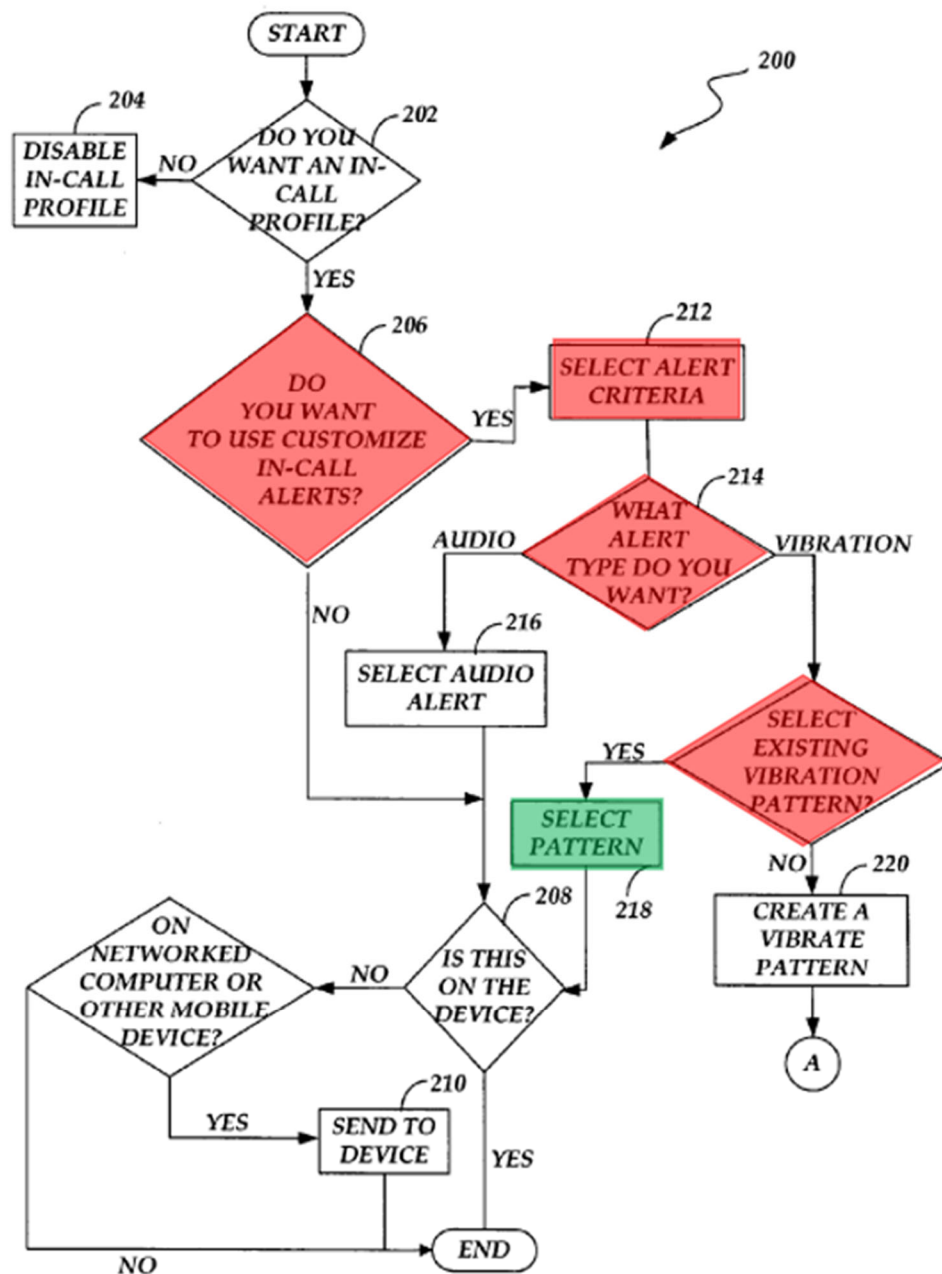


Fig. 2A

Id., Fig. 2A (annotated), [0033]. Additionally, “[t]he user using the vibration application 115 can create and/or edit vibrate patterns which are used by the mobile device 100 to control the operation of the vibration device 118... the user can use a

sliding scale or other means to define various vibrate intensities, frequencies ... by sliding a slider along the scale or inputting numbers which correspond to a particular amount or level.” *Id.*, [0038]. Using the mobile device’s user interface (e.g., buttons, soft keys, or a touch-sensitive display), a user can select various alert settings according to the type of notification event,” including “vibrating feedback.” *Id.*, [0005], [0014], [0021].

229. Thus, a POSITA would have recognized that Barton discloses or suggests a user programming vibration patterns (“user inputs”) via a user interface (e.g., buttons, soft keys, or a touch-sensitive display) (“user-input features”) to select a vibration pattern previously created and/or edited with user-defined vibrate intensity (“amplitude specified”) and vibration frequency (“frequency. . .specified”). In the combination, a user would utilize Fukumoto’s user-input features to create or update a mapping between a vibrate pattern (including frequency and amplitude) and an event (“frequency and an amplitude specified by one or more stored user values”). As discussed in Section XI.B.1.g), when that event occurs (e.g., a key press in Fukumoto), Fukumoto’s control component would cause its moveable component to oscillate at that frequency and amplitude (that the user specified in the lookup table in the combination) under MPF or non-MPF. As discussed above, a POSITA would have been motivated to use Barton’s user-programmed vibration patterns in

Fukumoto's mobile device, for example, to allow for user-driven customization of vibration patterns associated with a specific event.

4. Claims 2–3, 7–9, 15, 20

230. As discussed in ¶¶ 186–210 above, Fukumoto discloses or suggests claims 2–3, 7–9, 15, and 20. Because those claims depend from claim 1 or in the case of claim 20 recites the same limitations as claim 1 along with additional limitations, they would have also been obvious over the combination of Fukumoto and Barton.

5. Claim 17

231. Claim 17 depends from claim 1 and further recites “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.”

232. To the extent PO argues Fukumoto does not disclose or suggest this limitation, Fukumoto in combination with Barton teaches it. As discussed in ¶¶ 94–97, Barton teaches mobile device 100 includes vibration application 115 loaded onto memory 104 and vibration device 118. *Barton*, [0022]–[0024]. Using the mobile device's user interface (e.g., buttons, soft keys, or a touch-sensitive display), a user can select various alert settings according to the type of notification event,”

including “vibrating feedback.” *Id.*, [0005], [0014], [0021]. Specifically, “[t]he user using the vibration application 115 can create and/or edit vibrate patterns which are used by the mobile device 100 to control the operation of the vibration device 118... the user can use a sliding scale or other means to define various vibrate intensities, frequencies ... by sliding a slider along the scale or inputting numbers which correspond to a particular amount or level.” *Id.*, [0038]. Vibration device 118 “can be used to give feedback to the user such as for alerting the user of a newly arrived message and other information.” *Id.*, [0024]. A POSITA would have recognized and found it obvious that Barton’s device enables a user, when programming vibration patterns, to achieve desired patterns by independently varying amplitude (“vibrate intensities”) and frequency attributes of those patterns (e.g., change one but not the other, lower one and increase the other, etc.).

233. Thus, Barton causes a mobile device to vibrate (“oscillate”) at a particular frequency and intensity corresponding to the vibration pattern programmed by a user (“at a frequency and an amplitude that are independently specified by user input”) with the user inputs (“received from user-input features”). The Fukumoto-Barton combination as well as motivation to combine discussed above in ¶¶ 224–225, 229 for limitation 1[f] apply equally to claim 17.

E. Ground 1D: Fukumoto and Ueda Renders Obvious Claims 3-6.

1. Combination of Fukumoto and Ueda

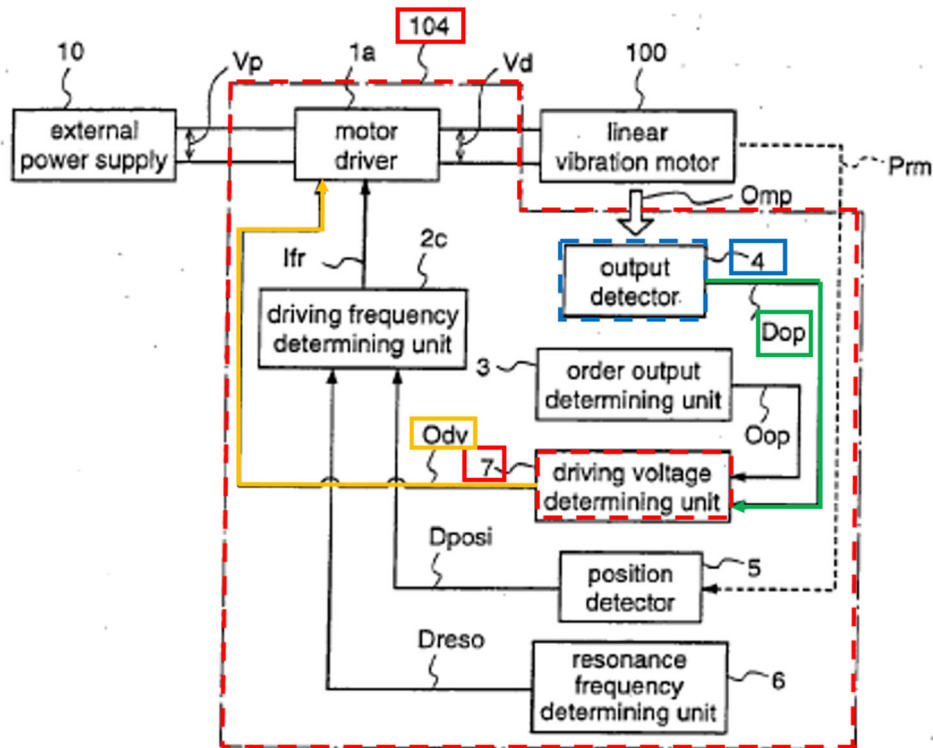
234. A POSITA would have been motivated to combine Fukumoto's mobile device utilizing an oscillatory actuator with Ueda's feedback control. First, a POSITA would have recognized that Fukumoto and Ueda are compatible because they are both directed to vibration generation in mobile devices. *Fukumoto*, Abstract, 37:5–12, Fig. 81; *Ueda*, Abstract, [0339]–[0349], Fig. 14. Further, a POSITA would have recognized that the proposed combination would have amounted to no more than applying a known technique (Ueda's feedback control) to a known device ready for improvement (Fukumoto's mobile device including its oscillatory actuator) to yield predictable results (an oscillatory actuator using feedback control to achieve the desired vibration output). Additionally, a POSITA would also have been motivated to use additional sensors such as Ueda's output and position detection sensors in Fukumoto to provide enhanced feedback control to Fukumoto's oscillatory actuator because a POSITA would have recognized that doing so would result in Fukumoto's mobile device more reliably delivering vibrations at the desired frequency and amplitude. *Ueda*, [0165]–[0166], [0347].

2. Claim 3

235. As I discussed above in ¶¶ 188–191, Fukumoto discloses or suggests the additional limitations of claim 3 under a non-MPF construction. To the extent

PO argues Fukumoto fails to disclose or suggest these limitations as non-MPF, it is my opinion that they would have been obvious based on Fukumoto in view of Ueda. In addition, for the reasons discussed below, it is my opinion that claim 3 would have been obvious based on Fukumoto and Ueda under a non-MPF or MPF construction.

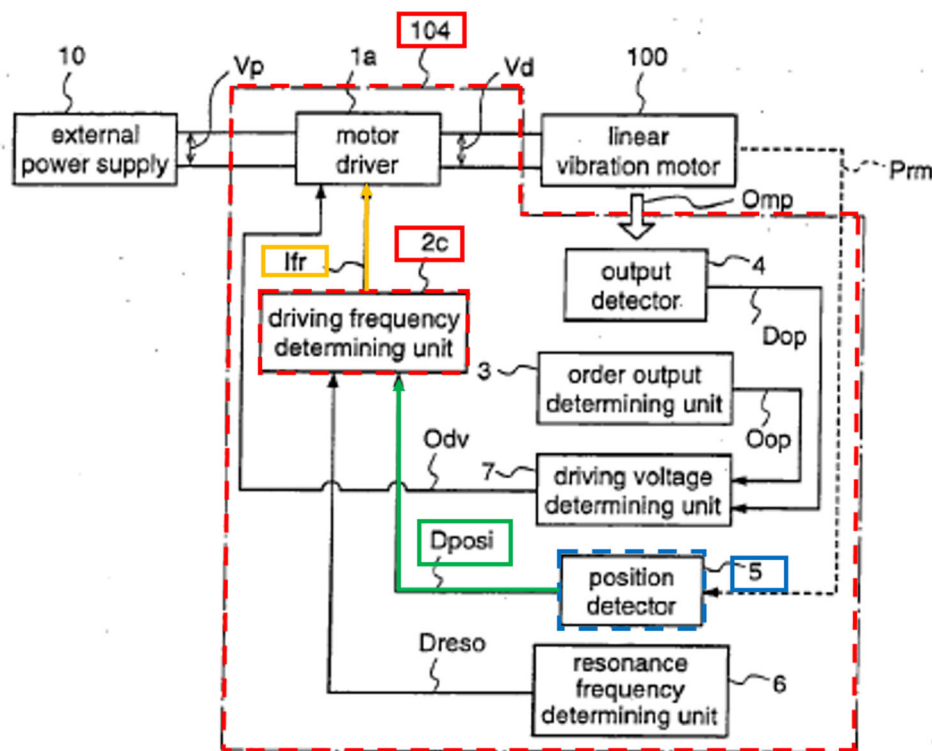
236. As to non-MPF, Ueda discloses closed-loop feedback control for a linear vibration motor based on the output from multiple sensors. For example, Ueda teaches “motor driving apparatus 104 includes an output detector 4 for detecting the motor output generated by the linear vibration motor 100 and outputting an output detection signal Dop indicating the detected motor output.” *Ueda*, [0141]. Driving voltage determining unit 7 receives “the output detection signal Dop from the output detector 4 and determines an amplitude value of the driving voltage of the linear vibration motor 100, i.e., an amplitude value of the AC voltage Vd to be supplied from the motor driver 1a to the linear vibration motor,” by comparing the detected signal (Dop) with the desired output signal (Oop). *Id.*, [0149]. Based on this comparison, the amplitude value “is changed to a larger value when the detected output Dop is smaller than the order output Oop, and conversely, the amplitude value of the AC voltage Vd is changed to a smaller value when the detected output Dop is larger than the order output Oop.” *Ueda*, [0162].



Ueda, Fig. 4(a) (annotated).

237. Additionally, Ueda teaches this for a second sensor (position detector 5). In particular, Ueda teaches “motor driving apparatus 104 further includes a position detector 5 for detecting the position of the reciprocating mover of the linear vibration motor 100, and outputting a position detection signal Dposi indicating the detected mover position.” *Id.*, [0142]. Ueda further teaches “when the output AC voltage Vd of the motor driver is applied to the linear vibration motor 100 ... a position Prm of the reciprocating mover of the linear vibration motor 100 is detected by the position detector 5, and a position detection signal Dposi... is output from the position detector 5 to the driving frequency determining unit 2c,” where “a driving

frequency of the linear vibration motor 100 is determined on the basis of the position detection signal Dposi from the position detector 5.” *Id.*, [0157]-[0159]. When the position detection signal Dposi indicates “the detected position does not exceed a predetermined reference position, the driving frequency of the linear vibration motor 100 is set at the resonance frequency,” but when the position detection signal Dposi exceeds the reference position “the driving frequency of the linear vibration motor 100 is set at a frequency higher than the resonance frequency.” *Id.*, [0160].



Id., Fig. 4(a) (annotated).

238. Therefore, Ueda discloses receiving Dop (“output signal”) from output detector 4 (“sensor”) and receiving $Dposi$ (“output signal”) from position detector 5

(“sensor”) during operation of the linear vibration motor 100 (“linear vibration module”), and adjusting amplitude based on Dop and adjusting frequency based on Dposi (“adjusts one or more operational control outputs of the control component according to the received output signals from the sensors”).

239. In the combination, Fukumoto’s control component would receive the output signals from sensors as taught in Ueda and adjust the operational control outputs according to those signals. As discussed above, a POSITA would have been motivated to use Ueda’s feedback control with the oscillatory actuator of Fukumoto, for example, so that Fukumoto’s mobile device more reliably delivers vibrations at the desired frequency and amplitude.

240. Therefore, Fukumoto in view of Ueda teaches the additional limitations of claim 3 under a non-MPF construction.

241. For MPF, the Fukumoto-Ueda combination discloses or suggests the additional function recited in claim 3 (“receives output signals from sensors within the linear vibration module during operation of the linear vibration module and adjusts one or more operational control outputs of the control component according to the received output signals from the sensors”) for the reasons discussed above. In addition, Fukumoto teaches the corresponding structure for claim 1 as discussed in ¶ 124. For the additional function recited in claim 3, the corresponding structure includes a processor programmed with an algorithm to perform the following

additional steps: (1) convert the received output signal into an integer, (2) compare that integer to an expected value, and (3) adjust one or more operational control outputs based on that comparison.

242. First, Ueda teaches converting Dop (the received output signal from output detector 4) into an amplitude value and converting Dposi (the received output signal from position detector 5) into a frequency. *Ueda*, [0149], [0152]. Second, Ueda compares each of those converted values against an expected value (amplitude against output order signal Oop and frequency against Dres0). *Ueda*, [0149], [0152]-[0153]. Finally, Ueda adjusts driving voltage and frequency (operational control outputs) based on those comparisons. *Ueda*, [0149], [0152]-[0153]. For the reasons discussed above, Ueda teaches a processor programmed with an algorithm to perform the additional steps in the corresponding structure for claim 3. And as discussed above, a POSITA would have been motivated to use Ueda's feedback control (which includes those additional steps) with the oscillatory actuator of Fukumoto, for example, so that Fukumoto's mobile device more reliably delivers vibrations at the desired frequency and amplitude.

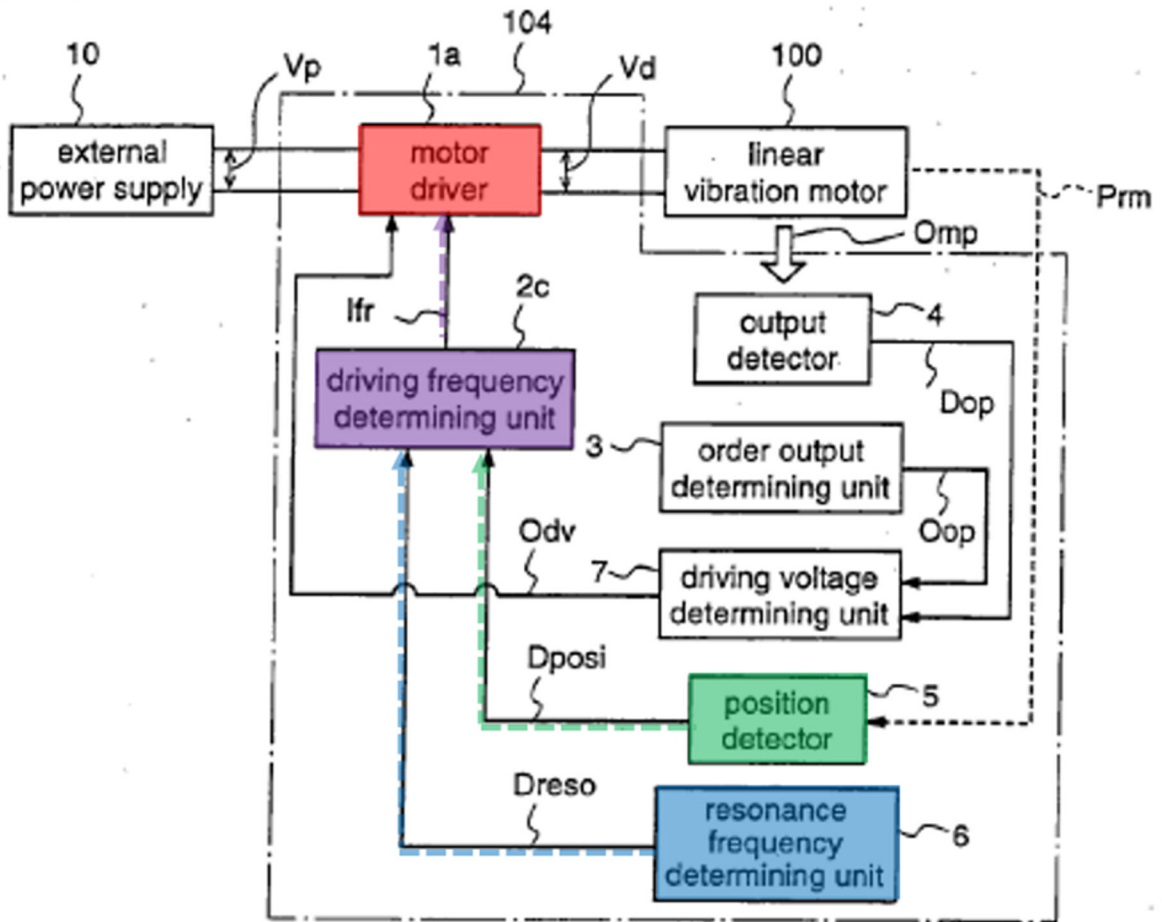
243. In sum, Fukumoto in combination with Ueda teaches the additional limitations of claim 3 under either a non-MPF or MPF construction.

3. Claim 4

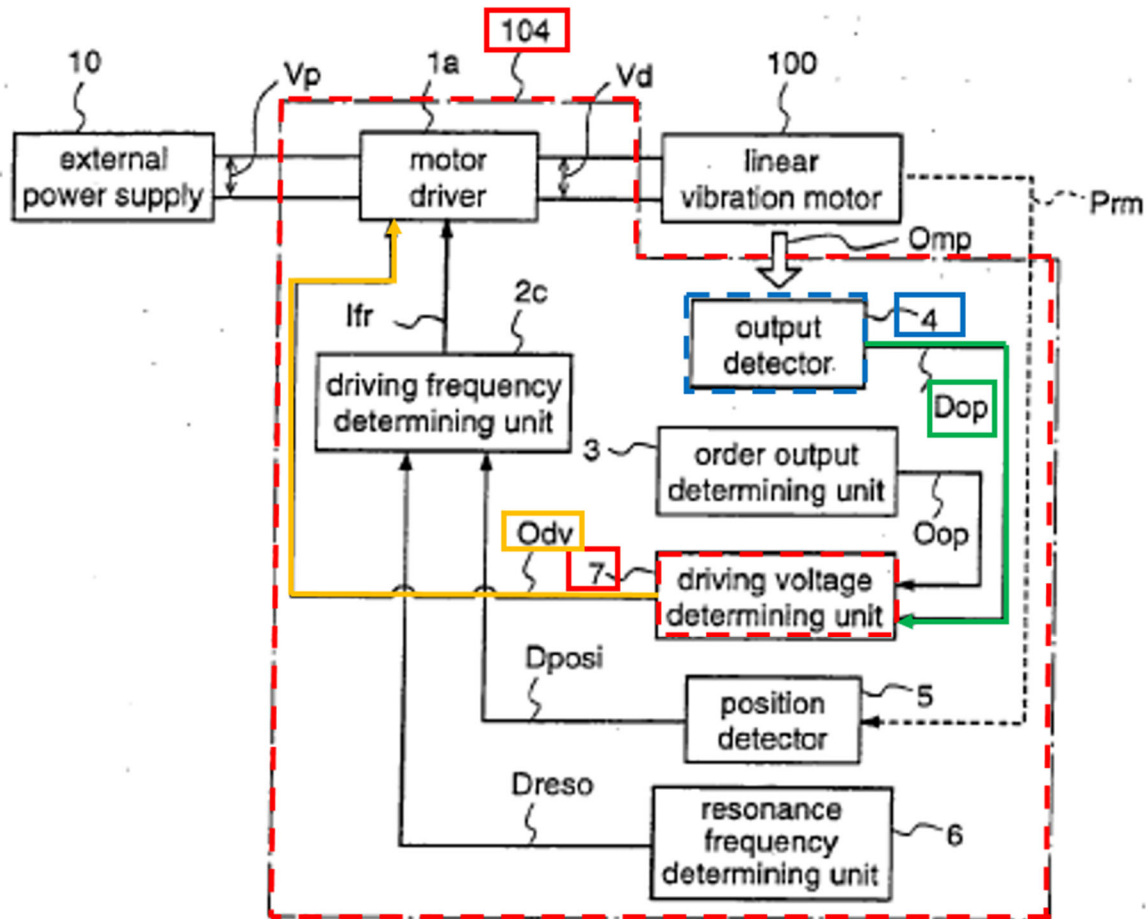
244. In my opinion, Fukumoto in combination with Ueda teaches the additional limitations of claim 4. As an initial matter and as discussed above in ¶¶ 125–126, “[t]he one or more operational control outputs of the control component,” “the sensors,” and “the one or more sensors” in claim 4 do not have proper antecedent basis. For this limitation, Petitioners address multiple possible interpretations, namely, (1) the first two terms should be “~~the~~ one or more operational control outputs of the control component” and “~~the~~ sensors,” and (2) this claim should depend from claim 3 rather than claim 1. Under either interpretation, Fukumoto in combination with Ueda teaches the additional limitations of claim 4.

245. As described above, Ueda’s “motor driving apparatus 104” includes a linear vibration motor 100 with sensors including output detector 4 and position detector 5 used to sense and output respective signals Dop and Dposi. *See* ¶¶ 235–243. Ueda’s apparatus further includes a resonance frequency determining unit 6 that outputs “Dreso,” a “resonance frequency signal,” to the driving frequency determining unit 2c along with position detection signal Dposi. *Ueda*, [0142]–[0143].

Fig.4 (a)



Id., Fig. 4(a) (annotated). Ueda provides operational control outputs (driving frequency Ifr, driving voltage Odv) to the linear vibration motor based on the received outputs from the output and position detectors (4, 5) and resonance frequency determining unit (6) so that the motor output (output detection signal Dop) approaches the desired motor output (output order signal Oop) and the position of the mover (position detection signal Dposi) is controlled to be within a desired range. Ueda, [0140], [0156], [0160]-[0162], [0169]-[0175].



Ueda, Fig. 4(a) (annotated). A POSITA would have been motivated to combine Ueda's feedback control with Fukumoto for the same reasons I discussed above in ¶ 234.

246. Thus, Fukumoto in view of Ueda teaches the additional limitations of claim 4 under a non-MPF construction. Because the corresponding structure for claim 4 is the same as for claim 3, as I discussed in ¶ 124, Fukumoto in view of Ueda also teaches the additional limitations of claim 4 under a MPF construction.

4. Claim 5

247. In my opinion, Fukumoto in combination view of Ueda discloses the additional limitations of claim 5. As discussed above, Fukumoto in combination with Ueda discloses the limitations of dependent claim 4. As I discussed above in ¶¶ 235–246, one of Ueda’s operational control parameters is an output order signal (Oop), which is the desired strength of vibration produced by linear vibration motor 100. Thus, Ueda teaches one of the “operational control parameters is a strength of vibration produced by the linear oscillation of the moveable component.” *Id.*

248. One of Ueda’s operational control outputs is a driving frequency (Ifr) derived from the combination of position detector signal Dposi and resonance frequency determining unit signal Dreso. When Ifr is set to a resonant driving frequency, the control component (motor driving apparatus 104) drives the moveable component to linearly oscillate by dynamically adjusting the power supplied to the driving component to produce linear oscillation at resonant frequency. *Ueda*, [0157]–[0160]. Driving frequency determining unit 2c adjusts the power supplied to the driving component as part of a standard closed-loop feedback control system. *Ueda*, [0152]–[0153]. Based on Ueda’s disclosure, a POSITA would have understood that in Ueda, the detected position of the mover (Dposi) is compared to an expected position based on the resonant frequency signal (Dreso), then the driving frequency is dynamically adjusted to match the resonant frequency

by adjusting the power to the motor. *Id.*. In the case of the handy phone, the driving frequency is adjusted to create more powerful (stronger) vibrations in the phone. *Ueda*, [0345]-[0347], [0349]. Thus, Ueda teaches “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.”

249. A POSITA would have been motivated to combine Ueda’s feedback control with Fukumoto for the same reasons I discussed above in ¶ 234.

5. Claim 6

250. In my opinion, Fukumoto in view of Ueda teaches the additional limitations of claim 6. As discussed above, Fukumoto in combination with Ueda discloses the limitations of dependent claim 4. As discussed above in ¶¶ 235–249, Ueda discloses an operational control parameter is strength of vibration. Ueda further discloses where one operational control parameter is a mode determined by a pattern of vibrations. *Ueda*, [0345]–[0346]. Therefore, Ueda discloses the operational control parameters include “both a strength of vibration produced by the linear oscillation of the moveable component and a current operational mode.”

251. In addition, Ueda discloses one of the operational control outputs is a frequency (*I*_{fr}) at which the control component (motor driving apparatus 104) drives

the moveable component to linearly oscillate. Ueda also discloses one of the operational control outputs is a driving voltage (Odv) which is fed to the motor driver from the driving voltage determining unit 7 to determine “an amplitude value of an AC voltage” supplied to the linear vibration motor. *Ueda*, [0108]–[0110], [0141], [0149]. Ueda further discloses the resonance frequency determining unit 6 adjusts the AC current supplied to linear vibration motor 100 by adjusting the phase, frequency, and amplitude of the AC current. *Id.* Thus, Ueda teaches “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 linearly oscillate.”

252. A POSITA would have been motivated to combine Ueda’s feedback control with Fukumoto for the same reasons I discussed above in ¶ 234.

F. Ground 1E: Fukumoto and Grant in view of Ueda Renders Obvious Claims 3–6

253. As I discussed above, ¶¶ 234–252 explains that Fukumoto in combination with Ueda renders obvious claims 3-6. Fukumoto in combination with Grant and Ueda also renders claims 3-6 obvious. For this ground, the additional teachings of Ueda discussed in ¶¶ 234–252 would be combined with the Fukumoto-Grant combination discussed in ¶¶ 213–223. A POSITA would have been motivated

to combine the relied upon teachings from Ueda with the Fukumoto-Grant combination for the same reasons as with Fukumoto alone. *See* ¶¶ 213–215, 234.

G. Ground 1F: Fukumoto and Barton in view of Ueda Renders Obvious Claims 3–6

254. As I discussed above, ¶¶ 234–252 explains that Fukumoto in combination with Ueda renders obvious claims 3-6. Fukumoto in combination with Barton and Ueda also renders claims 3-6 obvious. For this ground, the additional teachings of Ueda discussed in ¶¶ 234–252 would be combined with the Fukumoto-Barton combination discussed in ¶¶ 224–233. A POSITA would have been motivated to combine the relied upon teachings from Ueda with the Fukumoto-Barton combination for the same reasons as with Fukumoto alone. *See* ¶¶ 224–225, 234.

H. Ground 1G: Fukumoto and Erixon Renders Obvious Claims 7 and 8

1. Combination of Fukumoto and Erixon

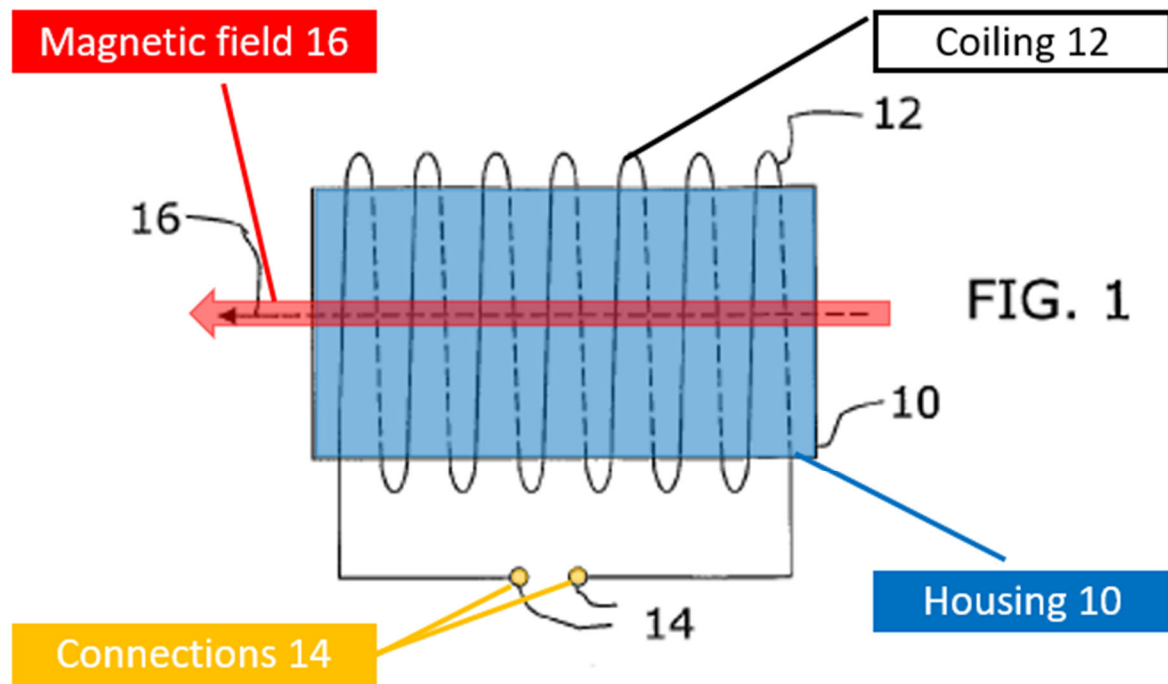
255. A POSITA would have found it obvious to apply the teachings of Erixon’s electromagnetic vibrator for use in a mobile phone with Fukumoto’s mobile device. First, a POSITA would have recognized that Fukumoto and Erixon are combinable because they are both directed to electromagnetic vibration generation in mobile devices using compact and energy efficient vibrators. *Fukumoto*, Fig. 3, Fig. 16, 14:38–15:4, 16:17–37, 50:48–59; *Erixon*, Abstract, Figs. 1, 2, [0002],

[0053], [0075], [0099], [0102]. Further, A POSITA would have recognized that the proposed combination would have amounted to no more than applying a known technique (Erixon's linear vibrator driven by electromagnetic coils and movement-repelling centering magnets in a linear housing surrounded by magnetic field-enhancing ferrofluid) to a known device ready for improvement (Fukumoto's mobile device including a linear oscillatory actuator driven by electromagnetic coils that uses a single spring in a case) to yield predictable results (a mobile device with a smaller and more efficient vibration unit). Additionally, a POSITA would also have been motivated to make this combination to increase the responsiveness and efficiency of the linear movement by adding conductive ferrofluid that simultaneously decreases the linear friction created by the linear vibrator's movement, which further decreases the amount of power required to achieve quicker vibrational effects and improves battery life of the mobile device. *Erixon*, Abstract, [0073]–[0074], [0106].

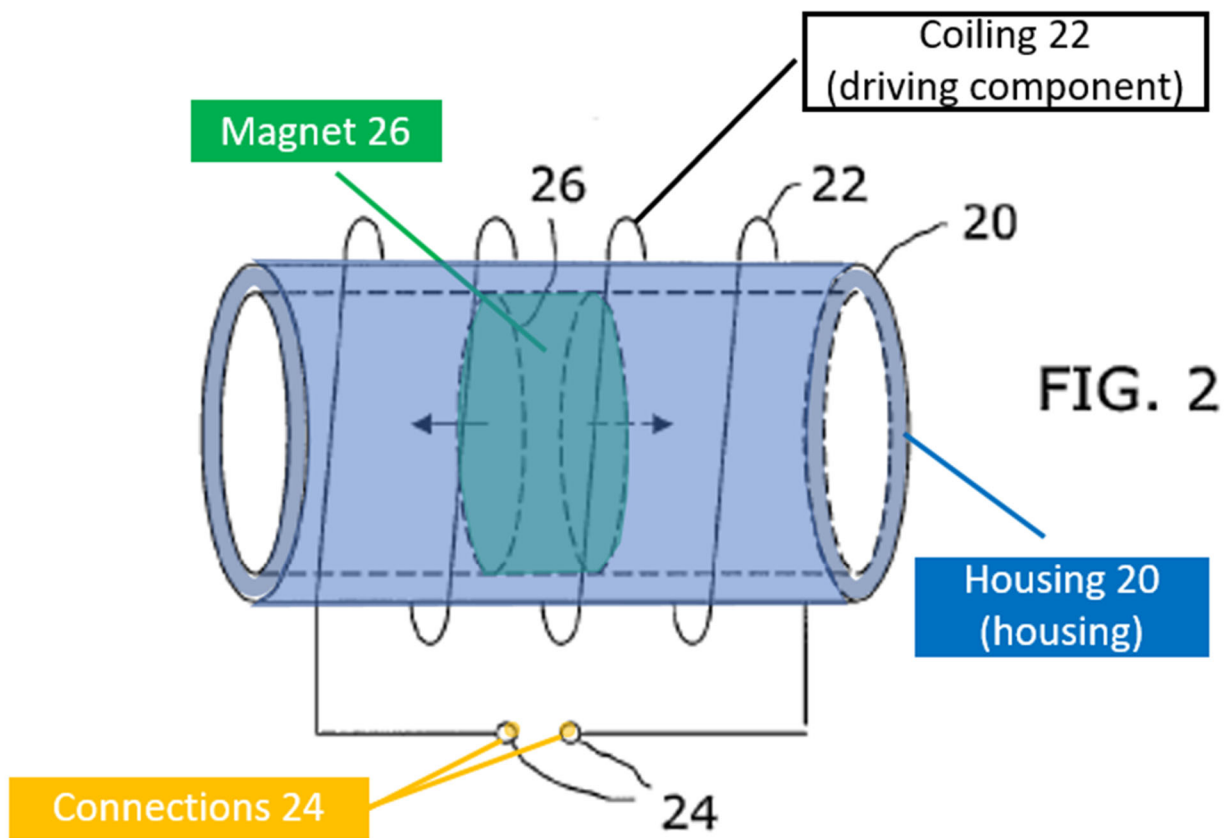
2. Claim 7

256. As I described in ¶¶ 192–194, above, Fukumoto discloses this limitation. To the extent PO argues Fukumoto does not disclose or suggest this limitation, Fukumoto in combination with Erixon teaches it. Erixon discloses an electromagnetic vibrator including a housing, coiling, permanent magnet assembly “arranged for motion along [a] track,” and ferrofluid mixture. *Erixon*, Abstract,

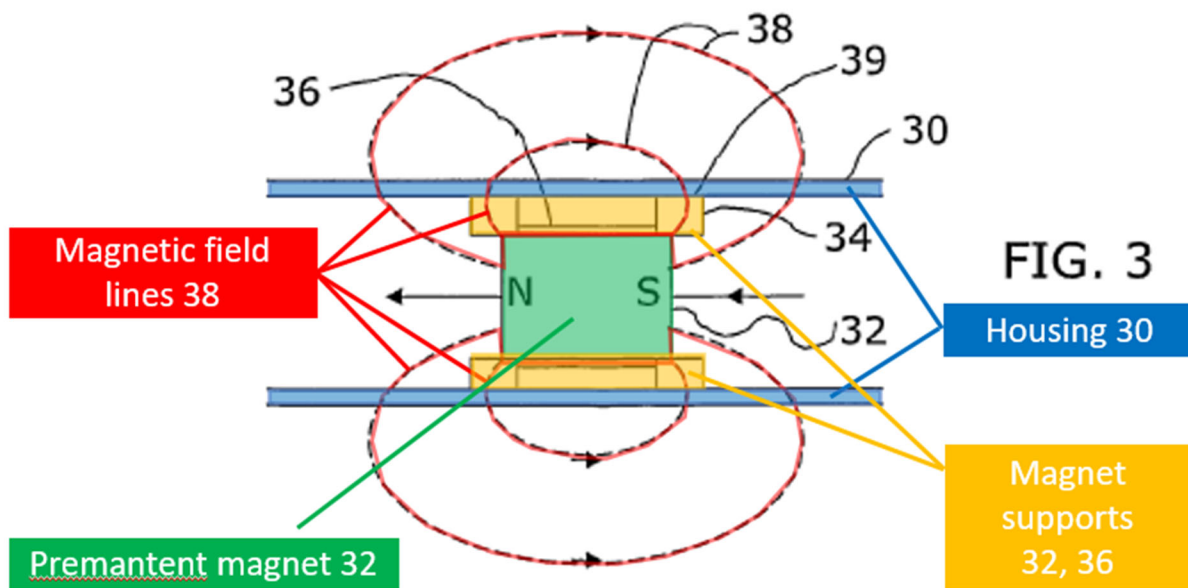
[0011]–[0015], [0037], [0102]. Voltage supplied to the coiling creates a magnetic field 16 “directed along the long axis of the housing” and interacts with a magnetic field from the axially-sliding magnet. *Id.*, [0055]–[0057].



Id., Fig. 1 (annotated). A magnetic axis of the sliding magnet is “parallel with the symmetry axis of the cylindrical housing” such that “the directions of the magnetic axis and the center of the magnetic field, created by the coiling, coincide.” *Id.*, [0056].



Id., Fig. 2 (annotated). Magnetic field lines 38 are “approximately parallel with the normal to the surface of the interface 39.” *Id.*, [0072].



Id., Fig. 3 (annotated). [0063]–[0064]. Therefore, Erixon discloses or suggests its coiling (“the driving component comprises one or more electromagnetic coils”) “generate[s] magnetic fields parallel to the directions in which the moveable component is driven by the driving component.”

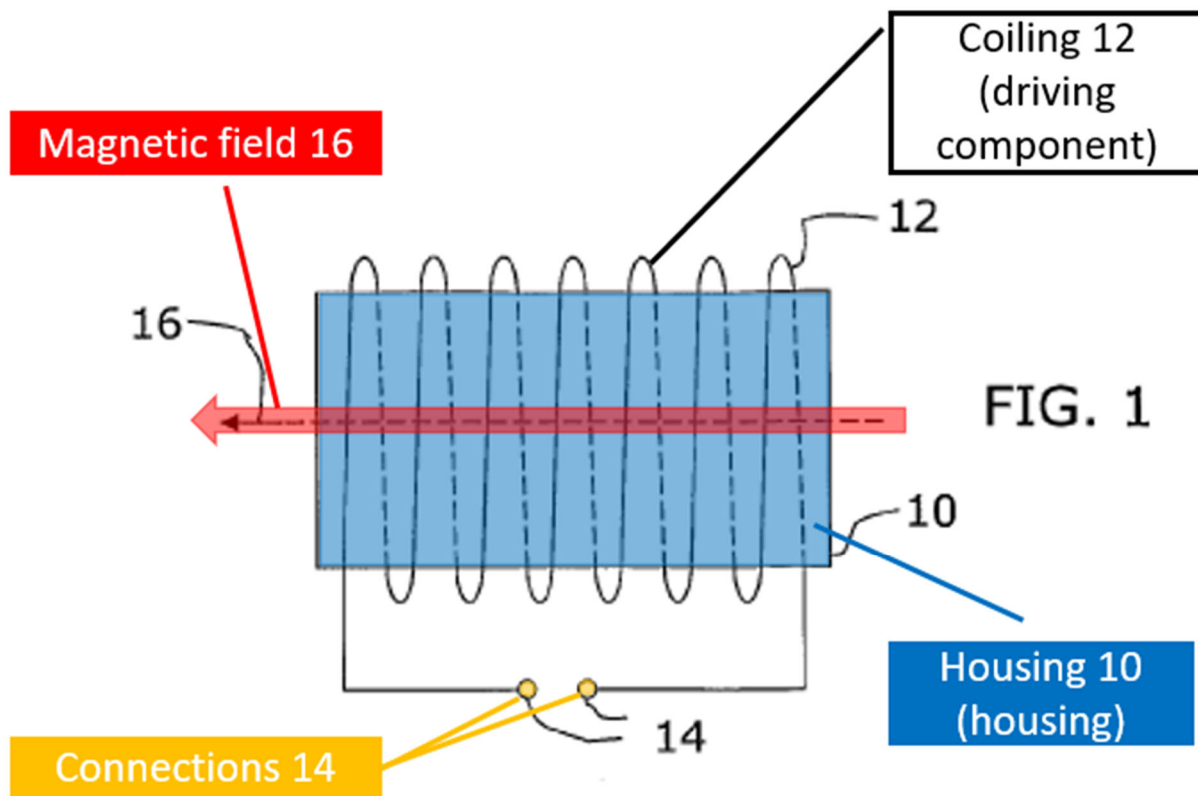
257. A POSITA would have found it obvious to apply the teachings of Erixon’s electromagnetic vibrator for use in a mobile phone with Fukumoto’s mobile device. First, a POSITA would have recognized that Fukumoto and Erixon are combinable because they are both directed to electromagnetic vibration generation in mobile devices using compact and energy efficient vibrators. *Fukumoto*, Fig. 3, Fig. 16, 14:38–15:4, 16:17–37, 50:48–59; *Erixon*, Abstract, Figs. 1, 2, [0002], [0053], [0075], [0099], [0102]. A POSITA would have been motivated to use Erixon’s coil configuration with Fukumoto because doing so would have amounted

to nothing more than simple substitution of a known coil configuration for a linear vibration actuator.

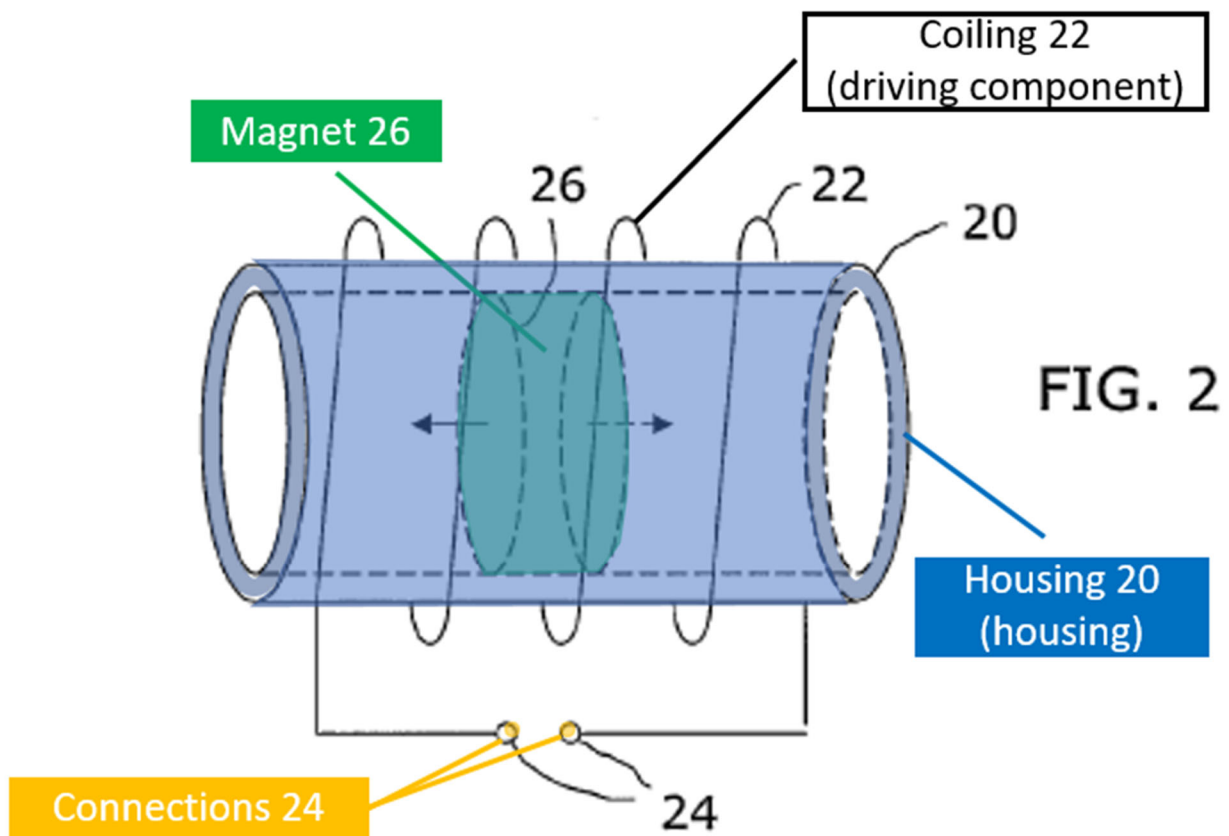
3. Claim 8

258. As described in ¶¶ 195–201 above, Fukumoto discloses this limitation. To the extent PO argues Fukumoto does not disclose or suggest this limitation, Fukumoto in combination with Erixon teaches it. Erixon’s electromagnetic vibrator includes a housing, coiling, ferrofluid mixture, and permanent magnet assembly “arranged for motion along [a] track.” *Erixon*, Abstract, [0011]–[0015], [0037], [0102]. The track is a “tubular cavity” that may be circular or “any other shape.” *Id.*, [0059]. Thus, Erixon’s track teaches a housing that is a linear tube.

259. In addition, in Erixon, voltage is supplied to the coiling via connections 14, creating one magnetic field that interacts with another created by the permanent magnet to create attracting and repelling forces in relation to each other. *Id.*, [0055]–[0057].

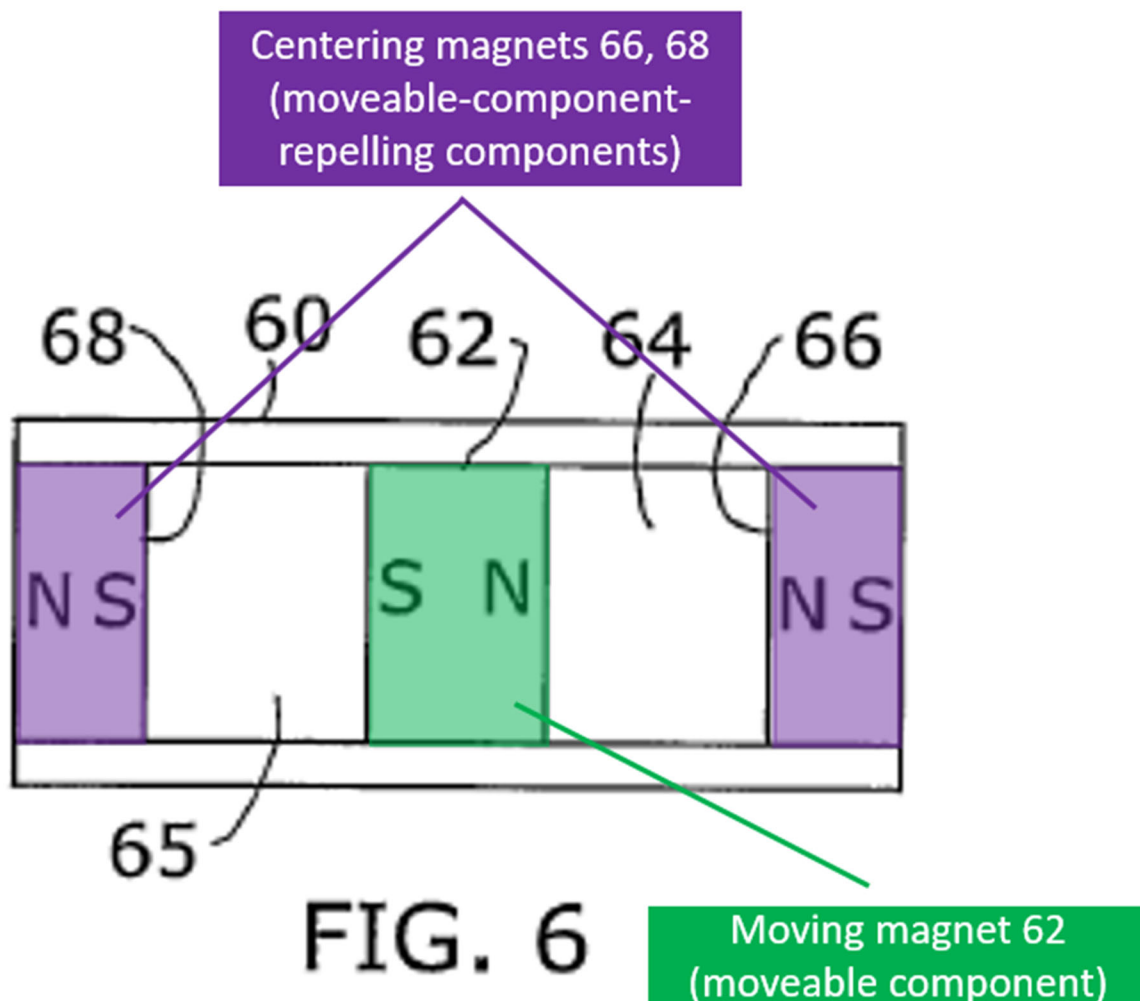


Id., Fig. 1 (annotated).



Id., Fig. 2 (annotated). Thus, Erixon's coiling ("driving component") is an electromagnetic coil, and its magnet 26 ("moveable component") is a permanent magnet that slides within Erixon's track.

260. Finally, Erixon discloses in an embodiment that centering magnets are placed at the ends of the housing to repel the moving magnet.



Id., Fig. 6 (annotated), [0091]–[0093]. In this embodiment, Erixon’s track (“housing”) is “capped at both ends by movable-component-repelling components selected from one of mechanical springs and magnets.”

261. A POSITA would have found it obvious to apply the teachings of Erixon’s electromagnetic vibrator for use in a mobile phone with Fukumoto’s mobile device for the same reasons I discussed in ¶ 257. For example, a POSITA would have been motivated to use Erixon’s configuration with Fukumoto because doing so

would have amounted to nothing more than simple substitution of known components of a linear vibration actuator.

I. Ground 1H: Fukumoto and Grant, Erixon Renders Obvious Claims 7, 8

262. Fukumoto in view of Grant and Erixon renders claims 7 and 8 obvious. For this ground, the additional teachings of Erixon discussed in ¶¶ 256–261 would be combined with the Fukumoto-Grant combination discussed in ¶¶ 213–223. A POSITA would have been motivated to combine Erixon with the Fukumoto-Grant combination for the same reasons as with Fukumoto alone. *See* ¶¶ 213–215, 255.

J. Ground 1I: Fukumoto and Barton, Erixon Renders Obvious Claims 7, 8

263. Fukumoto in view of Barton and Erixon renders claims 7 and 8 obvious. For this ground, the additional teachings of Erixon discussed in ¶¶ 256–261 would be combined with the Fukumoto-Barton combination discussed in ¶¶ 224–233. A POSITA would have been motivated to combine Erixon with the Fukumoto-Barton combination for the same reasons as with Fukumoto alone. *See* ¶¶ 224–225, 255.

K. Ground 1J: Fukumoto and Fuller Renders Obvious Claim 8

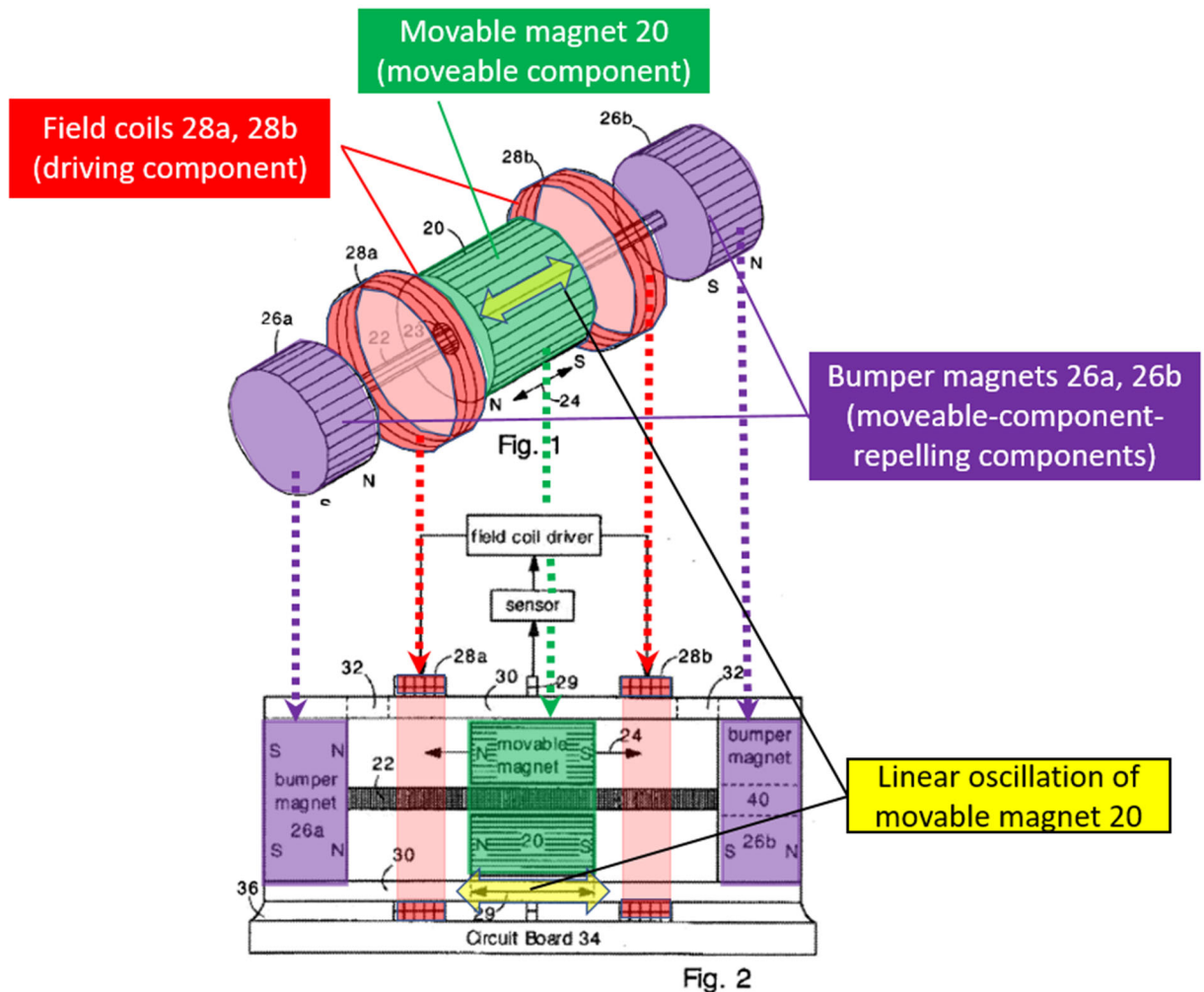
1. Combination of Fukumoto and Fuller

264. A POSITA would have found it obvious to apply the teachings of Fuller’s electromagnetic vibrator for use in a cell phone with Fukumoto’s mobile device. First, a POSITA would have recognized that Fukumoto and Fuller are

combinable because they are both directed to electromagnetic vibration generation in mobile devices using compact and energy efficient vibrators. *Fukumoto*, Fig. 3, Fig. 16, 14:38–15:4, 16:17–37, 50:48–59; *Fuller*, Abstract, Figs. 1, 2, [0004], [0005], [0026], [0038], [0053]. Further, A POSITA would have recognized that the proposed combination would have amounted to no more than applying a known technique (Fuller’s vibrator driven by electromagnetic coils and using bumper magnets) to a known device ready for improvement (Fukumoto’s mobile device including a linear oscillatory actuator driven by electromagnetic coils that uses a single spring) to yield predictable results (a mobile device with a smaller and more efficient vibration unit). Additionally, a POSITA would also have been motivated to make this combination to reduce the size of the linear oscillatory actuator and efficiency, thus improving battery life of the mobile device. *Fuller*, Abstract, [0004], [0036].

2. Claim 8

265. As described in ¶¶ 195–201 above, Fukumoto discloses this limitation. To the extent PO argues Fukumoto does not disclose or suggest this limitation, Fukumoto in combination with Fuller teaches it. Fuller discloses a “tubular enclosure,” for an electromagnetic vibrator that “has a toroidal movable magnet 20...free to slide in an axial direction 24.” *Fuller*, [0027].



Fuller, Figs. 1, 2 (combined and annotated). Thus, Fuller’s “tubular enclosure” teaches a housing that is a linear tube, and movable magnet 20 (“moveable component”) is a permanent magnet and slides within the tubular enclosure.

266. Fuller discloses field coils 28a, 28b to drive the movable magnet; “field coils 28 are oriented such that they apply push and pull forces to the movable magnet 20.” *Fuller*, Figs. 1, 2, [0027], [0035]. Fuller’s field coils (“driving component”) are electromagnetic coils.

267. Fuller further discloses “[b]umper magnets 26a 26b are fixedly disposed at opposite ends,” and “are fixed in place,” where “bumper magnets 26 are oriented such that they magnetically repel the movable magnet 20.” *Id.*, Figs. 1, 2, [0027]. In operation, “the movable magnet 20 oscillates under the influence of the field coils 28, it repeatedly rebounds from the magnetic field of the bumper magnets 26.” *Id.*, [0035]. Thus, Fuller’s tubular enclosure is capped at both ends by bumper magnets 26 (“movable-component-repelling components” which are “magnets”).

268. Thus, Fuller teaches claim 8’s additional limitation. A POSITA would have found it obvious to apply the teachings of Fuller’s electromagnetic vibrator for use in a cell phone to Fukumoto’s mobile device. First, a POSITA would have recognized that Fukumoto and Fuller are combinable because they are both directed to electromagnetic vibration generation in mobile devices. Fukumoto, Fig. 3, Fig. 16, 14:38–15:4, 16:17–37, 50:48–59; Fuller, Abstract, Figs. 1, 2, [0004], [0005], [0026], [0038], [0053]. Further, a POSITA would have been motivated to use Fuller’s configuration with Fukumoto because doing so would have amounted to nothing more than simple substitution of known components of a linear vibration actuator.

L. Ground 1K: Fukumoto and Grant and Fuller Renders Obvious Claim 8

269. Fukumoto in view of Grant and Fuller renders claim 8 obvious. For this ground, the additional teachings of Fuller discussed in ¶¶ 264–268 would be combined with the Fukumoto-Grant combination discussed in ¶¶ 213–223. A POSITA would have been motivated to combine Fuller with the Fukumoto-Grant combination for the same reasons as with Fukumoto alone. *See* ¶¶ 213–215, 264.

M. Ground 1L: Fukumoto and Barton and Fuller Renders Obvious Claim 8

270. Fukumoto in view of Barton and Fuller renders claim 8 obvious. For this ground, the additional teachings of Fuller discussed in ¶¶ 264–268 would be combined with the Fukumoto-Barton combination discussed in ¶¶ 224–233. A POSITA would have been motivated to combine Fuller with the Fukumoto-Barton combination for the same reasons as with Fukumoto alone. *See* ¶¶ 224–225, 264.

N. Ground 1M: Fukumoto, Dong and Ogusu Renders Obvious Claims 14 and 19

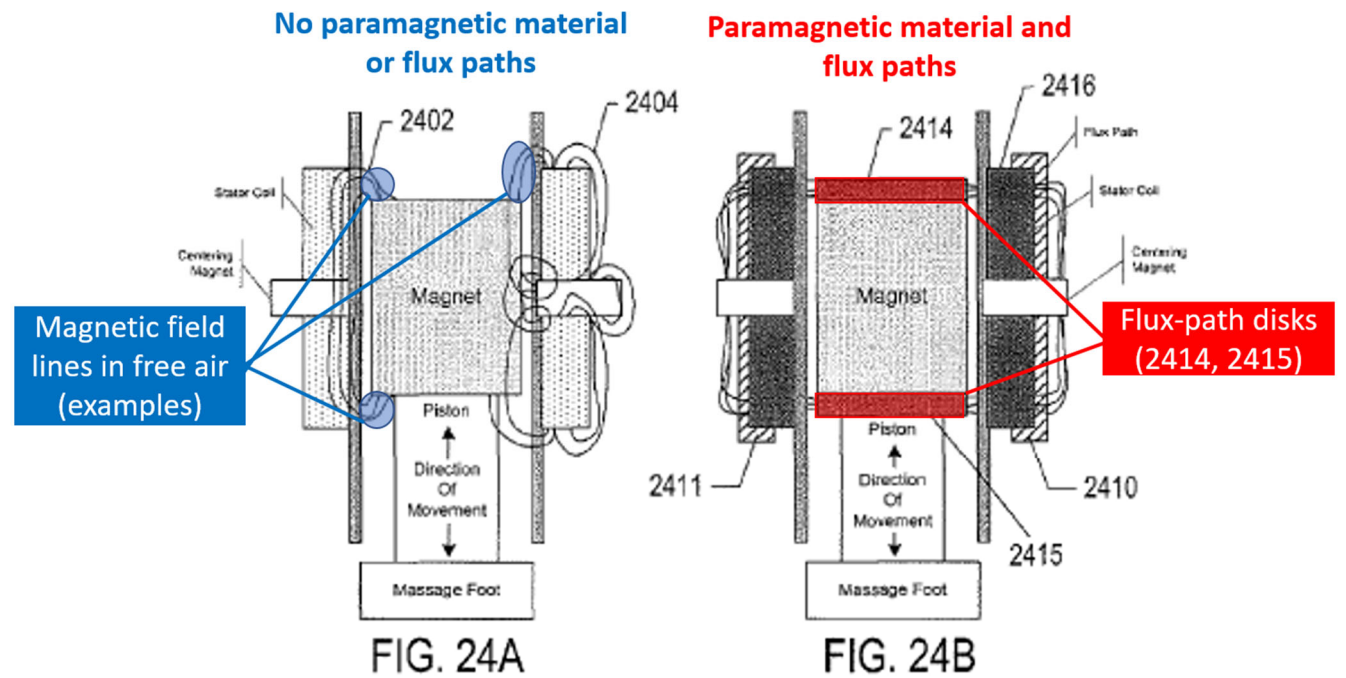
1. Dong's Prior Art Status

271. Dong was published on July 22, 2009. In my opinion, Dong qualifies as prior art for claims 14 and 19 because those claims are entitled to a priority date no earlier than January 6, 2012. In the '830 patent, Figures 24A, 24B, and 25 as well as their associated description ('830*Pat.*, 14:3-14:58) appear to be the only potential written description support for claims 14 and 19. In the '830 patent's priority chain,

these figures and associated description were not present in the May 18, 2009 provisional (Ex. 1029) or May 18, 2010 non-provisional (Ex. 1028); instead, they first appeared in the January 6, 2012 continuation-in-part application. *See* Ex. 1026. Thus, claims 14 and 19 have a priority date no earlier than January 6, 2012, and Dong qualifies as prior art to claims 14 and 19.

2. Claims 14 and 19

272. I understand Claim 14 depends from claim 1 and further recites: “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.” Claim 19 recites the same limitations as claim 1 along with the additional limitations of dependent claim 14. As context for claim 14’s additional limitations, the ’830 patent explains: “Free air can be considered to be analogous to a resistor in an electric circuit and increases the resistance, or magnetic reluctance, of a magnetic circuit and reduces and [sic] the flux of the magnetic field.” *’830Pat.*, 14:7-10. Thus, the ’830 patent explains that “paramagnetic materials” can be introduced to “provide a lower-resistance path for magnetic flux.” *Id.*, 14:13-19. The ’830 Patent distinguishes between an LVM embodiment with (Fig. 24A) and without (Fig. 24B) paramagnetic flux paths:



Id., Figs. 24A–B (annotated). According to the '830 Patent, paramagnetic flux paths are introduced to the LVM by including paramagnetic materials that “decrease the portion of magnetic field lines passing through free air” and therefore providing “a more efficient linear vibration module.” *Id.*, 14:20–35.

273. In my opinion, the additional limitation of claim 14 would have been obvious based Fukumoto in combination with Dong and Ogusu. In this combination, Fukumoto’s vibration actuator would be modified to incorporate paramagnetic materials to reduce the reluctance of one or more magnetic circuits within the linear vibration module based on the teachings of Dong and Ogusu. A POSITA would have recognized such paramagnetic materials could be configured in numerous ways in Fukumoto’s vibration actuator to decrease reluctance of the magnetic circuits

created during operation, and a POSITA would have been motivated to use paramagnetic materials in this way because decreasing reluctance would increase efficiency (i.e., greater vibrational force while using less power).

274. Paramagnetic materials were well known at the relevant time and tungsten was known as a paramagnetic material. Dong discloses using such paramagnetic material in its vibration actuator, namely, its counterweight 15 can be composed of tungsten. *Dong*, 6. A POSITA would have understood that adding a paramagnetic material such as tungsten to Fukumoto's vibration module (as taught in Dong) would reduce the reluctance of the magnetic circuits within Fukumoto's vibration actuator.

275. As discussed above, a POSITA would have been motivated to apply this teaching of Dong to Fukumoto's vibration actuator for better efficiency of the magnetic circuit in the vibration modules. Such a modification would have required only minor changes to Fukumoto's disclosed structure and a POSITA would have had a reasonable expectation of success in making them.

276. Ogusu's teachings further support the modification discussed above. In Ogusu a yoke made of ferromagnetic material or non-ferromagnetic materials mixed with ferromagnetic powders positioned between an electromagnetic coil and a permanent magnet to form a magnetic circuit. *Ogusu*, [0028]-[0029], [0038], Fig. 1 (annotated). A POSITA would have recognized that non-magnetic materials mixed

with ferromagnetic powders, such as disclosed in Ogusu, would have weak magnetic attraction similar to a paramagnetic material and would reduce the reluctance of magnetic circuits in the same way as a paramagnetic material. *'830 patent*, 14:10–19 (“[p]aramagnetic materials ... reduce the reluctance of a magnetic circuit and can therefore allow a magnetic field to more efficiently perform more work”); *Ogusu*, [0047] (“Since each yoke forms the magnetic loop having the shortest path, loss is small and higher efficiency can be obtained compared to a conventional device.”). Thus, Ogusu further supports that a POSITA would have been motivated to incorporate known materials, such as paramagnetic materials, into a Fukumoto’s oscillatory actuator to reduce the reluctance of the magnetic circuits to improve efficiency.

277. Therefore, it is my opinion that Fukumoto in view of Dong and Ogusu teaches claim 14’s additional limitations as well as claim 19.

O. Ground 1N: Fukumoto, Grant, Dong, and Ogusu Renders Obvious Claims 14 and 19

278. As I discussed above, ¶¶ 213–219 explains that Fukumoto in combination with Grant renders claim 1 obvious. I explain in ¶¶ 271–277 that Fukumoto in combination with Dong and Ogusu further renders obvious claims 14 and 19. Fukumoto in view Grant and further in view of Dong and Ogusu also renders claims 14 and 19 obvious. For this ground, the additional teachings of Dong and

Ogusu discussed in ¶¶ 271–277 would be combined with the Fukumoto-Grant combination discussed in ¶¶ 213–219. A POSITA would have been motivated to combine the relied upon teachings from Ogusu and Dong with the Fukumoto-Grant combination for the same reasons as with Fukumoto alone. *See* ¶¶ 275–277, 213–215.

P. Ground 10: Fukumoto, Barton, Dong, and Ogusu Renders Obvious Claims 14 and 19

279. As I discussed above, ¶¶ 224–229 explains that Fukumoto in combination with Barton renders claim 1 obvious. I explain in ¶¶ 271–277 that Fukumoto in combination with Dong and Ogusu further renders obvious claims 14 and 19. Fukumoto in view Barton and further in view of Dong and Ogusu also renders claims 14 and 19 obvious. For this ground, the additional teachings of Dong and Ogusu discussed in ¶¶ 271–277 would be combined with the Fukumoto-Barton combination discussed in ¶¶ 224–229. A POSITA would have been motivated to combine the relied upon teachings from Ogusu and Dong with the Fukumoto-Barton combination for the same reasons as with Fukumoto alone. *See* ¶¶ 275–277, 224–225.

Q. Ground 1P: Fukumoto and Saiki Renders Obvious Claims 15 and 20

1. Combination of Fukumoto and Saiki

280. A POSITA would have found it obvious to implement Saiki's complex vibration modes in Fukumoto's mobile device. First, a POSITA would have recognized that Fukumoto and Saiki are combinable because they are both directed to electromagnetic vibration generation in mobile devices using compact, self-contained actuators. *Fukumoto*, Fig. 3, Fig. 16 (elements 115a–b), 14:38–15:4, 16:17–37, 50:48–59; *Saiki*, Abstract, Figs. 2, 3B, 1:9–13, 8:58–9:28. Further, a POSITA would have recognized that the proposed combination would have amounted to no more than applying a known technique (Saiki's frequency signal synthesis) to a known device ready for improvement (Fukumoto's mobile device including its oscillatory actuator and drive signal generation circuit) to yield predictable results (creating additional vibration output options). Additionally, a POSITA would also have been motivated to make this combination to allow for greater flexibility and variety of available vibration waveforms. *Saiki*, 15:20–23 (disclosing a synthesized waveform “[in] which a large vibration force is maintained over time”), 15:46–60 (disclosing the ability to create and tailor the strength of both a vibration and sound signal separately for a preferred result).

2. Claims 15 and 20

281. I understand Claim 15 depends from independent claim 1 and further recites “wherein the control component drives simultaneous oscillation of the moveable component at two or more frequencies to generate complex vibration modes.” Claim 20 recites the same limitations as claim 1 along with the additional limitation of dependent claim 15. As discussed above in ¶¶ 208–210, Fukumoto discloses or suggests claim 15’s additional limitation. To the extent PO argues Fukumoto does not, claim 15 would have been obvious based on Fukumoto in combination with Saiki.

282. In my opinion, Saiki teaches or suggests the additional limitation recited in claim 15. Specifically, Saiki relates to a driving circuit in a portable telephone or pager that outputs two signals of two different frequencies. *Saiki*, 1:9-13, 2:10-36. Saiki discloses an electric signal generator that generates a synthesized vibration output waveform by combining eight point frequencies (P1-P8) such that those frequencies are either in phase or in reverse phase with each other. *Id.*, 14:47–15:5, 15:24-37. The resulting vibration output waveform in Figure 17B of Saiki reflects the complex vibration mode illustrated in Figure 22B of the ’830 patent.

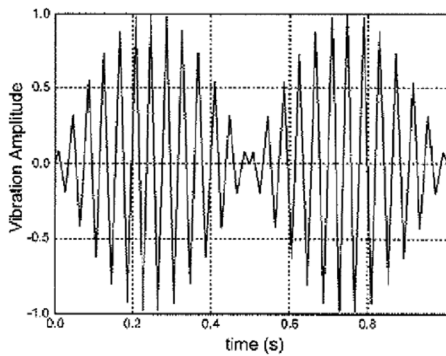
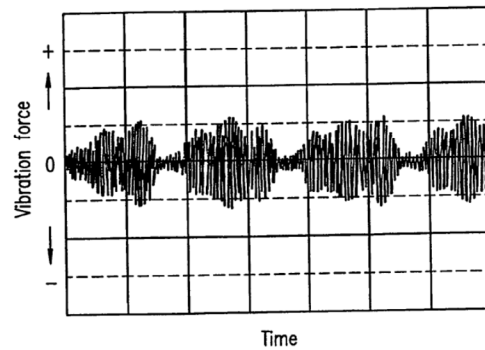


FIG. 22B

FIG. 17B



Compare '830 Patent, Fig. 22B, with Saiki, Fig. 17B.

283. As explained above, a POSITA would have found it obvious to implement Saiki's complex vibration mode with Fukumoto because, for example, combining Saiki's complex vibration mode with Fukumoto would have allowed Fukumoto's pager more flexibility in its vibration output.

284. Thus, Fukumoto and Saiki teach claim 15's additional limitation.

R. Ground 1Q: Fukumoto, Grant, and Saiki Renders Obvious Claims 15 and 20

285. As I discussed above, ¶¶ 213–219 explains that Fukumoto in combination with Grant renders claims 1 obvious. I explain in ¶¶ 280–284 that Fukumoto in combination with Saiki renders obvious claims 15 and 20. Fukumoto in view Grant and further in view of Saiki also renders claims 15 and 20 obvious. For this ground, the additional teachings of Saiki discussed in ¶¶ 280–284 would be combined with the Fukumoto-Grant combination discussed in ¶¶ 213–219. A

POSITA would have been motivated to combine the relied upon teachings from Saiki with the Fukumoto-Grant combination for the same reasons as with Fukumoto alone. *See* ¶¶ 213–215, 280.

S. Ground 1R: Fukumoto, Barton, and Saiki Renders Obvious Claims 15 and 20

286. As I discussed above, ¶¶ 224–229 explains that Fukumoto in combination with Barton renders claims 1 obvious. I explain in ¶¶ 280–284 that Fukumoto in combination with Saiki renders obvious claims 15 and 20. Fukumoto in view Barton and further in view of Saiki also renders claims 15 and 20 obvious. For this ground, the additional teachings of Saiki discussed in ¶¶ 280–284 would be combined with the Fukumoto-Barton combination discussed in ¶¶ 224–229. A POSITA would have been motivated to combine the relied upon teachings from Saiki with the Fukumoto-Barton combination for the same reasons as with Fukumoto alone. *See* ¶¶ 224–225, 280.

T. Ground 1S: Fukumoto, Saiki, and Masahiko Renders Obvious Claim 16

1. Masahiko's Prior Art Status

287. Masahiko was filed on July 26, 2011. In my opinion, Masahiko qualifies as prior art for claim 16 because that claim is entitled to a priority date no earlier than January 6, 2012. In the '830 patent, Figures 22B and 23 and the description at 13:34-59 appear to be the only possible written description support for

claim 16. In the '830 patent's priority chain, this figure and associated description were not present in the May 18, 2009 provisional (Ex. 1029) or May 18, 2010 non-provisional (Ex. 1028); instead, they first appeared in the January 6, 2012 continuation-in-part application. *See* Ex. 1026. Thus, in my opinion, claim 16's priority date is no earlier than January 6, 2012, and Masahiko qualifies as prior art for claim 16.

2. Combination of Fukumoto, Saiki, and Masahiko

288. A POSITA would have found it obvious to further implement Masahiko's beat vibration and aperiodic complex vibration mode in Fukumoto's mobile device. First, a POSITA would have recognized that the Fukumoto-Saiki combination and Masahiko are compatible because they are all directed to electromagnetic vibration generation in mobile devices. *Fukumoto*, 14:38–15:4, 16:29–33, 50:48–59; *Saiki*, Abstract, 1:9-13, 8:58–9:28; *Masahiko*, 1:17–21, 8:50–10:61. Further, a POSITA would have recognized that the proposed combination would have amounted to no more than applying a known technique (Masahiko's beat frequency and aperiodic oscillation) to a known device ready for improvement (the Fukumoto-Saiki combination's mobile device including an oscillatory actuator) to yield predictable results (an oscillatory actuator that generates a beat wave frequency to stop voltage application—and thereby vibration generation—abruptly; as well as an aperiodic waveform). Additionally, a POSITA would also have been motivated

to use Masahiko's particular beat and aperiodic wave forms with the Fukumoto-Saiki combination's drive circuit to allow for more abrupt start and stop to the vibrations as a predictable improvement in the "tactile haptic effects" experienced by a user of a mobile device. *Masahiko*, 2:13–47, 4:40-46, 10:7–10.

289. In addition, a POSITA would have had a reasonable expectation of success in making the proposed modification. To do so, a POSITA would have only needed to make minor software modifications to allow for the different complex vibration waveforms in the Fukumoto-Saiki combination. *Id.* Doing so would have been within the skill level of a POSITA at the relevant time. *Id.*

3. Claim 16

290. Claim 16 recites: "The linear vibration module of claim 15 wherein the complex vibration modes include: a primary oscillation frequency modulated by a modulating oscillation frequency; a beat frequency; and an aperiodic oscillation waveform."

291. As I discussed above in ¶¶ 281–284, the combination of Fukumoto and Saiki teaches or suggests all of the limitations of claim 15. As discussed below, Saiki teaches "a primary oscillation frequency modulated by a modulating oscillation frequency," and Masahiko teaches a "beat frequency" and "an aperiodic oscillation waveform." It would have been obvious to use these complex vibration

modes in Fukumoto. Accordingly, the combination of Fukumoto, Saiki, and Masahiko renders claim 16 unpatentable as obvious.

292. First, Saiki teaches or suggests “a primary oscillation frequency modulated by a modulating oscillation frequency.” In Saiki’s Figures 17A and 17B, a POSITA would have understood that P1 teaches the “primary oscillation frequency,” and P2 teaches a “modulating oscillation frequency.” In addition, a POSITA would have understood that P1 is modulated by P2 because P1 is in reverse phase with P2. *Saiki*, 15:24-37. As discussed above in ¶ 283, a POSITA would have been motivated to use Saiki’s complex vibration modes with Fukumoto.

293. Second, Masahiko teaches a “beat frequency.” In Masahiko, the beat vibration or f_B is a beat frequency. *Masahiko*, 12:55-56 (“Conversely, when $f_d < f$, for example, when $f = 196.25$ Hz at $f_0 = 157$ Hz, the beat vibration f_B is 39.25 Hz.”), Fig. 5.

294. As discussed above, a POSITA would have been motivated to use Masahiko’s beat frequency with the Fukumoto-Saiki combination. In particular, Masahiko teaches using its beat vibration (“beat frequency”) to stop vibration at the minimum amplitude (valley) to “shorten the time until stopping vibration.” *Masahiko*, 12:55-61. A POSITA would have found it equally beneficial to shorten the vibration stopping time in the Fukumoto-Saiki combination. A POSITA would have understood that quickly dampening vibration when the haptic response is no

longer needed (e.g., vibrating only during the time period where haptic effect is desired) would create an improved haptic experience and would support a wider range of haptic effects such as ticks and jolts.

295. Additionally, a POSITA would have had a reasonable expectation of success in making the proposed modification. To do so, a POSITA would have only needed to make minor software modifications to specify determine and utilize the beat frequency. Doing so would have been within the skill level of a POSITA at the relevant time.

296. Third, Masahiko teaches “an aperiodic oscillation waveform.” Masahiko discloses changing “period spikes” in the total energy of a system driven by a pure sine wave that eventually reaches steady state, but other bipolar, square-based waves used as drive signals continue to change the excitation and dampening phases to change in a non-repetitive, gradual manner. *Id.*, Fig. 6, 14:26–53, Figs. 15, 16, 22:56–23:59.

297. As I discussed at ¶ 288 above, a POSITA would have been motivated to use Masahiko’s aperiodic oscillation waveform with the Fukumoto-Saiki combination. In particular, a POSITA would have recognized the benefits of having different haptic patterns to communicate different information in portable electronic devices. Specifically, a POSITA would have recognized that aperiodic waveforms provide additional options for haptic patterns beyond those available by varying only

frequency or amplitude and would have found such additional options for haptic effects beneficial in the Fukumoto-Saiki combination.

298. For the reasons discussed above, claim 16 is unpatentable as obvious over Fukumoto combined with Saiki and Masahiko.

U. Ground 1T: Fukumoto, Grant, Saiki, and Masahiko Renders Obvious Claim 16

299. As I discussed above, ¶¶ 213–219 explains that Fukumoto in combination with Grant renders claim 1 obvious. I explain in ¶¶ 287–298 that Fukumoto in combination with Saiki and Masahiko renders obvious claim 16. Fukumoto in view Grant and further in view of Saiki and Masahiko also renders claim 16 obvious. For this ground, the additional teachings of Saiki and Masahiko discussed in ¶¶ 288–298 would be combined with the Fukumoto-Grant combination discussed in ¶¶ 213–219. A POSITA would have been motivated to combine Saiki and Masahiko with the Fukumoto-Grant combination for the same reasons as with Fukumoto alone. *See* ¶¶ 213–215, 288–288.

V. Ground 1U: Fukumoto, Barton, Saiki, and Masahiko Renders Obvious Claim 16

300. As I discussed above, ¶¶ 224–229 explains that Fukumoto in combination with Barton renders claim 1 obvious. I explain in ¶¶ 287–298 that Fukumoto in combination with Saiki and Masahiko renders obvious claim 16. Fukumoto in view Barton and further in view of Saiki and Masahiko also renders

claim 16 obvious. For this ground, the additional teachings of Saiki and Masahiko discussed in ¶¶ 287–298 would be combined with the Fukumoto-Barton combination discussed in ¶¶ 224–229. A POSITA would have been motivated to combine Saiki and Masahiko with the Fukumoto-Barton combination for the same reasons as with Fukumoto alone. *See* ¶¶ 224–225, 288–288.

W. Ground 2A: Ogusu and Fukumoto Renders Obvious Claims 1, 2, 7, 11, 15, 17, and 20

1. Combination of Ogusu with Fukumoto

301. A POSITA would have been motivated to combine the teachings of Ogusu and Fukumoto. First, a POSITA would have recognized that Ogusu and Fukumoto are compatible because they are both directed to vibration generation in mobile devices. *Ogusu*, [0001]–[0002]; *Fukumoto*, Abstract, 37:5–12, Fig. 81. Further, a POSITA would have recognized Ogusu lacks certain implementation details that were well known as shown in Fukumoto and would have been motivated to apply those implementation details to Ogusu as discussed below.

2. Claim 1

a) 1[pre]: “A vibration module comprising:”

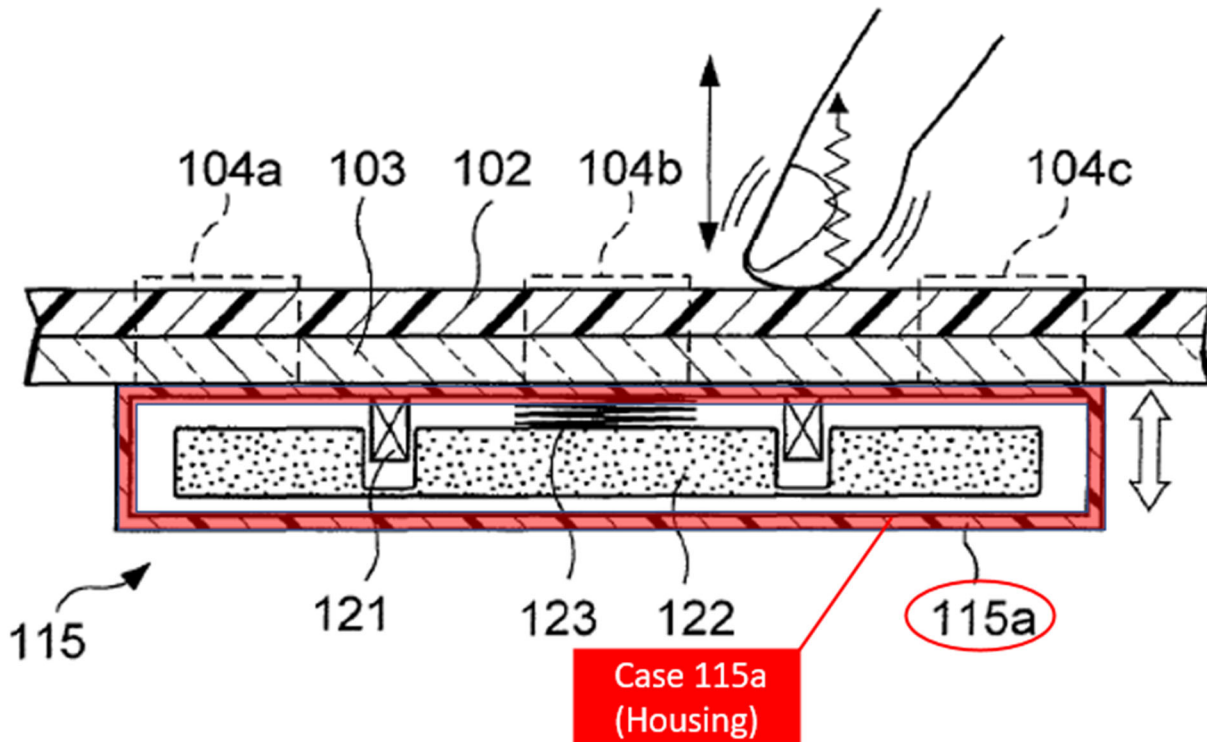
302. To the extent the preamble is limiting, it is my opinion that Ogusu discloses or suggests this limitation. Ogusu discloses a high efficiency “vibration actuator” using a moving magnet. *Ogusu*, [0001–2]. Ogusu’s vibration actuator oscillates in the same way as the ’830 patent. *Ogusu*, Figs. 1, 4, [0031]–[0032]; Ex.

1001, 4:21-27. In addition, as discussed below, Ogusu’s controller and vibrating device are contained in the same overall module. Thus, Ogusu discloses or suggests “a vibration module”.

b) 1[a]: “a housing”

303. In my opinion, Ogusu in combination with Fukumoto discloses or suggests this limitation. Ogusu discloses a vibration actuator is used as “vibration generating means for pagers.” Ogusu, [0002]. Ogusu does not explicitly depict a housing for its vibration actuator.

304. Nevertheless, a POSITA would have found it obvious and beneficial to enclose Ogusu’s vibration actuator in a housing to protect the components of the vibration actuator during pager assembly. In addition, it was well known to enclose such components in a housing. As one example, Fukumoto is similarly directed to a vibration actuator for use in portable electronic devices that includes case 115a (“a housing”), or alternatively main case 101 (“a housing”) under PO’s district court infringement contentions (Ex. 1022, 76–78)). *Fukumoto*, Figs. 1, 3, 1:13–19, 1:45–50, 13:20–26. As shown in Figure 3 of Fukumoto, Fukumoto’s vibration actuator includes case 115a (“a housing”).

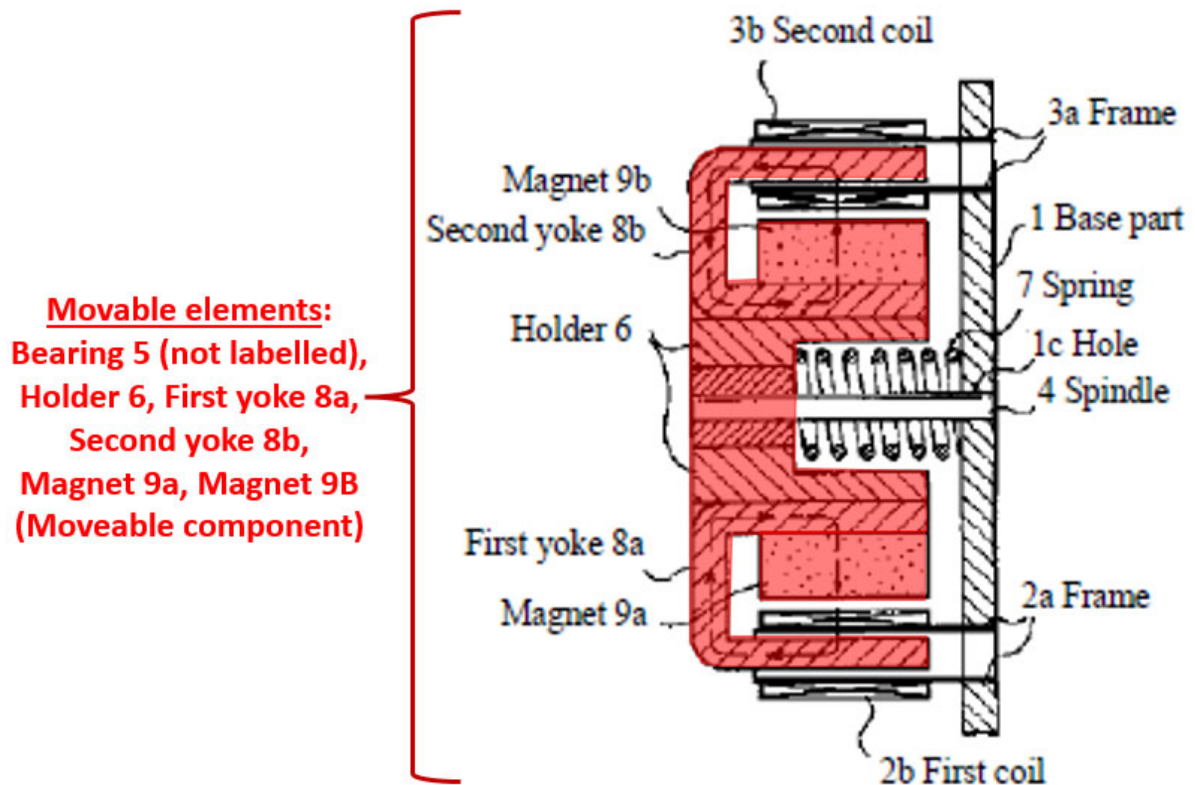


Id., Fig. 3 (annotated). For the reasons discussed above, a POSITA been motivated to modify Ogusu’s vibration actuator to include a “housing,” as taught in Fukumoto.

c) 1[b]: “a moveable component”

305. Ogusu discloses or suggests this limitation under a non-MPF or MPF construction. For non-MPF, Ogusu discloses a “movable element” comprising holder 6, bearing 5, yokes 8a and 8b, magnets 9a and 9b:

[FIG. 1]



Id., Fig. 1 (annotated), [0031]–[0032]. Thus, Ogusu’s moveable element discloses or suggests a “moveable component.”

306. For MPF, Ogusu discloses or suggests the recited function (“moves”) for the reasons discussed above. As I discussed above in ¶ 124, the corresponding structure for this limitation is a moving weight, which Ogusu discloses (moveable elements) for the same reasons discussed above.

307. In sum, Ogusu discloses or suggests this limitation under either a non-MPF or MPF construction.

d) 1[c]: “a power supply”

308. In my opinion, Ogusu discloses or suggests this limitation. Specifically, Ogusu discloses “a current in a predetermined direction is sent to the first coil 2b and the second coil 3b” to produce the coils’ magnetic fluxes parallel to the moving direction of the “thrust” created in a “magnetic circuit” upon the movable element, or “mover,” which moves in that resultant direction as a result. *Ogusu*, [0030]–[0031]. Ogusu also discloses “an input power supplied to the coil” in measurements of at least “0.3 W.” *Id.*, [0057]–[0058]. A POSITA would have recognized that applying electrical current to the coils to create a resultant movement requires a supply of electric power which can be measured in watts (“W”). Therefore, Ogusu discloses or suggests a “power supply.”

e) 1[d]: “user input features”

309. In my opinion, Ogusu alone or in combination with Fukumoto discloses or suggests this limitation. Ogusu discloses that “various vibrations can be switched by the selection of the pager control section by the user’s selection.” *Ogusu*, [0043]. A POSITA would have recognized that “the user’s selection” in Ogusu shows “user input features.” Specifically, a POSITA would have understood and found it obvious that for a user to make a selection, the user would do so through a user input feature. Accordingly, Ogusu discloses or suggests “user input features.”

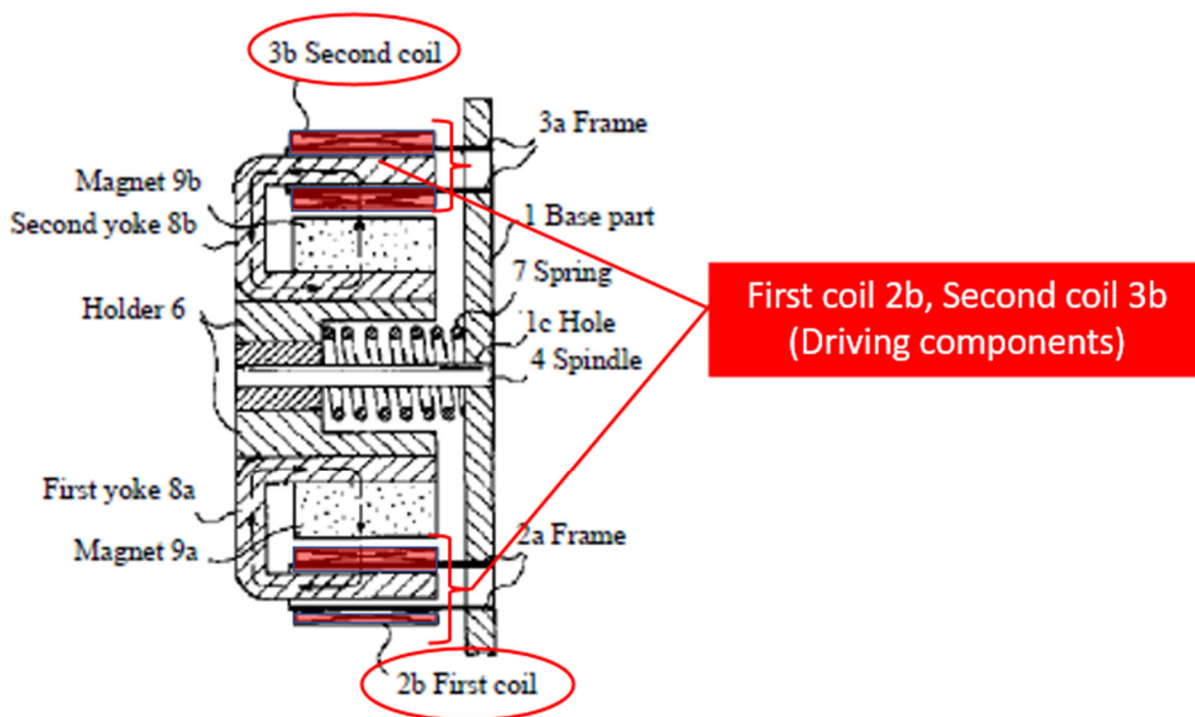
310. In addition, Fukumoto discloses a PDA with a “touch panel” and “push-button type operation keys” for a user to “input[] operation instructions to the PDA 101.” *Fukumoto*, 13:40–14:13, Figs. 1, 2. Thus, Fukumoto’s touch panel and push button keys disclose or suggest “user-input features.” A POSITA would have been motivated to incorporate user input features such as Fukumoto’s touch panel or push button keys into Ogusu’s pager to allow the user to make selections in Ogusu’s “pager control section.”

311. Therefore, Ogusu alone or in combination with Fukumoto discloses or suggests “user input features.”

f) 1[e]: “a driving component that drives the moveable component to oscillate within the housing; and”

312. In my opinion, Ogusu in combination with Fukumoto discloses or suggests this limitation under a non-MPF or MPF construction. For non-MPF, Ogusu discloses a first and second coil 2b and 3b:

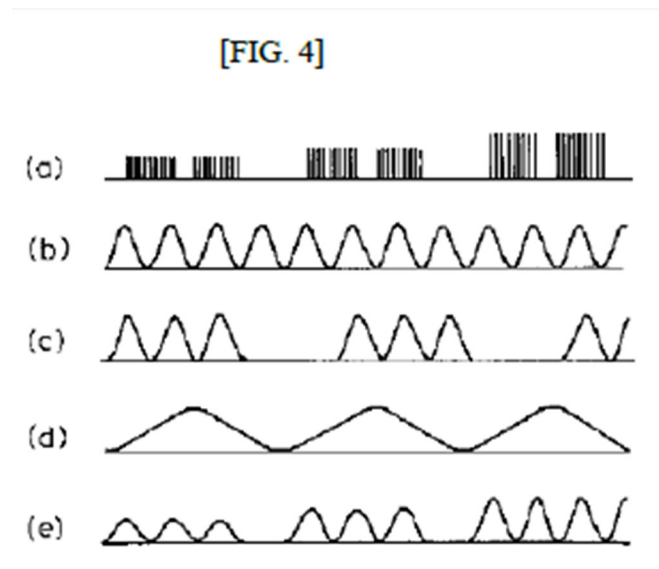
[FIG. 1]



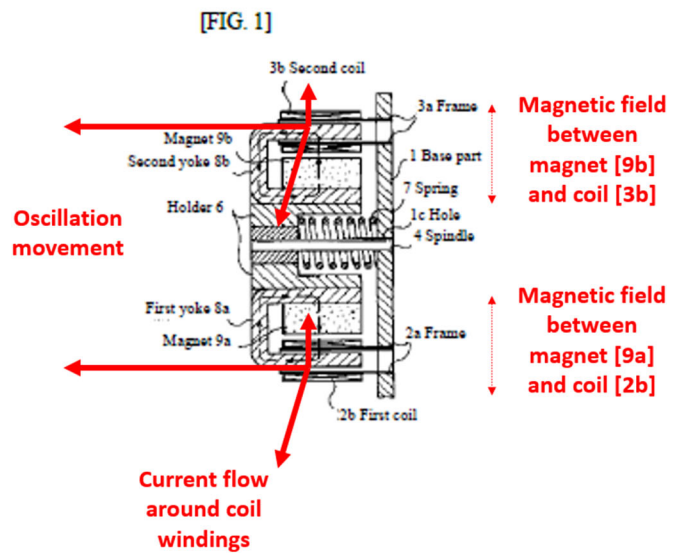
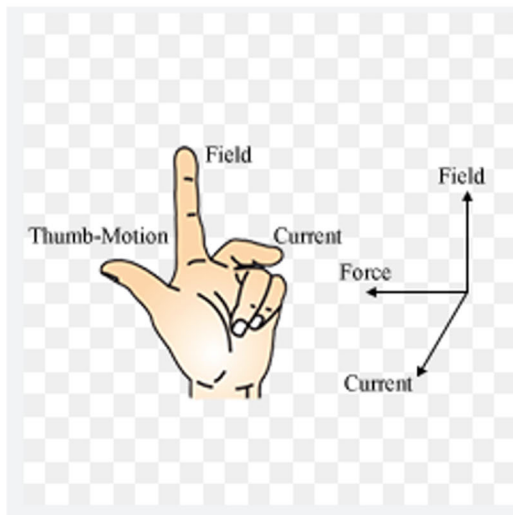
Id., Fig. 1 (annotated). First and second coils 2b and 3b drive the “movable element” (holder 6, bearing 5, yokes 8a and 8b, magnets 9a and 9b) in each of two opposite directions as the result of applied current:

When a current in a predetermined direction is applied to the first coil 2b and the second coil 3b, a **thrust** is applied to the first coil 2b and the second coil 3b arranged in the magnetic circuit according to Fleming’s left-hand rule. Occurs. **As a reaction to this thrust, the mover** (holder 6, bearing 5, yokes 8a and 8b, magnets 9a and 9b) **tries to move**. Therefore, by applying an alternating current to the first coil 2b and the second coil 3b, the mover generates vibration according to the current waveform. Further, since the mover has a magnet and has a certain amount of weight, the side of the base portion 1 also generates vibration in the **direction opposite** to that of the mover.

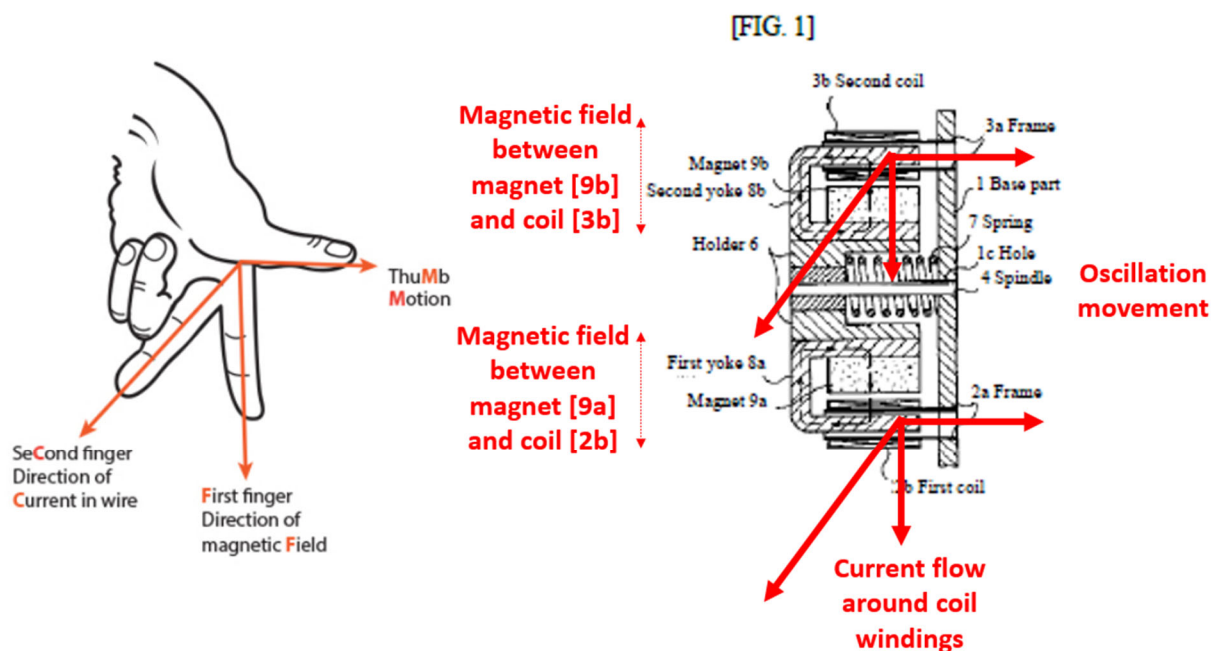
Id., [0031]–[0032]. The force in Ogusu is generated by supplying “alternating current” according to a “waveform of the current” such as that in depicted in Fig. 4:



Id., at Fig. 4, Fig. 1, [0031]–[0032]. A POSITA would have recognized or found it obvious that by applying such waveforms to the coils push the mover in one direction and then “pulls” that element in the opposite direction according to Fleming’s left-hand rule as directionally depicted by the magnetic flux lines below. This is the case because Ogusu refers to Fleming’s left-hand rule in the creation of the thrust, which is a principle dictating a direction of motion (force), magnetic field, and current flow that replicates the same directions as a user extending the thumb, index finger, and middle finger of his or her left hand:



See, e.g., <https://www.toppr.com/ask/question/state-flemingd-lefthand-rule-explain-it-with-help-of-labelled-diagrams/>. The same applies in reverse, when the current is switched:



See, e.g., <https://mammothmemory.net/physics/magnets-and-electromagnetism/electromagnetism/flemings-left-hand-rule-the-mnemonic-picture.html>. Further, a POSITA would have recognized Ogusu's "thrust" generated by the coils against the mover in one direction is reactively opposed by a spring-connected base portion in the opposite connection, which aids the two-way directional drive of the mover by diametrically opposing the "push" and "pull" applied by the current and initiates movement in the opposite direction.

313. Therefore, Ogusu discloses or suggests coils 2b and 3b ("driving component") that create thrust that causes the moveable element to move when current is applied in each of two directions ("drives the moveable component in each

of two opposite directions”), and in the combination with Fukumoto, that movement would occur “within the housing.”

314. For MPF, Ogusu in combination with Fukumoto discloses or suggests the recited function (“drives the moveable component in each of two opposite directions within the housing”) for the reasons discussed above. In addition, as I discussed in ¶ 124, the corresponding structure for this limitation is one or more coils of conductive wire. Ogusu discloses this corresponding structure (coils 2b and 3b) that performs the recited function for the same reasons discussed above.

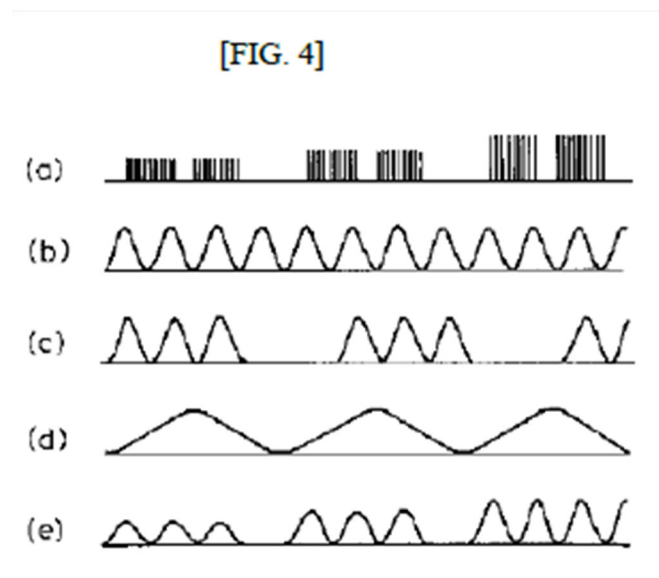
315. In sum, Ogusu in combination with Fukumoto discloses or suggests this limitation under either a non-MPF or MPF construction.

g) **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”**

316. In my opinion, Ogusu in combination with Fukumoto teaches this limitation under a non-MPF or MPF construction.

317. For non-MPF, Ogusu discloses a “pager control section” from which a user makes a selection to switch between “various vibrations.” *Ogusu*, [0043]. In *Ogusu*, vibrations are the result of applying different currents to the coils according to different waveforms. *See* ¶¶ 312–315. These different waveforms each have

different amplitudes and different frequencies varying from “several tens to several hundred Hz”:



Id., Fig. 4, [0017], [0019], [0032], [0037]–[0042], [0055]. Ogusu’s vibration actuator is “capable of generating vibration at an arbitrary frequency and amplitude” using such waveforms. *Ogusu, Abstract*, [0011]. Thus, Ogusu discloses applying alternating current to its two coils (“controls supply of power from the power supply to the driving component”) according to a waveform of a specific amplitude and frequency which can be chosen from a user selection (“to cause the moveable component to oscillate at a frequency and an amplitude” selected by a user via “stored values”) from an available pager control section (“stored values”).

318. Fukumoto teaches storing waveform data corresponding to user-selected waveforms of a specific frequency and amplitude (“to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more

stored values”). See ¶¶ 172–185. As I explained above in ¶¶ 301, it would have been obvious to a POSITA to store a user’s waveform selection as taught by Ogusu in a table as taught by Fukumoto user-selected waveforms in a table as Fukumoto to implement the full functionality of vibration control upon Fukumoto’s portable electronic device—e.g. pager (*Fukumoto*, 16:39–27) upon Ogusu’s portable electronic device—e.g., pager (*Ogusu*, [0003]–[0005])—predictably predisposed to such improvement to attain the same desirable, user-controlled result.

319. For MPF, Ogusu discloses or suggests the recited function for the reasons discussed above. In addition, as I discussed in ¶ 124, the corresponding structure includes a processor and an H bridge switch, where the processor is programmed with an algorithm to perform the following steps: (1) set the mode and strength to values represented by selections made by user input to the user input features, (2) provide a corresponding output to the power supply, and (3) provide a corresponding output to the H-bridge switch.

320. Although Ogusu does not explicitly disclose this corresponding structure, a POSITA would have understood that Ogusu uses a processor to choose among the various possible waveforms and to control the supply of power from the power supply to the coils to achieve those waveforms. Such a processor is disclosed in Fukumoto (CPU 113). For similar reasons as I described with respect to Fukumoto (see ¶¶ 172–185), a POSITA would have recognized that Ogusu uses an H-bridge

switch or other equivalent structure to convert power supplied from a battery in Ogusu to the selected waveform. Finally, a POSITA would have found it obvious to use an algorithm such as that disclosed in Fukumoto to supply power according to the desired waveform in Ogusu. I discussed Fukumoto's algorithm in detail in ¶¶ 172–185, above.

321. For the reasons discussed above, Ogusu in combination with Fukumoto teaches a processor, circuitry to convert power supplied from, for example, the battery in the electronic device to the AC drive signal (equivalent to the '830 patent's disclosed H-bridge switch), and an algorithm to perform the claimed function with at least equivalent steps to those disclosed in the '830 specification.

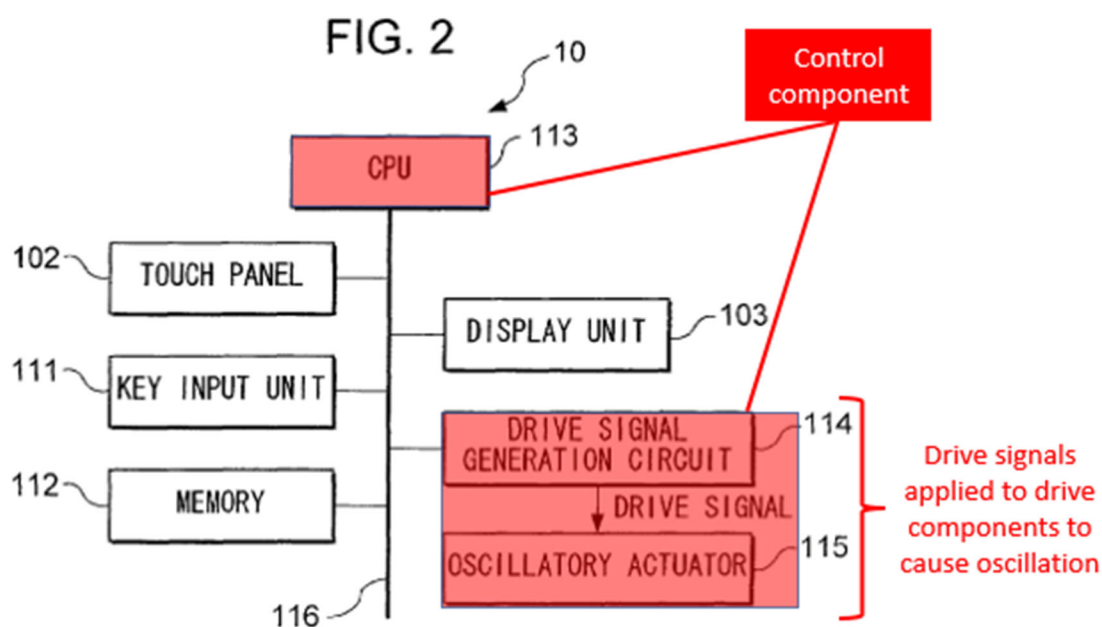
322. In sum, Ogusu discloses or suggests this limitation under a non-MPF construction, and Ogusu in combination with Fukumoto teaches this limitation under an MPF construction.

3. Claim 2

323. Ogusu in combination with Fukumoto teaches claim 2's additional limitations. In Ogusu, a user selects a vibration in the pager control section, and that vibration corresponds to a waveform with a specific amplitude and frequency which is then applied to the coils. *See* ¶¶ 316–322. A POSITA would have understood Ogusu supplies current and input power to produce the coils' magnetic fluxes parallel to the moving direction of the mover, which creates “thrust” upon the

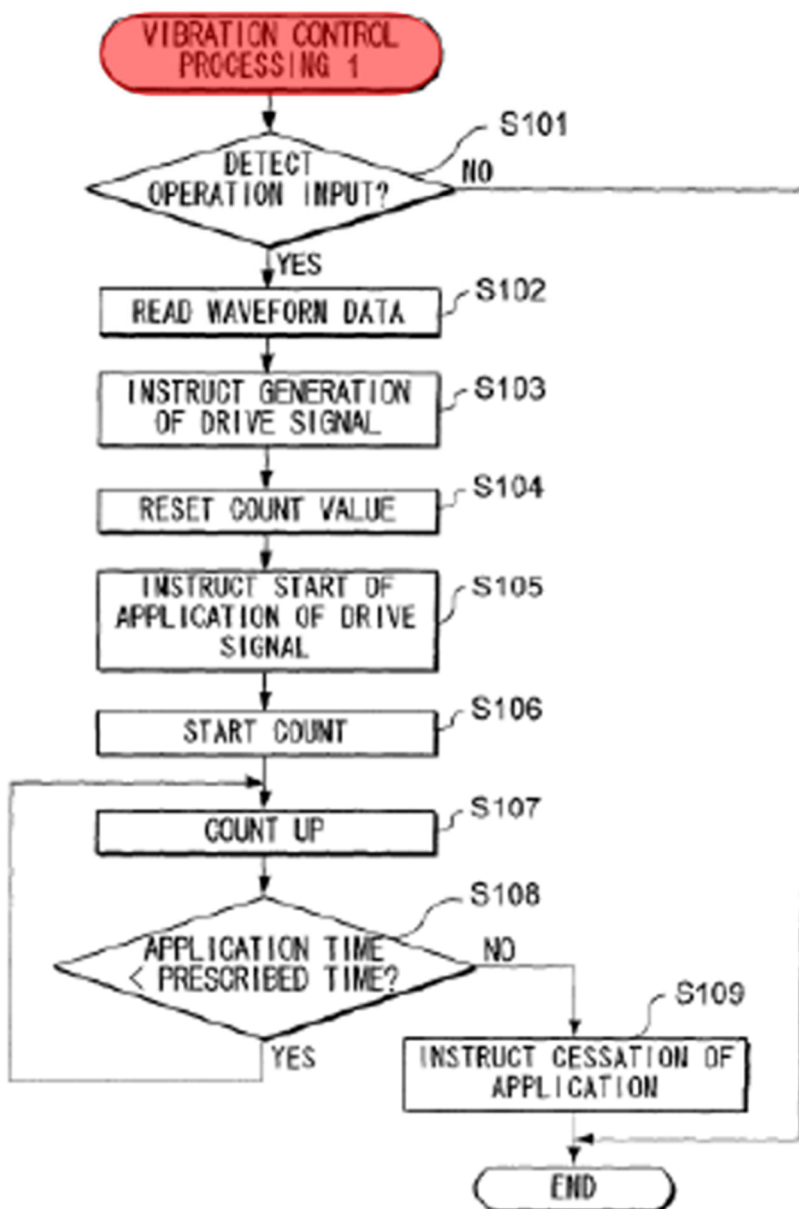
movable elements in the pager's "magnetic circuit" according to a user-selected waveform with particular amplitude and frequency. *See* ¶¶ 308–322 (citing Ogusu, Fig. 4, [0031], [0057]–[0058]).

324. In addition, Fukumoto discloses that a user's input starts a sequence of CPU-driven events that results in vibration of certain amplitude and frequency. *See* ¶¶ 166–185. Fukumoto's CPU-controlled vibration generation is depicted in at least Figures 2 and 5:



Id., Fig. 2 (annotated to show CPU-managed circuitry).

FIG. 5



Id., Fig. 5 (annotated to highlight control steps).

325. Applying these implementation details in Fukumoto to Ogusu would have amounted to no more than applying a known technique (Fukumoto's CPU-controlled PDA vibration generation process) to a known device ready for

improvement (Ogusu's pager control section vibration selection and generation process in a pager) to yield predictable results (a CPU-managed vibration generation process in Ogusu's pager providing a desired vibration output with a specific amplitude and frequency corresponding to a user input).

326. Thus, Ogusu alone or in combination with Fukumoto teaches claim 2's additional limitations.

4. Claim 7

327. It is my understanding that Claim 7 depends from claim 1 and further recites "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." As I discussed in ¶¶ 192–194, above, it is my opinion that a POSITA would have recognized '830 Patent, Claim 7 is referring to the finite portion of an arced magnetic field parallel to both the direction of magnetic force and resulting moveable component's movement when is recites, "generate magnetic fields parallel to the directions in which the moveable component is driven by the driving component" because this is consistent with the intrinsic evidence provided by the disclosure of the '830 Patent itself.

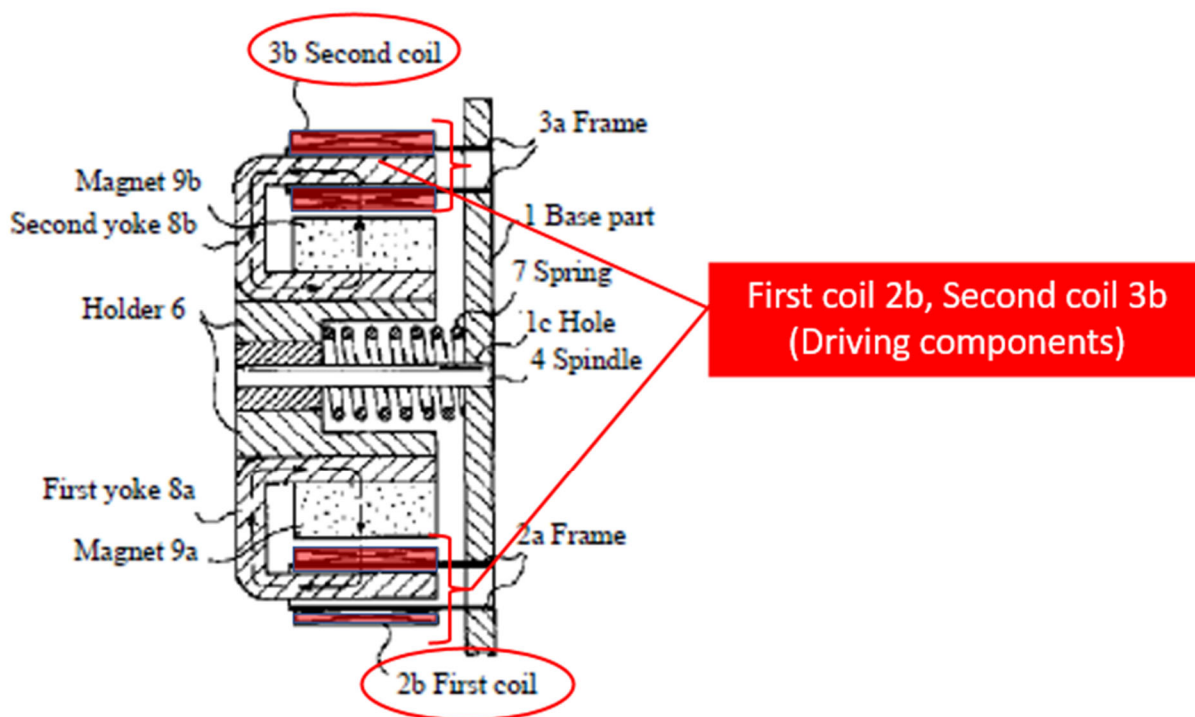
328. In my opinion, Ogusu discloses or suggests the additional limitation of claim 7. Ogusu discloses a driving component as I discussed in ¶¶ 312–315, above. Specifically, Ogusu discloses applying a current "in a predetermined direction" to

the first and second coils to produce a “thrust” according to “Fleming’s left-hand rule” that moves the “mover” parallel to that generated thrust. *Ogusu*, [0031]–[0032]. Therefore, *Ogusu* discloses or suggests its coils 2b and 3b (“driving component comprises one or more electromagnetic coils”) generate magnetic fields that are parallel to the direction in which the moveable component is being driven.

5. Claim 11

329. It is my understanding that Claim 11 depends from claim 1 and further recites “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 driving component.” In my opinion, *Ogusu* discloses or suggests the additional limitations of claim 11. Specifically, *Ogusu* discloses two or more driving components including a “first coil 2b and the second coil 3b.” *Ogusu*, [0031]–[0032]:

[FIG. 1]



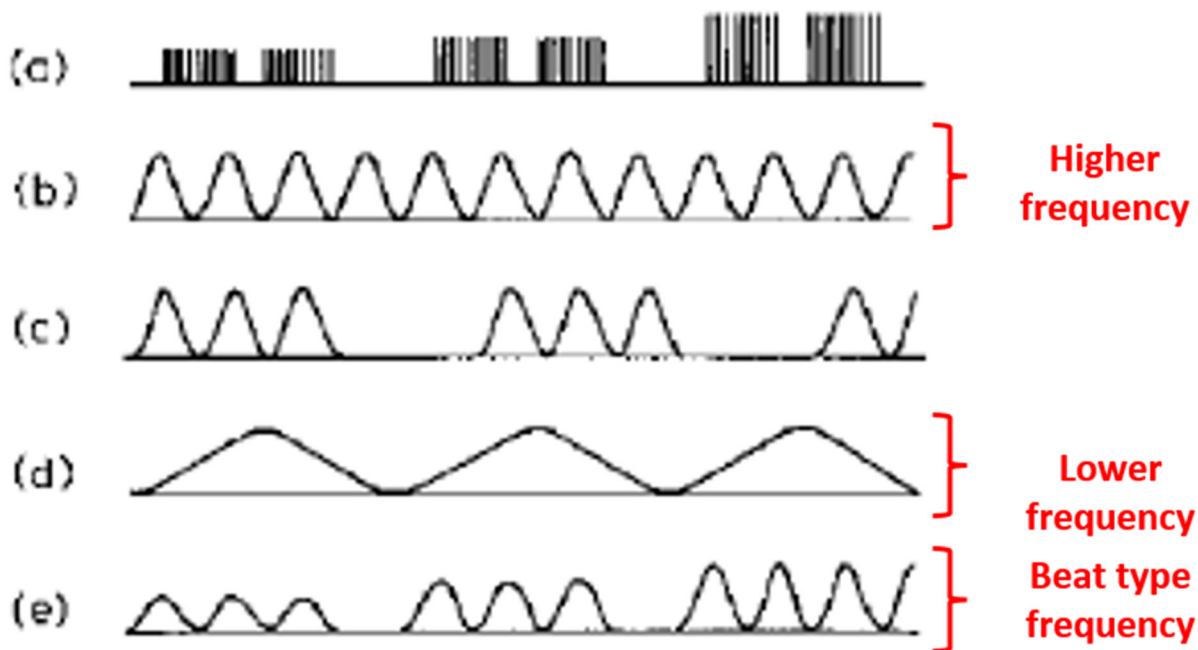
Id., Fig. 1 (annotated). A POSITA would have understood and found it obvious that Ogusu’s vibration actuator applies electric current in a particular waveform with respective amplitude attributes specific to each of the first and second coil. *Id.*, [0037]. Applying the specific waveform enables the vibration actuator to generate “accurate vibration . . . even for micro input” when “changing the frequency and an amplitude.” *Id.*, [0036], [0037]. A POSITA would have understood the first and second coils generate a vibrational result according to the amplitudes of the waveform-shaped current applied to the coils. Thus, Ogusu includes coils 2b and 3b (“two or more driving components”) and activates those coils according to the

chosen waveform (“each, when activated, driving the moveable component to oscillate with an amplitude particular to the driving component”).

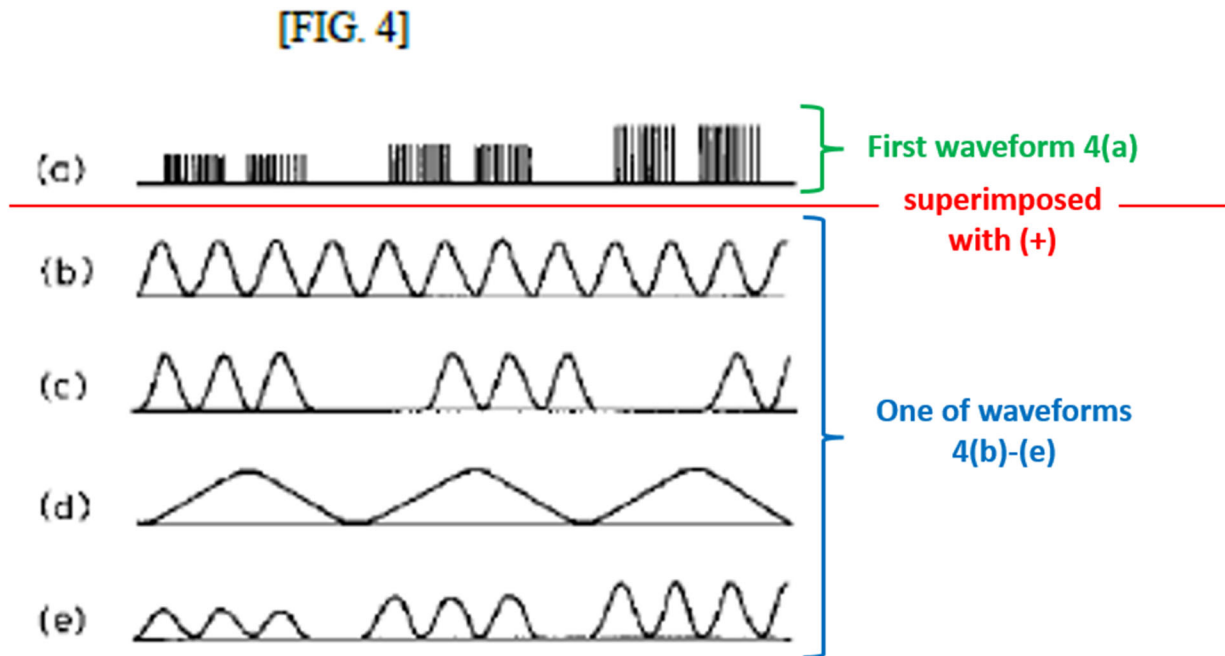
6. Claims 15 and 20

330. Claim 20 recites the same limitations as claim 1 along with the additional limitation of dependent claim 15. In my opinion, Ogusu discloses or suggests this additional limitation. In Ogusu, the mover vibrates as the result of applying different currents to the coils according to different waveforms. These different waveforms each have different frequencies:

[FIG. 4]



Id., Fig. 4 (annotated), [0032], [0037]–[0041]. Ogusu discloses “combin[ing] sound and vibration by superimposing the current waveform in Fig. 4(a) and the current waveforms in Fig. 4(b) onwards.” *Id.*, [0042].



Id., Fig. 4 (annotated).

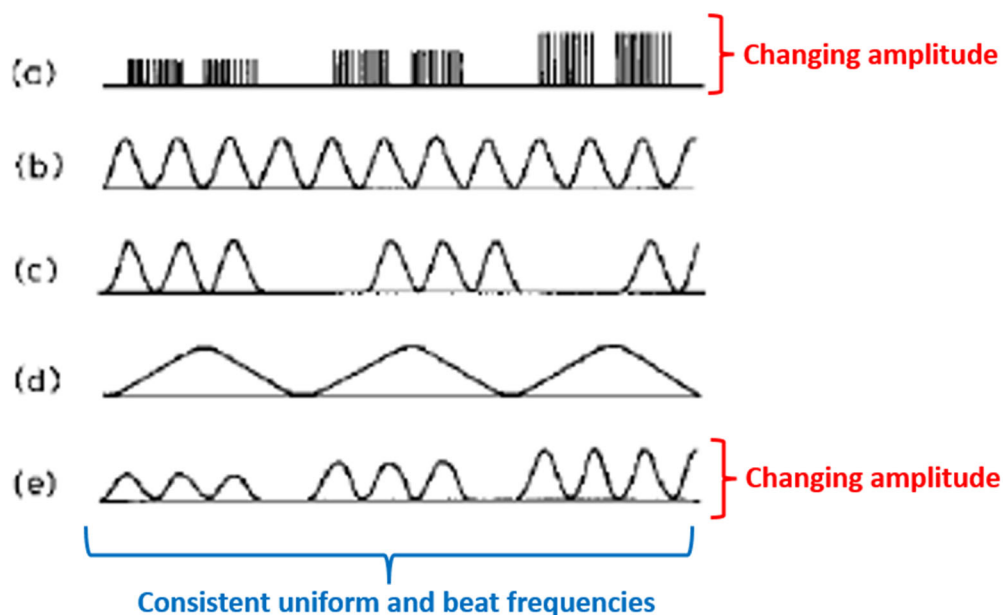
331. In my opinion, a POSITA would have recognized the combination of these two waveforms into one would create a complex vibration mode driving Ogusu’s moveable component at the plurality of different frequencies.

7. Claim 17

332. It is my understanding that Claim 17 depends from claim 1 and further recites “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.” In my opinion, Ogusu alone or in combination with Fukumoto teaches the additional limitations of claim 17. In Ogusu, a user selects a vibration in the pager control section available, and that corresponds to a waveform with a specific amplitude and frequency which is applied to the coils in Ogusu’s vibrator actuator. *See* ¶¶ 316–322; *Ogusu*, [0055]:

[FIG. 4]



Id., Fig. 4.

333. In addition, Fukumoto expressly discloses the process for correlating a user input to a desired waveform, converting that waveform to a drive signal, and applying that drive signal to its oscillatory actuator. *See* ¶¶ 172–185. In my opinion, applying the implementation details in Fukumoto to Ogusu would have amounted to

no more than applying a known technique (Fukumoto's process for converting a user input to a drive signal) to a known device ready for improvement (Ogusu's pager including its vibration actuator) to yield predictable results (a vibration actuator providing the desired vibration output with a specific amplitude and frequency corresponding to a user input).

334. Therefore, Ogusu alone or in combination with Fukumoto teaches the additional limitations of claim 17.

X. Ground 2B: Ogusu, Fukumoto, and Grant Renders Obvious Claims 1, 2, 7, 11, 15, 17, and 20

335. As I described above, ¶¶ 217–219, 221–223 explains that Fukumoto in view of Grant teaches limitation 1[f] as well as the additional limitations of claim 17. I explained at ¶¶ 301–334 that Ogusu in combination with Fukumoto renders claims 1, 2, 7, 11, 15, 17, and 20 obvious. Ogusu in view of Fukumoto and Grant also renders claims 1, 2, 7, 11, 15, 17, and 20 obvious. For this ground, the analysis of limitation 1[f] as well as the additional limitation of claim 17 I discussed in ¶¶ 217–219, 221–223 applies equally to the Ogusu-Fukumoto combination discussed in ¶¶ 301–334. A POSITA would have been motivated to combine the Fukumoto-Grant combination for those limitations with the Ogusu-Fukumoto combination for the same reasons as with Fukumoto alone. *See* ¶¶ 213–215, 301.

Y. Ground 2C: Ogusu, Fukumoto, and Barton Renders Obvious Claims 1, 2, 7, 11, 15, 17, and 20

336. As I described above, ¶¶ 227–229, 231–233 explains that Fukumoto in view of Barton teaches limitation 1[f] as well as the additional limitations of claim 17. I explained at ¶¶ 301–334 that Ogusu in combination with Fukumoto renders claims 1, 2, 7, 11, 15, 17, and 20 obvious. Ogusu in view of Fukumoto in view Barton also renders claims 1, 2, 7, 11, 15, 17, and 20 obvious. For this ground, the analysis of limitation 1[f] as well as the additional limitations of claim 17 I discussed in ¶¶ 227–229, 231–233 applies equally to the Ogusu-Fukumoto combination I discussed in ¶¶ 301–334. A POSITA would have been motivated to combine the Fukumoto-Barton combination for those limitations with the Ogusu-Fukumoto combination for the same reasons as with Fukumoto alone. *See* ¶¶ 224–225, 301.

Z. Ground 2D: Ogusu, Fukumoto, and Ueda Renders Obvious Claims 3–6

337. In Ground 1D (¶¶ 234–252), I explain how Ueda teaches the additional limitations of dependent claims 3-6 and that a POSITA would have been motivated to modify Fukumoto's PDA with Ueda's feedback control. The same analysis applies to combining Ueda's feedback control with the Ogusu-Fukumoto combination discussed above for independent claim 1 (¶¶ 301–322). In the combination here, the control component in the Ogusu-Fukumoto combination would receive the output signals from sensors as taught in Ueda and adjust the

operational control outputs according to those signals. For motivation to combine, modifying the pager in the Ogusu-Fukumoto combination with Ueda's feedback control would have amounted to no more than applying a known technique (Ueda's feedback control) to a device ready for improvement (the pager in the Ogusu-Fukumoto combination) to yield predictable results (a vibration actuator using feedback control to achieve the desired vibration output). Additionally, a POSITA would have recognized that doing so would have resulted in the pager in the Ogusu-Fukumoto combination more reliably delivering vibrations at the desired frequency and amplitude. *Ueda*, [0165]–[0166], [0347].

AA. Ground 2E: Ogusu, Fukumoto, Grant, and Ueda Renders Obvious Claims 3–6

338. As I described above, ¶ 335 explains that Ogusu in view of Fukumoto and Grant renders claim 1 obvious. I explained at ¶ 337 that Ogusu in combination with Fukumoto and Ueda renders Claims 3–6 obvious. Ogusu in view of Fukumoto, Grant, and Ueda also renders claims 3–6 obvious. For this ground, the additional teachings of Ogusu and Ueda discussed in ¶ 337 would be combined with the Fukumoto-Grant combination discussed in ¶¶ 213–219. A POSITA would have been motivated to combine the relied upon teachings from Ueda with the Ogusu-Fukumoto-Grant combination for the same reasons as with the Ogusu-Fukumoto combination. *See* ¶¶ 335, 337.

BB. Ground 2F: Ogusu, Fukumoto, Barton, and Ueda Renders Obvious Claims 3–6

339. As I described, ¶ 336 explains that Ogusu in view of Fukumoto and Barton renders claim 1 obvious. I explained at ¶ 337 that Ogusu in combination with Fukumoto and Ueda renders claims 3–6 obvious. Ogusu in view of Fukumoto, Barton, and Ueda also renders claims 3–6 obvious. For this ground, the additional teachings of Ogusu and Ueda discussed in ¶ 337 would be combined with the Ogusu-Fukumoto-Barton combination discussed in ¶¶ 224–229. A POSITA would have been motivated to combine the relied upon teachings from Ueda with the Ogusu-Fukumoto-Barton combination for the same reasons as with the Ogusu-Fukumoto combination. *See* ¶ 336, 337.

CC. Ground 2G: Ogusu, Fukumoto, and Erixon Renders Obvious Claims 7-8

340. As I described in Ground 1G (¶¶ 255–261), I explain how Erixon teaches the additional limitations of dependent claims 7–8 and that a POSITA would have been motivated to apply Erixon’s teachings of an electromagnetic vibrator for use in a mobile phone with Fukumoto’s mobile device. The same analysis applies to combining Erixon’s electromagnetic vibrator with the Ogusu-Fukumoto combination discussed above for independent claim 1 (¶¶ 301–322). In the combination here, the Ogusu-Fukumoto combination is further combinable with Erixon because all are directed to electromagnetic vibration generation in mobile

devices using compact and energy efficient vibrators. *Fukumoto*, Fig. 3, Fig. 16, 14:38–15:4, 16:17–37, 50:48–59; *Ogusu*, [0002]; *Erixon*, Abstract, Figs. 1, 2, [0002], [0053], [0075], [0099], [0102]. Further, A POSITA would have recognized that the proposed combination would have amounted to no more than applying a known technique (*Erixon*’s linear vibrator driven by electromagnetic coils and movement-repelling centering magnets in a linear housing surrounded by magnetic field-enhancing ferrofluid) to a known device ready for improvement (the *Ogusu-Fukumoto* combination’s mobile device including a linear oscillatory actuator driven by electromagnetic coils that uses a single spring in a case) to yield predictable results (a mobile device with a smaller and more efficient vibration unit). Additionally, a POSITA would also have been motivated to make this combination to increase the responsiveness and efficiency of the linear movement by adding conductive ferrofluid that simultaneously decreases the linear friction created by the linear vibrator’s movement, which further decreases the amount of power required to achieve quicker vibrational effects and improves battery life of the mobile device. *Erixon*, Abstract, [0073]–[0074], [0106]

DD. Ground 2H: Ogusu, Fukumoto, Grant, and Erixon Renders Obvious Claims 7-8

341. As I described above, ¶ 335 explains that *Ogusu* in view of *Fukumoto* and *Grant* renders claim 1 obvious. I explained at ¶ 340 that *Ogusu* in combination

with Fukumoto and Erixon renders claims 7 and 8 obvious. Ogusu in view of Fukumoto, Grant, and Erixon also renders claims 7–8 obvious. For this ground, the additional teachings of Erixon discussed in ¶¶ 255–261 would be combined with the Ogusu-Fukumoto-Grant combination discussed in ¶ 335. A POSITA would have been motivated to combine the relied upon teachings from Erixon with the Ogusu-Fukumoto-Grant combination for the same reasons as with the Ogusu-Fukumoto combination. *See* ¶¶ 335, 340.

EE. Ground 2I: Ogusu, Fukumoto, Barton, and Erixon Renders Obvious Claims 7-8

342. As I described above, ¶ 336 explains that Ogusu in view of Fukumoto and Barton renders claim 1 obvious. I explained at ¶ 340 that Ogusu in combination with Fukumoto and Erixon renders claims 7 and 8 obvious. Ogusu in view of Fukumoto, Barton, and Erixon also renders claims 7–8 obvious. For this ground, the additional teachings of Erixon discussed in ¶¶ 255–261 would be combined with the Ogusu-Fukumoto-Barton combination discussed in ¶ 336. A POSITA would have been motivated to combine the relied upon teachings from Erixon with the Ogusu-Fukumoto-Barton combination for the same reasons as with the Ogusu-Fukumoto combination. *See* ¶¶ 336, 340.

XII. Secondary Considerations

343. At this stage of these proceedings, it is my understanding that Petitioner has no burden to identify and rebut secondary considerations. Rather, it is my understanding that Patent Owner must first present a prima facie case for such consideration, which Petitioners should then have the chance to rebut. That said, I have considered evidence of secondary considerations that I am aware of at this time, and I am currently unaware of any evidence of secondary considerations that would support a finding of non-obviousness.

I, Andrew Wolfe, declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: June 14, 2023

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'A. Wolfe', is written above a horizontal line.

Andrew Wolfe, Ph.D.

EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent 9,941,830 B2 (“’830Pat.”)
1002	File History of U.S. Patent 9,941,830 (“’830FH”)
1003	Declaration of Andrew Wolfe, Ph.D.
1004	Curriculum Vitae of Andrew Wolfe, Ph.D.
1005	U.S. Patent 7,292,227 B2 (“Fukumoto”)
1006	U.S. Patent Application Publication 2006/0284849A1 (“Grant”)
1007	U.S. Patent Application Publication 2006/0248183A1 (“Barton”)
1008	U.S. Patent Application Publication 2004/0169480A1 (“Ueda”)
1009	U.S. Patent Application Publication 2008/0174187A1 (“Erixon”)
1010	U.S. Patent Application Publication 2008/0001484A1 (“Fuller”)
1011	China Patent Application Publication 101488697A (“Dong”)
1012	Certified Declaration of Dong Translation
1013	U.S. Patent 7,006,641 (“Saiki”)
1014	U.S. Patent 8,917,486 (“Masahiko”)
1015	Japan Patent Application Publication JPH08196053A (“Ogusu”)
1016	Certified Declaration of Ogusu Translation
1017	Complaint in <i>Resonant Systems, Inc. v. Samsung Elecs. Co., Ltd.</i> , 2:22-cv-00423 (E.D. Tex. October 26, 2022)
1018	Docket Control Order in <i>Resonant Systems, Inc. v. Samsung Elecs. Co., Ltd.</i> , 2:22-cv-00423 (E.D. Tex.)
1019	Discovery Order in <i>Resonant Systems, Inc. v. Samsung Elecs. Co., Ltd.</i> , 2:22-cv-00423 (E.D. Tex.)
1020	Joint Motion for Entry of Agreed Docket Control Order in <i>Resonant Systems, Inc. v. Samsung Elecs. Co., Ltd.</i> , 2:22-cv-00423 (E.D. Tex.)
1021	Joint Motion for Entry of Agreed Discovery Order in <i>Resonant Systems, Inc. v. Samsung Elecs. Co., Ltd.</i> , 2:22-cv-00423 (E.D. Tex.)
1022	Amended Infringement Contentions in <i>Resonant Systems, Inc. v. Samsung Elecs. Co., Ltd.</i> , 2:22-cv-00423 (E.D. Tex.)
1023	U.S. Patent 9,369,081 B2 (“’081Pat.”)

1024	File History of U.S. Patent 9,369,081 (“’081FH”)
1025	U.S. Patent 8,860,337B2 (“’337Pat.”)
1026	File History of U.S. Patent 8,860,337B2 (“’337FH”)
1027	U.S. Patent 8,093,767B2 (“’767Pat.”)
1028	File History of U.S. Patent 8,093,767B2 (“’767FH”)
1029	File History of Provisional Patent Application 61/179,109
1030	U.S. Patent Application Publication 2011/0144426A1 (“Blenk”)
1031	U.S. Patent Application Publication 2011/0248817A1 (“Houston”)
1032	U.S. Patent Application Publication 2007/0261185A1 (“Guney”)
1033	U.S. Patent No. 3,919,616 (“Allison”)
1034	U.S. Patent Application Publication 2009/0295739A1 (“Nagara”)
1035	U.S. Patent Application Publication 2008/0153554A1 (“Yoon ’554”)
1036	U.S. Patent Application Publication 2008/0155415A1 (“Yoon ’415”)
1037	Exar Databook, <i>XR-8038: Precision Waveform Generator</i> , Chapter 1 at 213–214 (1985), (“Exar”)
1038	Herbert Friedman, <i>99 Electronic Projects</i> , Lafayette Radio Electronics at 126 (1971), (“Friedman”)
1039	Paul Horowitz and Winfield Hill, <i>The Art of Electronics, 2nd Edition</i> , Cambridge University Press at 153–293 (1980), (“Horowitz”)
1040	Water G. Jung, <i>IC Op-Amp Cookbook, Second Edition, The Art of Electronics, 2nd Edition</i> , Howard W. Sams & Co., Inc. at 360–362 (1974), (“Jung”)
1041	Jacob Millman, <i>Micro-Electronics: Digital and Analog Circuits and Systems</i> , McGraw-Hill Book Company at 651–653 (1979), (“Millman”)
1042	STMicroelectronics, <i>L298: Dual Full-Bridge Driver</i> , STMicroelectronics at 1–13 (2000), (“STMicroelectronics”)

CLAIM LISTING

Reference	Claim Limitation
Claim 1	
1[pre]	A vibration module comprising:
1[a]	a housing;
1[b]	a moveable component;
1[c]	a power supply;
1[d]	user-input features;
1[e]	a driving component that drives the moveable component to oscillate within the housing; and
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[pre]	The vibration module of claim 1 wherein the control component is one of:
2[a]	an variable oscillator circuit with additional control circuitry; and
2[b.i]	a control component that includes a microprocessor,
2[b.ii]	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 linear 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 linear vibration module produces desired outputs from the one or more sensors corresponding to one or more operational control parameters.
Claim 5	
5[a]	The vibration module of claim 4 wherein the one or more operational control parameters is a strength of vibration produced by the linear oscillation of the moveable component; and
5[b]	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	
6[a]	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
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	
8[a]	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;

8[b]	wherein the movable component is a magnet shaped to slide within the tube; and
8[c]	wherein the driving component is an electromagnetic coil.
Claim 9	
9	The vibration module of claim 1 wherein the housing is a linear tube, capped at both ends by movable-component-repelling components; and wherein the moveable component includes an electromagnetic-coil driving component and microprocessor.
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 14	
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.
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	
16	The vibration module of claim 15 wherein the complex vibration modes include: a primary oscillation frequency modulated by a modulating oscillation frequency; a beat frequency; and 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 19	
19[pre]	A vibration module comprising:
19[a]	a housing;

19[b]	a moveable component;
19[c]	a power supply;
19[d]	user-input features;
19[e]	a driving component that drives the moveable component to oscillate within the housing;
19[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; and
19[g]	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.
Claim 20	
20[pre]	A vibration module comprising:
20[a]	a housing;
20[b]	a moveable component;
20[c]	a power supply;
20[d]	user-input features;
20[e]	a driving component that drives the moveable component to oscillate within the housing; and
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; and
20[g]	wherein the control component drives simultaneous oscillation of the moveable component at two or more frequencies to generate complex vibration modes.