

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VALVE CORPORATION,
Petitioner,

v.

IMMERSION CORPORATION
Patent Owner.

Case No. IPR2024-00714
Patent No. 10,627,907

DECLARATION OF JEAN RENARD WARD

Valve Exhibit 1003 Valve v. Immersion
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I. INTRODUCTION

1. My name is Jean Renard Ward. I have been retained by Wolf, Greenfield & Sacks, P.C., counsel for Petitioner Valve Corp. to assess Claims 1-20 (“the challenged claims”) of U.S. Patent No. 10,627,907 (“the ’907 Patent”) (EX1001). I am being compensated for my time at the rate of \$500 per hour, plus actual expenses. This is consistent with the rate I generally charge for this sort of work. My compensation is not dependent in any way upon the outcome of the *inter partes* review of the ’907 Patent, nor on the outcome of any related litigation.

2. I expect to make myself available for deposition in this matter. This Declaration is based on information currently available to me. I reserve the right to continue my investigation and study, which may include a review of documents and information that may be produced, as well as a review of deposition testimony from depositions for which transcripts are not yet available or that may yet have taken place in this matter. Therefore, I expressly reserve the right to expand or modify my opinions as my investigation and study continue, and to supplement my opinions in response to any additional information that becomes available to me, any matters raised by Immersion or the Patent Office, and/or other opinions provided by Immersion’s experts, or in light of any relevant orders by an appropriate authoritative body.

II. QUALIFICATIONS AND PROFESSIONAL EXPERIENCE

3. I received an SBEE degree (combined program in Electrical Engineering and Computer Science) from the Massachusetts Institute of Technology as a member of the class of 1973.

4. I am a practicing engineer. For a number of years, I have primarily been doing consulting projects and contract development work under the business name of Rueters-Ward Services. I have worked professionally in the general field of software engineering and relevant hardware for approximately 50 years, primarily in pen/touch computing and related technologies, applications of public-key cryptography, and web development. In recent years, my major projects have concerned pen/touch computing: also referred to simply as pen computing or touch computing. Pen computing refers to computing that makes use of a pen, stylus (including a finger), or other touch-sensitive tool, and a tablet or touchscreen. This is contrasted with computing that makes use of devices such as a physical keyboard or a physical mouse.

5. During and immediately after my university studies, from 1973 to 1977, I worked at Data General Corporation on compilers and source-level emulation tools for a number of programming languages.

6. For the next approximately 17 years, I worked primarily on many aspects of pen computing, both software and hardware, at a number of development

companies. From 1977 to 1987, I was heavily involved in the development of base technology and three generations of pen-computing products of Pencept Inc., a pioneering commercial company for pen-computing technology that I co-founded. Pencept filed for and was granted a number of patents for my work during that time. My contributions included developing novel techniques for gesture and handwriting recognition, new paradigms for pen- and stylus-based user interfaces, two generations of an applicative computer language for gesture and handwriting recognition, and engineering solutions to problems with touchscreens and digitizing tablets.

7. While at Pencept, I participated in the re-engineering of off-the-shelf commercial tablets that detected touch from an electronic stylus; the engineering evaluation of off-the-shelf tablet technologies, including at least one having transparent touchscreen sensors that responded both to finger touches and to touch by a specialized stylus; and the design of a custom electronic tablet responsive to an electromagnetic stylus.

8. During that time and in the years following, I authored or co-authored a number of peer-reviewed articles concerning pen-computing, generative models for handwriting variability, and digitizer/touchscreen technologies and error behaviors.

9. These articles are listed in my CV, which is EX1004 to this declaration. I was an invited speaker at an international research conference on handwriting recognition in Montreal, Canada. I also made presentations concerning gesture input for Pencept and its competitors to the Graphical Kernel System (GKS) and Programmer's Hierarchical Interactive Graphics System (PHIGS) standardization committees for computer graphics systems, and organized and chaired a panel discussion concerning real-world problems of handwriting recognition technology at another academic conference. I was also invited to visit and speak to the research groups in pen computing at a number of major computer technology companies, including IBM in the United States and the AEG-Telefunken Research Center in Germany.

10. In 1989, I joined the Freestyle development group at Wang Laboratories as a Software Architect. Freestyle was a direct-manipulation pen-computing system that integrated stylus- and voice-input and annotations. During my tenure there, Wang filed for and later was granted U.S. and international patents for my work on simulating virtual keyboard and mouse input from stylus user input on a touch-sensitive tablet. In addition, I was the lead engineer for Wang on a joint hardware project with for a low-power, touchscreen technology using a capacitive stylus for a line of highly-portable handheld computers.

11. In 1991, at the end of Freestyle development, I joined Slate Corporation, a company formed to develop pen-centric applications for both the new Pen-Point (GO Corporation) and Pen Windows (Microsoft) operating systems for tablet and touchscreen computers. During that time, I was Slate's representative and the co-chair of a number of meetings involving GO Corporation, Microsoft, and other companies concerning the JOT cross-platform storage-level standard for compressed electronic ink data, and was the primary author of the first draft for that standard. I made presentations regarding the history of pen computing to technical groups interested in the topic. I also conducted tutorials on touchscreen/pen interfaces and technology at two annual meetings of the Society for Information Display, the leading engineering society for display technologies.

12. From approximately 1993 onward, my professional work has been primarily as an independent developer and consultant in the areas of applications of public-key cryptography and computer security, in addition to pen/touch computing.

13. Since the late 1980s, I have maintained an extensive library of references relating to pen-computing, touchscreens, and related technical subjects. I have continually published a working annotated bibliography of these references on the internet for more than 20 years.

14. In about 1985 to 1987, I was preparing an article for publication in the IEEE journal "Systems Man and Cybernetics", which included a substantial review

of problems presented by handwriting variability in the field of handwriting and gesture recognition using touch screens and tablets. About this same time, I also prepared a tutorial article for the IEEE publication Computer Graphics and Applications on some of the broad variety of touch screen and tablet technologies and an introduction to their technical limitations. In the course of preparing those articles, I began keeping a bibliography in electronic form, with annotations, to assist in referencing the articles. I also spent several days, for each article, doing technical research in the MIT engineering library – the Internet did not exist at that time. At the end of those projects, I had an electronic database of several hundred references with annotations. To assist me in keeping up to date and preparing possible future presentations or articles (such as a presentation I gave a few years later on the history of pen and touchscreen computing), I decided to add other references I collected in my professional work, and to continue adding references of interest.

15. When the Internet became available, a number of technical people in computer-related fields began publishing their technical materials on the Internet as a service to each other. As a service to those with an interest in the field, I also began posting my bibliography online in about the early 1990s. In more recent years, because of my professional work and because of the relation to applications, the bibliography also contains references related to computer security, cryptography, and DRM digital rights management.

16. The bibliography is available on my professional web site at www.ruetersward.com, and on a number of mirrors. The annotations appearing in the bibliography were written by me to provide a short statement/reminder of what I thought was interesting and/or relevant about each reference at the time. It has been my usual practice to update the bibliography at irregular periods several times a year or more often, as I had time. The bibliography has been cited in technical papers by others, by the USPTO, and in academic degree theses such as at M.I.T.

17. I obtained copies of the many of the publications and references in the course of the projects I have worked on throughout my career, others through my independent reading and study. I keep hard or electronic copies of the majority of the references as part of my personal records. I have read the references in my bibliography because of my professional work, my intellectual interests, to keep up to date with developments in pen-computing and other fields, and/or to record the history of the field.

18. Touchscreens and touch sensors are haptic/tactile input devices, responding to touch and similar input. The technologies extend to touch, pressure, force and proximity sensing broadly, as well as to many aspects of interactive computing systems and devices. As these devices are also used in conjunction with haptic/tactile output, in multiple forms, my technical interests (and the reference bibliography) includes haptic output and interactions. (For personal reasons, I have

a particular interest in technologies of tactile displays and tactile devices for the visually impaired). It has been my practice, as the fields have evolved over the years, to include references for these various related and intertwined subjects in the bibliography for their relevance.

19. I also have a personal collection of touch screen and touch tablet devices that I have acquired over the years. These include equipment from past projects I have worked on, as well as other items I considered of note, including a very early model portable phone with an integrated touch screen and display, a very early calculator that used an electromechanical touchpad for handwritten entry of calculations, at least one model of a very early PDA with an integrated touch screen and display and handwriting recognition, and various models from the early 1990's of portable touchscreen computers running one or another complete touchscreen operating systems, and devices such as smartphones with haptic/vibrotactile feedback.

20. A copy of my curriculum vitae with descriptions of my education, professional achievements, and qualifications is attached to this declaration as EX1004. It includes a listing of relevant industry experience, publications, presentations, and prior testimony.

III. MATERIALS REVIEWED AND CONSIDERED

21. My findings, as explained below, are based on my years of education, research, experience, and background in the fields of software engineering, haptics programming, human-computer interaction and/or pen and touch computing, as well as my investigation and study of relevant materials for this declaration. When developing the opinions set forth in this declaration, unless noted otherwise, I have assumed the point of view of a person having ordinary skill in the art (“POSITA”), as set forth in Section V below. In forming my opinions, I have studied and considered the materials identified in the list below

Exhibit	Description
1001	U.S. Patent No. 10,627,907
1002	Prosecution History of U.S. Patent No. 10,627,907
1003	Declaration of Jean Renard Ward
1004	CV of Jean Renard Ward
1005	U.S. Patent Appl. Pub. No. 2008/0055244 (“Cruz-Hernandez”)
1006	U.S. Patent Appl. Pub. No. 2007/0152988 (“Levin”)
1007	U.S. Patent Appl. Pub. No. 2013/0147610
1008	U.S. Patent Appl. Pub. No. 2001/008849
1009	Proof of Service in <i>Immersion Corp. v. Valve Corp.</i> , 2:23-cv-00712
1010	Defendant Valve’s Motion to Stay Pending <i>Inter Partes</i> Review, <i>Immersion Corp. v. Valve Corp.</i> , 2:23-cv-00712 (W.D. Wash.)
1011	Federal Court Management Statistics (September 2003)
1012	U.S. Patent Appl. Pub. No. 2006/0142657
1013	<i>Immersion Corp. v. Valve Corp.</i> , 2:23-cv-00712, Dkt. No. 1 (Complaint) (W.D. Wash.) (filed Oct. 20, 2023)
1014	Plaintiff’s Preliminary Infringement Contentions, <i>Immersion Corp. v. Valve Corp.</i> , 2:23-cv-00712 (W.D. Wash.) (served Oct. 20, 2023)
1015	Exhibit E to Plaintiff’s Preliminary Infringement Contentions, <i>Immersion Corp. v. Valve Corp.</i> , 2:23-cv-00712 (W.D. Wash.) (served Oct. 20, 2023)

1016	U.S. Patent Appl. Pub. No. 2004/0032395 (“Goldenberg”)
1017	U.S. Patent Appl. Pub. No. 2007/0139375 (“Rosenberg”)
1018	U.S. Patent No. 6,203,432 (“Roberts”)
1019	November 21, 2023 Order Setting Jury Trial in <i>Immersion Corp. v. Valve Corp.</i> , Case No. 2:23-cv-00712 (W.D. Wash.)
1020	U.S. Patent No. 4,739,128
1021	U.S. Patent No. 6,480,185
1022	<i>RESERVED – NOT USED</i>
1023	International Application Publication Number WO 1999/066997A1
1024	Minsky et al., “Feeling and seeing Issues in force display.” In Proceedings of the 1990 symposium on Interactive 3D graphics (I3D '90). Association for Computing Machinery, New York, NY, USA, 235–241.
1025	Miller et al., "Design of 3D haptic widgets". Proceedings of the Symposium on Interactive 3D Graphics, 1999, pp. 97-102.
1026	U.S. Patent No. 5,914,705
1027	U.S. Patent No. 5,414,337
1028	U.S. Patent No. 4,590,909
1029	U.S. Patent No. 3,721,309
1030	U.S. Patent No. 2,710,596
1031	U.S. Patent No. 2,679,234
1032	“Jog dial.” Wikipedia, https://en.wikipedia.org/w/index.php?title=Jog_dial&oldid=332257258 (accessed Nov. 21, 2023)
1033	U.S. Patent No. 4,866,542
1034	U.S. Patent No. 5,289,439
1035	U.S. Patent No. 4,549,173
1036	U.S. Patent No. 4,344,351
1037	“Submachine gun.” Wikipedia, 10 November 2014, https://en.wikipedia.org/w/index.php?title=Submachine_gun&oldid=633180945 (accessed Feb. 10, 2024)
1038	“Sa 23.” Wikipedia, 9 December 2014, https://en.wikipedia.org/w/index.php?title=Sa_23&oldid=637263283 (accessed Feb. 10, 2024)
1039	U.S. Patent No. 4,553,258
1040	U.S. Patent No. 4,865,149
1041	Ramstein et al., “The PANTOGRAPH: A large workspace haptic device for a multi-modal human-computer interaction.” CHI'94, Conference on Human Factors in Computing Systems ACM/SIGCHI Companion-4/94. 57-58 (1994).

1042	Rosenberg, "A Force Feedback Programming Primer-For PC Gaming Peripherals Supporting I-Force 2.0 and Direct-X 5.0," Immersion Corporation 1997.
1043	U.S. Patent No. 5,184,319
1044	Solomon, "Sensors Handbook" 2 nd Edition, McGraw-Hill 2010.
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1046	Webster, J.G., & Eren, H. (Eds.). (2014). Measurement, Instrumentation, and Sensors Handbook: Spatial, Mechanical, Thermal, and Radiation Measurement (2 nd ed.). CRC Press.
1047	Buxton, "Touch Gesture and Marking," chapter 7 of Baecker, Human-Computer Interaction
1048	U.S. Patent No. 6,160,489
1049	Strong, "An Electrotactile Display," IEEE, Trans. On Man-Machine Sys., mms-11:1 (Mar. 1970)
1050	Massie, "Initial Haptic Explorations with the Phantom: Virtual Touch Through Point Interaction" MIT Thesis (1996)
1051	Bliss, "Optical-to-Tactile Image Conversion for the Blind," IEEE, Trans. On Man-Machine Sys., mms-11:1 (Mar. 1970)
1052	European Patent Publication No. EP 0265011A1
1053	U.S. Patent No. 5,388,992
1054	IBM, "Mouse Ball-Actuating Device with Force and Tactile Feedback," IBM Technical Disclosure Bulletin 32:9B (Feb. 1990)
1055	Fukumoto, "Active Click Tactile Feedback for Touch Panels," CHI 2001 Interactive Posters (2001)
1056	International Application Publication Number WO 92/00559A1
1057	U.S. Patent Application Publication No.2006/0241864A1
1058	U.S. Patent No. 5,782,639
1059	U.S. Patent Application Publication No. 2006/0049010
1060	International Application Publication Number WO 2004/042693
1061	U.S. Application Publication No. 2003/0030619
1062	U.S. Patent No. 6,424,333
1063	European Application Publication No. EP0799597A1
1064	U.S. Patent No. 5,719,561
1065	U.S. Patent No. 5,973,441
1066	Minsky, "Computational Haptics: The Sandpaper System for Synthesizing Texture for a Force-Feedback Display" MIT Thesis (1995)
1067	U.S. Patent No. 5,451,924

1068	Patrick, “Design Construction and Testing of a Fingertip Tactile Display for Interaction with Virtual and Remote Environments,” MIT Thesis (1990)
1069	Massie, “The PHANToM Haptic Interface—A Device for Probing Virtual Objects” in ASME, Dynamic Systems and Control (1994)
1070	U.S. Patent No. 5,982,352
1071	U.S. Patent No. 6,131,097
1072	U.S. Patent No. 6,337,678
1073	U.S. Patent No. 6,219,034
1074	U.S. Patent No. 6,219,032
1075	U.S. Patent No. 4,885,565
1076	Wilson, Sensor Technology Handbook. Elsevier 2005.
1077	Sydenham P.H., Thorn R. (Eds.). (2005.) Handbook of Measuring System Design. John Wiley & Sons, Ltd.
1078	Zumbahlen, “Basic Linear Design,” Analog Devices, Inc. 2007.
1079	Sheingold, “Nonlinear Circuits Handbook: Designing with Analog Function Modules and ICs (2 nd ed.),” Analog Devices, Inc. 1976.
1080	Johnson, “Process Control Instrumentation Technology (8 th ed.),” Pearson Education Limited 2014.
1081	deSilva, Sensors and Actuators: Control System Instrumentation. CRC Press 2007.
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1084	U.S. Patent No. 5,012,415
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1086	“function.” Wikitionary, (30 August 2017) https://web.archive.org/web/20170830044824/https://en.wiktionary.org/wiki/function (accessed Feb. 22, 2024) Wiktionary
1087	“transfer function.” Wikitionary, (7 April 2014) https://web.archive.org/web/20140407051205/http://en.wiktionary.org/wiki/transfer_function (accessed Feb. 22, 2024)
1088	“Analog-to-digital converter.” Wikipedia, 26 November 2014, https://en.wikipedia.org/w/index.php?title=Analog-to-digital_converter&oldid=635499644 (accessed Feb. 19, 2024)
1089	“Analog-to-Digital (ADC) Converter Types & ADC Functions” Arrow, https://www.arrow.com/en/research-and-events/articles/analog-to-digital-adc-converter-types-and-basic-functions (accessed Feb. 22, 2024)

1090	“How do Analog to Digital Converters (ADCs) work?” CircuitBread, (17 May 2022) https://www.circuitbread.com/ee-faq/how-do-analog-to-digital-converters-adcs-work (accessed Feb. 22, 2024)
1091	“computation.” Wikitionary, (14 August 2014) https://web.archive.org/web/20140814222220/http://en.wiktionary.org/wiki/computation (accessed Feb. 25, 2024)
1092	Carlson, Handbook of Analog Computation. Electronic Associates, Inc. 1971.
1093	“Analog computer.” Wikipedia, 30 November 2014, https://en.wikipedia.org/w/index.php?title=Analog_computer&oldid=636030888 (accessed Feb. 22, 2024)
1094	“analogue computer”, Newnes Dictionary of Electronics. 2002.
1095	“analog computer” Merriam-Webster Dictionary. 2 July 2013. https://web.archive.org/web/20130702122319/http://www.merriam-webster.com/dictionary/analog%20computer (accessed Feb 24, 2024)
1096	“analogue computer” Oxford Dictionary of Computer Science (2016)
1097	Ulmann, Analog Computing. Oldenbourg Wissenschaftsverlag GmbH. 2013.
1098	Hyndman, Analog and Hybrid Computing. Pergamon Press. 1970.
1099	Scott, Analog and Digital Computer Technology. McGraw-Hill. 1960.
1100	Dictionary of Computer and Internet Terms (10 th ed.) Kaplan Publishing. 2009.
1101	U.S. Patent No. 5,189,355
1102	U.S. Patent No. 6,703,550
1103	U.S. Patent No. 5,513,306
1104	U.S. Application Publication No. 2003/0114075A1
1105	U.S. Patent No. 6,107,765
1106	U.S. Patent No. 5,642,288
1107	U.S. Patent No. 5,530,859
1108	U.S. Patent No. 7,671,846
1109	U.S. Patent No. 4,428,005
1110	"Stick shaker." Wikipedia. https://en.wikipedia.org/wiki/Stick_shaker (accessed Feb. 20, 2024)
1111	U.S. Application Publication No. 2011/0295395A1

IV. MY UNDERSTANDING OF THE RELEVANT LAW

22. I am not an attorney. My knowledge of the law is that of a lay person. As I am not a legal expert, I offer no opinions on the law. Unless noted otherwise, wherever I may use a term which has some special meaning in a legal context, I imply no such special legal meaning should be assigned to use of that term. Further, as I have no special expertise in the law, I am likely unaware whether a term even might or might not have some special legal meaning, nor what any such meaning might be.

23. In developing my opinions, Petitioner's attorneys ("Counsel" for short) discussed various relevant legal principles with me. When I have thought that my understanding could be based inadvertently in some part on my experience elsewhere, I have sought to confirm or correct that understanding with Counsel. I understood these principles when they were explained to me and have relied upon such legal principles, as explained to me, in the course of forming the opinions set forth in this declaration. I summarize my understandings in this respect as follows:

24. I understand that "*inter partes* review" (IPR) is a proceeding before the United States Patent & Trademark Office for evaluating the patentability of an issued patent's claims based on prior-art patents and printed publications.

25. I understand that, in this proceeding, Petitioner has the burden of proving that the challenged claims of the '907 Patent are unpatentable by a

preponderance of the evidence. I understand that “preponderance of the evidence” means that a fact or conclusion is more likely true than not true.

26. I understand that, in IPR proceedings, claim terms in a patent are “construed” or given their ordinary and customary meaning as understood by a person of ordinary skill in the art (“POSITA”) in the context of the entire patent and the prosecution history pertaining to the patent. If the specification or prosecution history provides a special definition for a claim term that differs from the meaning the term would otherwise possess, that special definition controls. I have applied these standards in my analysis and in deriving the opinions in this declaration.

27. I understand that a patent or other publication must first qualify as prior art before it can be used to render a patent claim anticipated or obvious. I understand that whether or not a particular reference qualifies as prior art is a legal determination: as I am not a lawyer, I have relied on Counsel to inform me as to whether a reference qualifies as prior art.

28. I understand that determining whether a particular patent or printed publication constitutes prior art to a challenged patent claim can require determining the effective filing date (also known as the priority date) to which the challenged claim is entitled. I understand that for a patent claim to be entitled to the benefit of the filing date of an earlier application to which the patent claims priority, the earlier application must have described the claimed invention in sufficient detail to convey

with reasonable clarity to a POSITA that the inventor had possession of the claimed invention as of the earlier application's filing date. I understand that a disclosure that merely renders the claimed invention obvious is not sufficient written description for the claim to be entitled to the benefit of the filing date of the application containing that disclosure.

29. I understand that for an invention claimed in a patent to be patentable, it must be, among other things, new (novel—*i.e.*, not anticipated) and not obvious from the prior art. My understanding of these two legal standards is set forth below.

A. Legal Standard for Anticipation

30. I understand that for a patent claim to be “anticipated” by the prior art (and therefore not novel), each and every limitation of the claim must be found, expressly or inherently, in a single prior-art reference. I understand that a claim limitation is disclosed for the purpose of anticipation if a POSITA would have understood the reference to disclose the limitation based on inferences that a POSITA would reasonably be expected to draw from the explicit teachings in the reference when read in light of a POSITA's knowledge and experience.

31. I understand that a claim limitation is inherent in a prior art reference if that limitation is necessarily present when practicing the teachings of the reference, regardless of whether a person of ordinary skill recognized the presence of that limitation in the prior art.

B. Legal Standards for Obviousness

32. I understand that if a patent claim is not anticipated, a patent claim may be invalid if it would have been obvious in view of a single prior-art reference or a combination of prior-art references.

33. I understand that a patent claim is obvious if the differences between the subject matter of the claim and the prior art are such that the subject matter as a whole would have been obvious to a person of ordinary skill in the relevant field at the time the invention was made. Specifically, I understand that the obviousness question involves a consideration of:

- 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
- if present, objective factors indicative of non-obviousness, such as commercial success, long-felt but unresolved needs, failure of others, etc. sometimes referred to as “secondary indicia” or “secondary considerations.”

To my knowledge, Patent Owner has not asserted any such secondary considerations with respect to the '907 Patent.

34. I understand that in order for a claimed invention to be considered obvious, a POSITA must have had a reason for combining teachings from multiple

prior-art references (or for altering a single prior-art reference, in the case of obviousness in view of a single reference) in the fashion proposed.

35. I further understand that in determining whether a prior-art reference would have been combined with other prior art or with other information within the knowledge of a POSITA, the following are examples of approaches and rationales that may be considered:

- combining prior-art elements according to known methods to yield predictable results;
- simple substitution of one known element for another to obtain predictable results;
- use of a known technique to improve similar devices in the same way;
- applying a known technique to a known device ready for improvement to yield predictable results;
- applying a technique or approach that would have been “obvious to try,” *i.e.*, choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success.
- known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art;

- some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior-art reference or to combine prior-art reference teachings to arrive at the claimed invention. I understand that this teaching, suggestion, or motivation may come from a prior-art reference or from the knowledge or common sense of one of ordinary skill in the art.

36. I understand that a universal motivation known in a particular field to improve technology can provide a motivation to combine prior art references even absent any hint or suggestion in the references themselves. I also understand that obviousness is determined in light of all the facts and that a given course of action often has simultaneous advantages and disadvantages, and that this does not necessarily obviate the existence of a motivation to combine teachings from multiple references.

37. I understand that for a single reference or a combination of references to render the claimed invention obvious, a POSITA must have been able to arrive at the claimed invention by modifying, implementing, or combining the teachings of the applied references.

V. THE PERSON OF ORDINARY SKILL IN THE ART

38. I understand that the novelty of a patent claim is based on the point of view of a Person of Ordinary Skill in the Art (“POSITA”). I understand that a

POSITA is a hypothetical person of ordinary inventive skill in the relevant art, who would also be aware of and understand the teachings of all possible prior art references. I also understand that a POSITA is not an automaton, but a person of ordinary creativity. I have applied this standard throughout my declaration.

39. I was asked to provide an opinion as to the level of skill for a POSITA as of December 23, 2014.

40. The '907 Patent relates to videogame controllers and other electronic devices that provide users with haptic effects. EX1001, 1:14-16. The patent describes user input elements (for example, joysticks or triggers of a videogame controller), as well as haptic output devices (for example, actuators) that are associated with the user input elements. The haptic output devices are used to provide "haptic effects" when the input element moves into certain position ranges. EX1001, 4:9-21.

41. In the context of the '907 Patent and the relevant prior art, a POSITA in this matter would have a bachelor's degree in electrical engineering, computer science, or a related field, plus at least two years of industry or graduate level experience with software engineering, haptics programming, human-computer interaction, and/or other relevant experience.

42. In reaching this opinion as to the hypothetical POSITA, I have considered the types of problems encountered in the art, the prior art solutions to

those problems, the rapidity with which innovations are made, the sophistication of the technology, and the educational level and professional capabilities of workers in the field.

43. I have at least the qualifications of a POSITA. In many aspects my qualifications and expertise exceed that of a POSITA. However, I have also worked with many people who fit the characteristics of a POSITA, and I am familiar with their level of skill in and around December 23, 2014.

44. When developing my opinions for this declaration, and unless otherwise noted, my analysis and conclusions are based on the point of view and expertise of a POSITA.

VI. PRIMARY REFERENCES CONSIDERED

45. As I discuss more fully in Section XI, my analysis in this declaration focuses primarily on the following references:

Reference	Exhibit No.	Shorthand
U.S. Patent Appl. Pub. No. 2004/0032395	EX1016	Goldenberg
U.S. Patent Appl. Pub. No. 2008/0055244	EX1005	Cruz-Hernandez
U.S. Patent Appl. Pub. No. 2007/0139375	EX1017	Rosenberg
U.S. Patent No. 6,203,432	EX1018	Roberts
U.S. Patent Appl. Pub. No. 2007/0152988	EX1006	Levin

VII. SUMMARY OF MY OPINIONS

46. As I discuss more fully in Section XI, my opinion is that Claims 1-20 of the '907 Patent are each unpatentable. In particular, I have concluded that:

- Goldenberg anticipates and/or renders obvious Claims 1-6, 8-13, and 15-19.
- Goldenberg in view of Cruz-Hernandez renders obvious Claims 7, 14, and 20.
- Rosenberg anticipates and/or renders obvious Claims 1-4, 6, 8-11, 13, 15-17, and 19.
- Roberts in view of Rosenberg renders obvious Claims 5, 12, and 18.
- Roberts in view of Rosenberg and further in view of Cruz-Hernandez renders obvious Claims 7, 14, and 20.
- Levin anticipates and/or renders obvious Claims 1, 3-4, 6, 8, 10-11, 13, 15, 17, and 19.

VIII. AN OVERVIEW OF THE STATE OF THE RELEVANT ART

47. As part of my analysis and review, I considered what would have been known and understood by a POSITA as of December 23, 2014, which Counsel has informed me is the earliest priority date to which Claims 1-20 are entitled. I give an overview here, and additional overview comments on the background knowledge of a POSITA are presented in my analyses of the primary references. The overview,

of course, cannot be exhaustive. On this point, internal citations such as page numbers for background references are only exemplary of relevant teachings of the reference.

A. Remarks Concerning User Input Elements and Devices

48. The following is not intended to provide a narrow definition of any term, but to show the breadth of understanding that a POSITA would have in considering the art, and teachings of the art.

49. A POSITA would have understood that user input devices broadly include a class of electro-mechanical devices that permit a user of the device to provide some input to an associated system. A POSITA would also have understood that a user input device may have one or more user input elements, which may be components of the device that enable the user to provide a particular input. For example, a videogame controller may be a user input device for a videogame system, and a trigger, button, or joystick may be a user input element of the device. As another example, a radio interface may be a user input device that includes various knobs, buttons and touch sensors as user input elements. A POSITA would have understood that these are only two examples in a broad category of user input devices and elements, and that the relevant devices and elements include many other types besides videogame controllers and radio interfaces (for example, video playback interfaces, computer system components such as a keyboard or a mouse, and many

others). A POSITA would appreciate the generality of such principles also from multiple examples of input devices with multiple components or sub-devices.¹

B. Remarks Concerning Haptics

50. A POSITA would have been familiar with the term “haptics” as referring to a relation to contact or touch involving the human body. In the context of the relevant art it would have been used to characterize both input to a system via touch, and output or display from a system that can be perceived by one or more of the human senses of touch.² A POSITA would also know that other terms used in the art, such as “tactile,” “kinesthetic,” “tactual,” “force output,” “feel,” etc., had also been used interchangeably with “haptic” in various contexts, and would understand the meanings in context.

51. For ease in reading, I will generally use the terms “haptic” and “tactile.” Concerning haptic output, a POSITA would be familiar with multiple examples of

¹ EX1020 (US 4739128) teaches a single manipulandum – a joy stick that functions both as a joy stick and as a button without a separate “button.” The references also teaches passive force output using resilient spring. EX1021 (US 6480185) has similar teachings with examples of a trackball or a joystick, with passive force output, using a plunger biased by a spring. A POSITA would have understood these teachings to be applicable to more than just joystick/trackball-like devices, as a potentially preferred design choice to a separate button or other user input element.

² For example, a POSITA would have known how EX1047 (Buxton, “Touch Gesture and Marking,” chapter 7 of Baecker, *Human-Computer Interaction*) discusses both haptic input and haptic output, as well as force feedback.

and techniques for haptic output and feedback, including forces, vibrations, and electrical stimulation, as well as patterns of haptic output.³

52. In addition to haptic/touch input devices, a POSITA would have been familiar with multiple kinds of electronically-controlled haptic/tactile actuators for output of haptic effects. These would include voice-coil actuators,⁴ oscillatory or piezoelectric actuators,⁵ solenoids,⁶ and electromagnetic⁷ actuators, among many others.

53. A POSITA would be familiar with various techniques involving force-based feedback or output, such as simulations of real-world sensation. As one

³ For example, EX1048 (US 6160489) teaches the use of a plurality of distinctive tactile alert patterns (vibrations) generated with an axially offset counterweight driven by a motor, since audible alerts may not be heard, and visual indicators produced can go undetected by the user until the user looks. EX1049 (Strong, “An Electrotactile Display”) teaches direct electrotactile stimulation of the nerves in touching fingers, using different voltage amplitudes to indicate different touch areas and boundaries.

⁴ For example, EX1050 (Massie, “Initial Haptic Explorations with the Phantom: Virtual Touch Through Point Interaction”) teaches piezo elements and voice-coil speakers as vibrotactile actuators.

⁵ For example, EX1051 (Bliss, “Optical-to-Tactile Image Conversion for the Blind”) describes piezoelectric actuators for producing tactile sensations at small spacing.

⁶ For example, EX1052 (EP 0265011A1) teaches using piezoelectric or electromagnetic tactile elements as a matter of design choice for a computer mouse: a computer processor sends signals to activate the tactile elements, such as to produce vibrations while the cursor coincides to a special area.

⁷ For example, EX1053 (US 5388992) teaches voice-coil or small motor transducers to produce tactually perceived vibrations and also teaches directly converting output sound signals to tactile vibrations.

example, a POSITA would have been familiar with techniques for simulating clicks, frictions, textures, and resistive forces, via special and/or temporal patterns of vibrations.⁸

54. Along the same lines, a POSITA would know the teachings that haptic “jolt” sensations can be produced by short bursts of force or periods of vibration.⁹ In addition, a POSITA would also know from prior-art teachings that a jolt sensation is a vibrotactile sensation.¹⁰ For that matter, a POSITA would know from the prior

⁸ For example, EX1054 (IBM, “Mouse Ball-Actuating Device with Force and Tactile Feedback”) teaches tactile outputs for clicks, vibrations, crossing over line boundaries, and making mouse detents. It also teaches different tactile feedback for different regions, such as stepping over a grid or into an illegal zone. EX1055 (Fukumoto, “Active Click Tactile Feedback for Touch Panels”) teaches generating click feel sensations to a tapping fingertip using short periods of vibration, vibrating the whole touch panel. EX1056 (WO 9200559A1) teaches simulating textures, clicks, and edge effects via continuous or pulsed vibrations, when the user’s finger or stylus is moving across a surface, as well as “soft” function keys.

⁹For example, EX1006 (US 2007/0152988A1) [0036] and EX1023 (WO 1999066997A1) [4:25] teach that a “jolt” may be a force sensation. EX1057 (US 2006/0241864A1) teaches authentication sensations composed of quick jolts, over varying duration (e.g. 240 milliseconds), the jolts being constructions as sinusoidal vibrations of 80 Hz or 20 Hz, etc. at [0107], [0109], [0110]. Likewise, EX1055 (Fukumoto “Active Click Tactile Feedback for Touch Panels”) teaches a “click feel” (that is, jolt sensation) that is expressed by adding a single pulse or short burst signal by an electric to vibration transducer (page 121), and EX1058 (US 5782639) teaches a chassis mounted vibration generator which simulates jolts from explosions at 19:52-53.

¹⁰For example, this was taught by EX1059 (US 2006/0049010) which discloses at [0026] that: “Other vibrotactile effects may also be implemented, such as a jolt, shake, buzz, or other suitable vibrotactile effect.” (emphasis added). Likewise, EX1060 (WO 2004042693) teaches that “Suitable tactile sensations include

art that vibrotactile and force sensations also include sensations for clicks, touch and contact, rotation, textures, and thumps, etc.¹¹, and that vibrotactile sensations can be substituted for force-reflecting reactive feedback.¹²

55. In addition, a POSITA would have known and fully appreciated the prior art teachings for simulating detents with both vibrotactile and force feedback,

vibrations, for example, jolts and textures, and a plurality of distinct tactile sensations can be created by varying the frequency, amplitude and waveform output by the actuator 6" at 5:12-15 (emphasis added). Also EX1061 (US 2003/0030619) states at [0045] "a jolt of 'pulse' sensation can be output, which is a single impulse of force that quickly rises to the desired magnitude and then is turned off or quickly decays back to zero or small magnitude" and continues at [0060] "[i]n vibrotactile embodiments, only a very small range of motion is required to produce effective pulses (jolts) or vibrations on the direction pad 18." (emphasis added).

¹¹ For example, EX1062 (US 6424333) teaches vibrotactile simulation of sensations of textures (1:35), pressure (5:18-25), and contact with fluids and solids (5:41-43); EX1063 (EP 0799597A1) teaches vibro-tactile stimulation to convey a sense of rotation at 3:20-23; EX1064 (US 5719561) teaches using an array of vibrators to give the sensation of jumps or taps on user's forearm and upper arm; EX1065 (US 5973441) teaches the creating of thumping sensations (that is, jolts) utilizing piezo transducers in a vibratory mode; EX1066 (Minsky, "Computational Haptics: The Sandpaper System for Synthesizing Texture for a Force-Feedback Display") teaches simulating texture sensations through vibration; EX1024 (Minsky, "Feeling and Seeing Issues in Force Display") teaches simulating textures by computing output forces in real-time based on position and a texture depth map.

¹²For example, this would be known from EX1067 (US 5451924), which discusses using vibrotactile sensory modalities as substitution for force feedback (9:51-53), pointing to some of the burdens of reactive force feedback (3:32-50). It would also be known from references such as EX1068 (Patrick, "Design Construction and Testing of a Fingertip Tactile Display for Interaction with Virtual and Remote Environments"), which also points to advantages of using tactile (vibrotactile) display as a substitute instead of reactive display, for example at page 12 ("tactile feedback might be substituted for reactive force-feedback"), and page 23, ("detailed design of a vibrotactile display").

such as a force output when an input element reaches or nears a particular position in a range of motion, such as when a knob (or virtual knob) is rotated to a particular position or by a particular distance.¹³

56. A POSITA would also have been aware of the broad motivations for incorporating haptic feedback into interactive systems such as: to supplement or replace non-haptic feedback of mechanical systems;¹⁴ to provide “cue” information about an object or some status;¹⁵ to provide a confirmation that an input or gesture

¹³For example, EX1025 (Miller, “Design of 3D haptic widgets”) teaches an exemplary volume control knob with a detented “off” position: the user feels a resistance to motion -- an opposing force -- until nearing the “off” position: the user may feel a decrease or direction reversal of the force on entering the detent position, to make the knob feel as though it had snapped into place. It also teaches push-button force profiles, and the use of a deadband and hard stops, and the feeling of ridges at an edge (a boundary).

EX1026 (US 5914705) describes detent mechanisms in terms of a restoring force (a force opposite to the displacement) when a user attempts to leave a valid stop position. It also teaches force profile vs. displacement for opposing/restoring forces for forward and reverse motion.

EX1027 (US 5414337) contains teachings regarding simulating typical mechanical detent mechanisms, using a torque actuator. It also mentions that mechanical detent systems degrade over time, and have less flexibility. In its prior art, it refers to “control wheels” for editing video images, with tactile feedback.

¹⁴ For example, EX1069 (Massie, “The PHANToM Haptic Interface—A Device for Probing Virtual Objects”) teaches the importance of haptic cues and “feeling the [virtual] buttons click”, when virtual buttons substitute for physical buttons/switches with the absence of sound. A POSITA would have understood that this teaching of haptic cues is not restricted to virtual buttons.

¹⁵ As one example, EX1070 (US 5982352) teaches a “digitizer” pad or touchscreen incorporating tactile feedback cues, both passive and active, via piezo vibrators, air blasts, sound waves or the like, as well as sensing of force location.

was accomplished successfully;¹⁶ to provide different haptic feedback or output to indicate an action on a particular region or software element;¹⁷ to provide output and feedback circumstances in which audio, visual, or other output or display might not be effective;¹⁸ or the use of haptic feedback (such as force feedback) to act as a deterrent (or “punishment”) to affect a user to act to change their interaction or behavior.¹⁹

57. Inasmuch as the prior art teaches the use of haptic feedback to take the place of the tactile or haptic feel of mechanical systems, a POSITA would naturally look to the designs of those mechanical systems. For example, a POSITA would have been motivated to know and use the teachings of mechanical automotive

¹⁶ For example, EX1071 (US 6131097) teaches the use of haptic cues, for example to indicate a particular selection has actually occurred.

¹⁷ For example, EX1072 (US 6337678) teaches graphical buttons, and a control processor receiving commands which specify the type of haptic response each touch exhibit, with different “feels” between disabled and enabled buttons. EX1073 (US 6219034) teaches associating operating system user interface elements, such as buttons, with types of tactile commands, as well as teaching profiles. EX1074 (US 6219032) teaches associating force sensations with graphical objects, to assist the user in selecting a desired function or to inform the user of graphical objects.

¹⁸ For example, EX1075 (US 4885565) teaches tactile feedback to indicate a successful selection via a touchscreen, because audio feedback may be masked by radio or road noise, and to minimize taking away visual contact.

¹⁹ For example, see: EX1028 (US 4590909), EX1029 (US 3721309).

steering systems such as power-assist steering,²⁰ jog/shuttle mechanisms such as those used in media editing,²¹ and mechanical triggers.²²

²⁰ EX1030 (US 2710596) teaches techniques for adding “feedback” in power steering so that the driver/user has a sense of the road, and a mechanism using a mechanical spring. (1:18, 1:33). It also teaches proportional mechanical feel-back (11:45) and a force to react against the driver’s control member (12:28, 12:65). As a further example, EX1031 (US 2679234) teaches providing a “feel” coupling force applied (using a sensor) to an output force (1:15). It also teaches concerning a restoring force towards a neutral central position (1:23, 1:35), and adding restoring force to the restoring force of the spring, and providing a feel by hydraulically resisting input movements with left/right forces (4:22).

²¹Jog wheels/jog dials/shuttle dials/etc. were known to be implemented both with relative rotary encoders with no stops, and on rotary knobs with stops. EX1032 (“Jog dial.” Wikipedia) teaches a multi-function rotary dial control for both a “shuttle” speed (velocity) mode depending on the angular offset position of the control: in a “jog” mode in which the playback speed depends on the rotation speed of the control.

EX1035 (US 4549173) teaches a jog/shuttle rotational control for scrolling through video, with video advancing according to input rotation speed (positional control), and a slow/fast scrolling based on input position. It further teaches that the slower scrolling takes a longer time to find desired data, while fast scrolling makes it difficult to stop scrolling at a desired position.

EX1101 (US 5189355) feedback teaches a single rotary knob control device (implemented using a microprocessor) for multiple functions such as shuttle, jog, or variable play speed, with a different “feel” or mechanical characteristics for each function. It also teaches rotary encoders, detent feedback, and tactile feel with controllable braking torque (force) duration in opposition to the direction of motion, to denote limits of rotation.

EX1102 (US 6703550) teaches a rotary control and both a rate control mode (playback rate is based on position) and a position control mode (playback matches as the control is turned): it also teaches haptic feedback of various forms, such as position-based detents or springs, and time-base jots and pops, depending on the mode, and that the user can select functions by pressing on the knob axially without having to remove his or her grip from the knob. From the description, a

58. As well as this, a POSITA would have known the teachings of providing varying feedback depending on force/pressure levels of an input.²³

59. A POSITA would also have been familiar with the use of profiles – a general engineering principle²⁴ – such as force/haptic profiles, relating the haptic

POSITA would infer that the nominal reference position for the audio time position is reset to the current knob position when modes are changed.

EX1109 (US 4428005) describes a single rotary control knob with photocouplers as rotation detectors (an optical encoder) with change-overs between jog/shuttle modes when the control knob is pressed. It also teaches that the shuttle input mechanism is frictionally disengaged from the knob when not in shuttle mode, and the knob can turn freely: the friction otherwise holds the knob at its current position, and it cannot be freely rotated by imparting an initial force. A POSITA would have understood in context that the neutral or “current” reference position of the knob is effectively reset whenever changing over to shuttle mode.

EX1103 (US 5513306) teaches a jog/shuttle potentiometer control for viewing temporal events such as video information. It does not, however, discuss separate jog and shuttle modes.

EX1107 (US 5530859) teaches a software version of a single circular jog/shuttle control knob with jog and shuttle modes. The shuttle rate is set to zero each time the shuttle mode is activated, at the current position.

²²A POSITA would have known and understood references such as EX1036 (US 4344351), which discussed the operation of progressive triggers. EX1037 (“Submachine gun.” Wikipedia) and EX1038 (“Sa23.” Wikipedia) also discuss progressive triggers.

²³ For example, a POSITA would know the teachings of references such as: EX1062 (US 6424333), which teaches vibrational feedback of varying levels depending on the force or pressure input by a user on an object; and EX1108 (US 7671846), from which a POSITA would have recognized that the process described comprises a normalization of the pressure values across the range.

²⁴As one example, force profiles are discussed in a different context for user input on a pressure-sensitive tablet, in EX1039 (US 4553258). EX1040 (US 4865149) discusses torque profiles (force profiles) and the control of “feel” of steering to a

output or feedback to a user particular input. For example, a POSITA would have been familiar with the many teachings of position-based force/haptic profiles, as well as time-based force/haptic profiles, and their combinations.²⁵ Similarly, a POSITA would have been familiar with the use of profiles for non-haptic purposes. For example, time-based and/or position-based profiles for a joystick would have been used to produce a change in movement of a videogame character from movement of the joystick. Similarly, time-based and/or position-based profiles for a volume knob would have been used to produce a change in volume from movement of the knob. Such profiles would also have been used with a jog shuttle dial, for example to produce a change in scroll speed from movement of the shuttle dial.

user/driver. It also mentions controlling a steering torque profile to compensate for wear in the center region of steering.

²⁵EX1041 (Ramstein, “The PANTOGRAPH: A large workspace haptic device for a multi-modal human-computer interaction”) teaches force profiles for buttons, based on position of input. EX1042 (Rosenberg, “A Force Feedback Programming Primer-For PC Gaming Peripherals Supporting I-Force 2.0 and Direct-X 5.0”) – a tutorial – teaches both position- and time-based profiles for haptic feedback or force reflection, discussing springs, jots, rigid surfaces, and other effects, as well as combining feel sensations. It also teaches that profiles may be stored and played back, or that the force feedback may be computed. EX1043 (US 5184319) teaches force profiles for determining a desired force values to be applied to a pressure-sensing part of the user’s body (for example, a fingertip). It also teaches both position-dependent profiles (for example, opposing/resisting force as a button is depressed: resistive force is released at the button’s toggle point: the release of force is thus part of the profile) and time-dependent profiles (for example, for simulation of textures).

60. In addition, a POSITA would also be aware of the historical range of teachings of vibrational and force haptic feedback, including feedback based on a position sensor input, in critical situations.²⁶ Accordingly, a POSITA would appreciate the width and depth of the range of relevant prior art.

C. Remarks Concerning Transducers

61. A POSITA would have been familiar with all the relevant teachings of transducers. This would include the teachings that transducers convert one form of signal or energy into another, both for input to or within a system, and for output from or within a system. A POSITA would thus have been familiar with the teachings that sensors are transducers used for input, such as to convert a physical quantity (position, force, etc.) to an electronic signal. Such known teachings would also include that actuators are transducers used for output, such as converting an electronic or other signal to a vibration, force, audio output, or other haptic or tactile output such as an electric stimulation. A POSITA would further have known that a transducer may be used both for input and for output.

62. For example, a POSITA would be familiar with the various technologies and used for pressure and force sensors; torque sensors;

²⁶ EX1110 (“Stick shaker.” Wikipedia) describes the use of haptic feedback to prevent airplanes from stalling by initially “shaking” the plane’s control yoke, and then “pushing” the yoke forward to prevent stall if the response from the pilot(s) is inadequate.

position/displacement, velocity, and acceleration sensors (accelerometers); and proximity sensors, as well as the techniques used with them, such as the well-known and broad concepts of normalization and mapping as applied to transducers. Exemplary tutorial references include: EX1044 (Soloman, “Sensors Handbook”),²⁷ EX1045 (Fraden, “Handbook of Modern Sensors: Physics, Designs, and Applications”),²⁸ EX1046 (Webster, “Measurement, Instrumentation, and Sensors Handbook: Spatial, Mechanical, Thermal, and Radiation Measurement”),²⁹ EX1076 (Wilson, “Sensor Technology Handbook”),³⁰ and EX1077 (Sydenham, “Handbook of Measuring System Design”).³¹

²⁷EX1044 discusses, among other teachings: problems of sensor repeatability (p. 1003); normalization to [0,1] at full scale (p. 550); normalization done conventionally for a sensor component (p. 1000, 1036); and normalization being done digitally and/or in a processor (p. 1035, 1037).

²⁸The teachings of EX1045 include problems of long-term stability (repeatability) and aging of mechanical components; dead-band zones; normalization may comprise scaling of values (p. 21); conventional to normalize ADC values to a fractional binary form (p. 175), and intentional use of dead-band zones or hysteresis to eliminate undesired oscillations (p. 268)

²⁹EX1046 contains teachings regarding mechanical drift, aging, and offsets (pp. I-2 to I-4), drift in spring components (p. 4-6), and that measurement is a process of mapping actual (analog) values into sensor values (p. 4-2)

³⁰EX1076 includes multiple teachings regarding normalization with sensors: normalization may be useful so that sensor data can be compared (p. 68); it was conventional to build normalization into system input (p. 141); and normalizing so that “full scale” for a sensor is a particular value.

³¹EX1077 also teaches that measurement is a “mapping” process from observed input to a number. (p. 357, p. 771). It also teaches the use of normalization to

63. Similarly, a POSITA would also have known, and understood how to apply, all the relevant teachings of control systems and instrumentation, including measurement systems, as well as the relevant teachings related to sensors, actuators, and transducers in general. In addition, this would have included tutorial references on electronics design, including teachings for the design of systems using various components. Exemplary references include: EX1078 (Zumbahlen, “Basic Linear Design”),³² EX1079 (Sheingold, “Nonlinear Circuits Handbook”),³³ EX1080 (Johnson, “Process Control Instrumentation Technology”),³⁴ EX1081 (DeSilva,

allow a measurement instrument (a sensor) to be applied to many ranges of tasks (p. 355), to factor out known perturbing effects (p. 804), or simply for engineering convenience (p. 110).

³²EX1078’s teachings concerning linear design include that a look-up table is a mapping, as is the transfer function of an electronic component (p. 6.38). In addition it teaches normalization to a desired range so that values can be compared (p. 8.7, also p. 7.71), that it was conventional to normalize ADC value coding to fractional binary (p. 5.3), and that voltages and currents would be normalized to match the input range of an ADC, and to normalize the output of a DAC (p. 5.2).

³³EX1079’s many teachings include mapping by a table in read-only memory for ADCs and DACs (p. 31), as well as multiple teachings and motivations concerning normalization: to match signals to a desired operating range (p. 1), to remove engineering units (p. 34), to scale values so as not to exceed a range (p. 37), to make analysis easier (p. 54) or to help in design (p. 54).

³⁴ EX1080’s teachings cover both sensor and actuator design, for example: conventional normalization in ADC values provides greater immunity to drift and power supply voltage changes (p. 124); problems of backlash both on sensors, and other transducers (p. 309), and the intentional introduction of deadband/hysteresis to prevent problems of “jiggle” (p. 135-136).

“Sensors and Actuators: Control System Instrumentation”),³⁵ and EX1082 (Liptak, “Instrument Engineers’ Handbook”).³⁶ Mechanical problems such as steering controls not returning to center position are also taught in the prior art.³⁷

64. A POSITA would have understood and appreciated further technical aspects and teachings regarding designs which involve sensors and other transducers. These would include the practical aspects of sensor behavior, such as dead-zones and dead-band behaviors, backlash and hysteresis behaviors, problems of reproducibility, accuracy, and the design choices to use only part of the range of sensor and the multiple motivations for doing so. A POSITA would also have appreciated the effects of, and known and understood the many techniques for dealing with or ameliorating, these and other imperfect behaviors, such as the

³⁵EX1081, by its title a reference on both sensors and actuators, contains teachings concerning zero drift, full scale drift, and stability (pp. 160, 161, 188); changes in mechanical spring stiffness (p. 161), and mechanical problems of backlash, friction, and mechanical drift (p. 317). DeSilva also discusses shaft encoders, incremental optical encoders, and absolute optical encoders in sections of Chapter 5, “Digital Transducers”, including Gray coding and encoder errors.

³⁶EX1082 contains teachings regarding imprecision in both optical encoder and potentiometer position sensors (p. 1378), backlash (p. xxx, p. 1187), deadzones (p. xlix), sensitivity changes and drift in nominal zero in transducers (p. 73), problems of variable contact resistance (p. 73). It also contains multiple teachings regarding normalizations, such as the motivation to remove engineering units and for compatibility (p.1874).

³⁷EX1104 (US 2003/0114075A1) discusses this, and teaches a microprocessor controller re-centering the steering electromechanically.

intentional introduction of deadzones and deadbands,³⁸ as well as the use of sub-ranges (boundary ranges) for various motivations, as well as oversampling and undersampling, linearization, and interpolation.

65. A POSITA would have known of multiple kinds of position and displacement sensors, such as optical encoders and sensors based in various ways on voltage measurements and potentiometers. A POSITA would also have understood, appreciated, and been able to apply the teachings regarding potentiometers in general.

D. Additional Remarks on Prior Art Teachings

1. Regarding Normalization

66. As noted above, a POSITA would have been abundantly familiar with the broadly-applied concept of normalization, and would have known that values may be normalized³⁹ in multiple ways as a matter of design choice, convenience,

³⁸I note that some references use deadband and dead zone interchangeably, others use them to distinguish between the “dead region” being at a nominal neutral position, or relative to the current position. The teachings are at least strongly related. A POSITA would also know the relatedness of teachings of an intentional dead zone/dead band or intentional hysteresis for addressing unwanted oscillations.

³⁹A POSITA would understand “normalize” as a broad concept of converting information or data to a more convenient or standardized form or range, such as normalization of a data base structures, normalization of statistical measures, or normalization of values to a particular standard of or convenient range of units. On this point, a POSITA would be aware of definitions of “normalize” (such as EX1083 (“Normalize,” Oxford American Dictionary): normalize: 2 |tr.| (often, **be**

and/or simplification in general. A POSITA's knowledge would have included the conventional teachings of: normalizing to remove engineering units to simplify a design; normalization of ADC values to fractional binary form; normalizing to a full-scale range of [0,1], or [-1,1], or [0, 2π radians], or other range of choice; normalizing to simplify design analysis; normalizing to allow more convenient use of alternative components; normalizing to remove offsets/biases and/or to re-scale the range of values of a transducer; normalization of sensor component values as a conventional matter; that normalization was conventional to do digitally and/or in a processor; normalization as a matter of transducer calibration, normalization to correct for non-linearities; to normalize positions by offsetting or resetting with respect to a reference position; etc. Additional remarks can be found in the footnotes regarding exemplary references.

67. As one particular example from the many prior art references, EX1084 (US 5012415) teaches normalization in a microprocessor-based control system (Abstract) employing a calibration procedure that produces an offset and scale equation (2:5, 4:43-47) applied to the output of an ADC (3:15) as a normalization to produce normalized output. EX1105 (US 6107765) teaches (in the context of a

normalized) *Math.* multiply (a series, function, or item of data) by a factor that makes the norm or some associated quantity such as an integral equal to a desired value (usually 1)), as well as other definitions of "normalize."

position normalizing system for an automatic garage door device) normalizing a “zero” reference position as a matter of configuration. It also teaches setting travel limits. EX1106 (US 5642288) (in the context of a document scanner—in other words, a sensor) teaches normalizing the positions of rectangles in scanned images so that the images can be compared, to account for how an operator may place documents on a scanner in different positions.

2. Regarding Transfer Functions and Mapping

68. A POSITA would have appreciated and been able to apply all the relevant teachings concerning transfer functions and mapping. A POSITA would have understood as a matter of mathematics that any defined function is a mapping. EX1085 (“Mapping.” The Penguin Dictionary of Mathematics); see also EX1086 (“Function.” Wiktionary), EX1087 (“Transfer Function.” Wiktionary). Therefore a POSITA would have understood that any component or system that performs a transfer function performs a mapping. Also, an ADC (analog-to-digital converter) operates to perform a mapping from input voltage to digital output value. EX1088 (“Analog-to-digital converter.” Wikipedia. On this point, a POSITA would have understood a potentiometer and ADC could be used to implement a position sensor

performs a mapping in more than one way: from voltage to a digital value, and from position to a digital value.⁴⁰

69. Further on this point, a POSITA would have known the teachings that measurement (a fundamental use of sensors) is itself a process of mapping actual values to sensor values. EX1046, p. 4-2; EX1077, pp. 357, 771. A POSITA would also have understood that the use of a look-up table or correction table is a mapping, as is any transfer function (EX1078, p. 6.38), and that this was conventional to do with ADCs and DACs (digital-to-analog converters). EX1079, p. 31.

3. Regarding Analog Calculation and Computation

70. A POSITA would have known that calculations⁴¹ may be performed in analog form as well as in digital form. As an example, a POSITA would have been familiar with the teachings of exemplary references such as: EX1097 (Ulmann,

⁴⁰ Other references published after 2014 include: EX1089 (“Analog-to-Digital (ADC) Converter Types & ADC Functions,” Arrow), EX1090 (“How do Analog to Digital Converters (ADCs) work?” CircuitBread).

⁴¹ A POSITA would also understand “computation” and “calculation” effectively to be synonyms. For example, per EX1091 (“Computation.” Wiktionary) “computation” and “calculation” are synonyms. On the same point, EX1092 (Carlson, “Handbook of Analog Computation”) teaches this for example in its title – it also contains teachings concerning normalization (pp. 97, 98); EX1093 (“Analog computer.” Wikipedia) describes analog computers, including mechanical devices, as performing calculations. EX1094 (“Analogue computer.” Newnes Dictionary of Electronics) describes analog devices carrying out mathematical operations on signals. See also, EX1095 (“Analog computer.” Merriam-Webster Dictionary) and EX1096 (“Analogue computer.” Oxford Dictionary of Computer Science).

“Analog Computing”), EX1098 (Hyndman, “Analog and Hybrid Computing”), EX1099 (Scott, “Analog and Digital Computer Technology”), and EX1100 (Downing, Dictionary of Computer and Internet Terms), all of which discuss analog computation.⁴²

71. Further on this point, a POSITA would have known the teachings that components such as operational amplifiers perform calculations in analog form. A POSITA would also have understood that an ADC (regardless of calculations performed internally, such as an ADC which included elements such as a digital counter, or a comparator) produces digital output, and therefore performs calculations.

IX. OVERVIEW OF THE '907 PATENT

An Overview of the Patent Specification⁴³

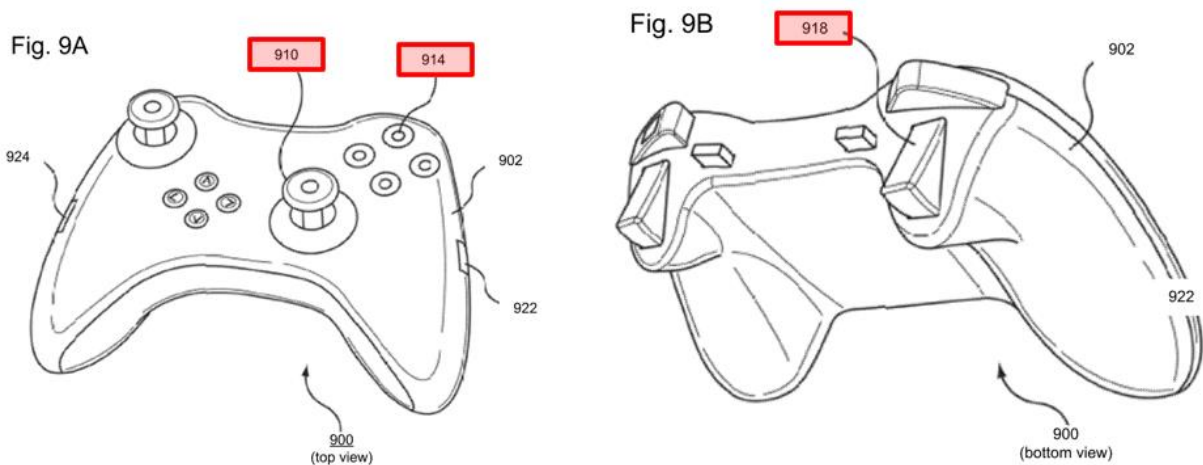
72. The '907 Patent relates to devices that “produce haptic effects.” 1:14-33. The Patent states that “haptic effects” such as vibrations or resistive forces are used to “provide cues to users,” and/or to “provide realistic feedback to create greater

⁴²EX1097 also teaches normalization (p. 55, 113). EX1098 (Hyndman, “Analog and Hybrid Computing”) teaches that an operational amplifier is the fundamental unit in the electronic analog computer (p. 15), as does EX1100 similarly in its definition of “operational amplifier.” EX1099 teaches that a potentiometer also is a computing element.

⁴³ Unless otherwise noted, citations in §IX.A are to the '907 Patent (EX1001).

sensory immersion within a simulated or virtual environment.” *Id.* The Patent concedes that videogame controllers with such haptic feedback or effects were known at the time of filing.⁴⁴ *Id.*

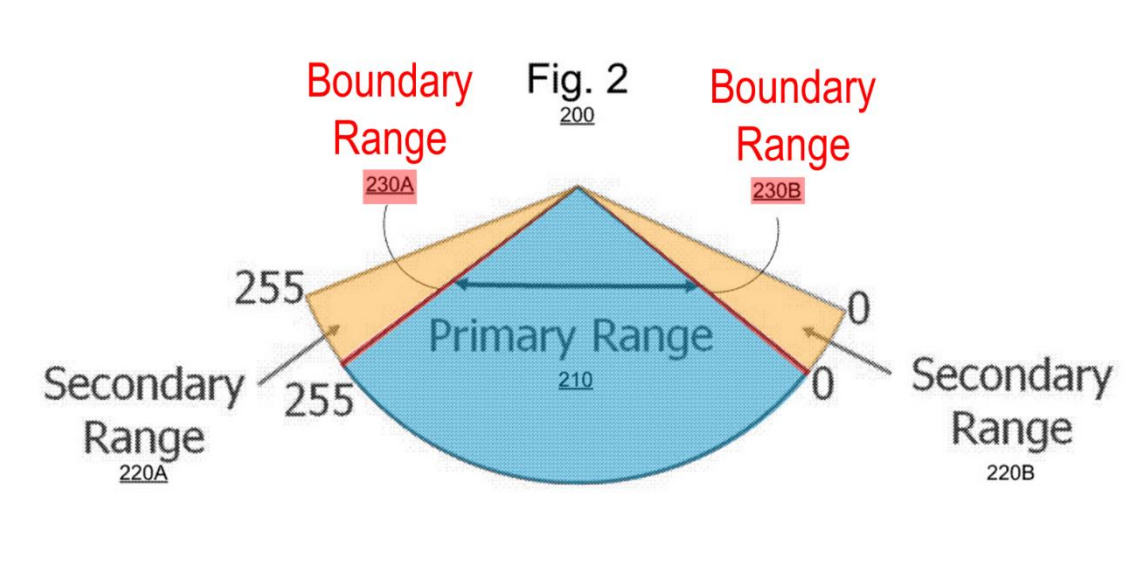
73. The Patent describes the delivery of haptic feedback through “a user input element,” such as a button or a trigger on a videogame controller, which is “associated with a haptic output device.” 2:39-41. Figures 9A-9B (annotated below) depict one such videogame controller, with user input elements that include joystick 810/910, button 814/914, and trigger 818/918 (13:27-32; 12:39-44):



74. The Patent also describes the range of motion for a user input element, for purposes of delivering haptic feedback in response to different movements within the range of motion. Figure 2 (annotated below) illustrates “a range of motion 200 for a user input element” such as a trigger. 5:13-18. “[R]ange of motion 200 may

⁴⁴ EX1008

include a primary range 210 and secondary ranges 220A, 220B.” 5:19-20. There are also “boundary ranges 230A, 230B.” 5:20-23. “[B]oundary ranges 230A, 230B may be defined so as to partially overlap primary range 210 and secondary ranges 220A, 220B.” 5:20-23.



75. A “position sensor” coupled to the input element monitors the element’s position within its range of motion. 13:6-8; 5:44-46 (position can be represented as “a range of values between 0 and 255”). The position sensor creates signals indicative of the input element’s position, and sends the signals to a processor that instructs actuators to provide haptic effects. 13:16-20.

76. Figure 4 depicts an implementation of the ’907 Patent’s methods using a “flow diagram.” 9:8-11. At step 410, “primary” and “secondary” ranges of positions for the “user input element” are “define[d].” 9:21-23. At step 420, “a boundary range of positions for the user input element” is “define[d]” and “partially

overlap[s] each of the primary and secondary ranges.” 9:24-28. Once the ranges are defined, the “position of the user input element” is “monitor[ed]” (430), and haptic effects are rendered “when the user input element enters positions within the boundary range” (440). 9:28-33.

A. An Overview of the Prosecution History

77. The '907 Application was filed on August 8, 2018 with one independent claim. EX1002, 59.

78. The Applicant preliminarily amended claim 1 and added claims 2-20. *Id.*, 90-94. The Examiner initially overlooked the Preliminary Amendment and issued an Office Action rejecting the originally-filed claim 1 as anticipated by Quaid (EX1012). EX1002, 98-102. After the Applicant brought the Preliminary Amendment to the Examiner’s attention, the Examiner issued a new Office Action only rejecting the amended independent claims for non-statutory double patenting. *Id.*, 219-223. The Applicant overcame the rejection with a terminal disclaimer. *Id.*, 252-253, 264.

X. CLAIM INTERPRETATION

79. I understand that claim terms must be construed according to their plain and ordinary meaning when read in in light of the specification and the prosecution history.

80. In the prior art analysis that I provide in Section XI, I apply the plain and ordinary meaning of the claim terms with the exception that in Ground 3 explain how the prior art anticipates and/or renders obvious Claims 1-4, 6, 8-11, 13, 15-17 and 19 under an interpretation of the claims with which I do not agree, but which I understand Patent Owner currently contends is the proper interpretation of the claims. In other words, my analysis in Ground 3 uses the interpretation of the claims that Patent Owner thinks is right even though I do not agree with that interpretation. I discuss this in more detail in Ground 3.

XI. UNPATENTABILITY GROUNDS

81. To the extent that “unpatentability” may be a legal term, I use the term only to indicate that I find that a claim to be either anticipated or obvious based on my analysis.

A. Ground 1: Claims 1-6, 8-13, and 15-19 Are Anticipated By and/or Obvious Over Goldenberg

Goldenberg (EX1016)⁴⁵

82. Goldenberg relates to “control knob devices including force feedback” ([0007]) and discloses “haptic sensations for a rotational haptic feedback device such as a knob.” [0010]; [0041] (“The knob 26 is preferably provided with force

⁴⁵ Unless otherwise noted, citations in §XI.A are to Goldenberg (EX1016).

feedback” that can “have the tactile feel of detents” which “affords a cleaner, richer user experience.”).

83. Goldenberg discusses “[a] number of force sensations...suitable for use with” knobs. [0068]. Multiple force sensations can be grouped together to form a “force model” ([0070]), which establishes rules “for implementing the force effects included in the model based on conditions such as time, knob position, motion, velocity.” [0102].

84. As one example of a force model, Goldenberg describes a “jog shuttle model.” [0115]. The jog shuttle model provides the user a “control paradigm for scrolling through a list or controlling a function or value.” *Id.* The jog shuttle model is depicted in Figure 8 below.⁴⁶ In Figure 8, the vertical axis “F” represents the amount of force applied to the knob (via an actuator), while the horizontal axis “x” represents the position of the knob’s rotation (clockwise or counterclockwise) relative to its origin position:

⁴⁶ Goldenberg contains obvious typographical errors by which Figure 8 is mistakenly referred to as Figure 7. *Compare* [0027] (“FIG. 8 is a diagrammatic illustration of a jog shuttle force mode”) *with* [0116] (“FIG. 7 is a force vs. position profile 390 illustrating a jog shuttle model.”). Additionally, the origin position is referred to as “origin position O” in the text, even though it is depicted using the letter “D” in Figure 8.

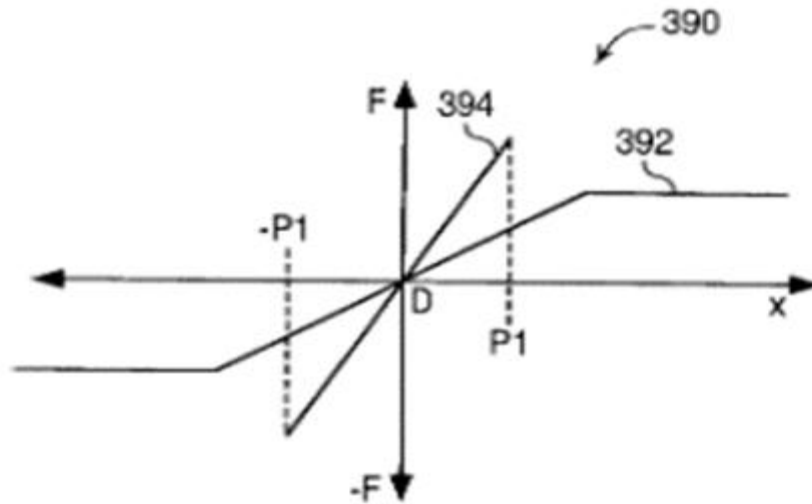


FIG. 8

[0115]-[0117]; [0027]; [0080].

1. Claim 1

a. [1PRE]

“A method for controlling a user input element associated with a haptic output device, the method comprising:”

85. A “user input element” is a portion of an electronic device that “a user interacts with” to cause an action associated with the device. EX1001, 1:34-35. Examples of user input elements include buttons, triggers, and joysticks on a videogame controller. EX1001, 1:34-35, 4:31-33, 5:17-18.

86. Goldenberg’s control knob “is manipulated by the user to control various functions of [an electronic] device.” [0030]; [0031]; [0034]; FIG. 1. In other

words, a user interacts with Goldenberg's control knob to cause an action associated with the device. Thus, the control knob is "*a user input element*," as claimed.

87. The control knob includes "an actuator 84" ([0046]) that provides force feedback and/or haptic feedback to the knob. [0010] ("rotational haptic feedback device such as a knob"); [0015]-[0016]; [0060] ("actuator 216 transmits forces to knob 26"); FIG. 2 (actuator 84). The '907 Patent confirms that "*a haptic output device*" can be an actuator. EX1001, 4:36 ("An actuator is an example of a haptic output device."). Thus, the control knob ("*a user input element*") is "*associated with a haptic output device*," as claimed.

88. As discussed below in relation to limitations [1A]-[1B], Goldenberg discloses methods for controlling the haptic feedback provided to its knob.

b. [1A]

"defining position and range information for the user input element associated with the haptic output device, including"

89. Goldenberg's method uses "force profiles" which define, among other things, "position and range information" that is used "to determine appropriate output actuator signals." [0066]. Goldenberg's Figures 4A-4D, 5A-5B, and 8-10 illustrate various examples of such force profiles. As noted above with respect to Figure 8 (see above ¶84), the "rotational positions" of the knob within its rotary

degree of freedom are represented along the horizontal “x” axis, while the output force(s) associated with each rotational position is/are represented along the vertical “F” axis for each force profile. [0073]; *see also* [0021]-[0024]; [0027]-[0029]; [0080].

90. Figure 8 below depicts Goldenberg’s “jog shuttle force model.” [0027]; [0070] (a “force model” combines “force effects” with “rules for implementing the force effects...based on conditions such as...knob position....”); [0102]; [0116]. For clarity, I note that Goldenberg uses the terms “force model” and “force profile” interchangeably. Goldenberg draws no clear distinction between a force model and a force profile, and several Figures are alternately referred to as illustrating a force model or a force profile⁴⁷. *Compare* [0027] (“FIG. 8 is a diagrammatic illustration of a jog shuttle force model” (emphasis added)) *with* [0116] (referring to “a force v. position profile 390” (emphasis added)); *compare* [0028] (FIG. 9 is a diagrammatic illustration of a “push-push” force model” (emphasis added)) *with* [0120] (referring to “a Push-Push profile 400” (emphasis added)); *compare* [0029] (“FIG. 10 is a

⁴⁷ This interchangeability of “model” and “profile” is consistent with other usage in the prior art. For example, EX1042 treats “model” and “profile” similarly: Figure 2-2 Refers to “Force Displacement Profiles” for a simulated spring, and the text refers to “the spring model”. Compare also Figure 2-2 “Force Displacement Profile” with Figure 3-1 “Hooke’s Law: Spring Force”, for which the text refers to a spring being “modeled”.

diagrammatic illustration of a cast force model” (emphasis added)) *with* [0122] (referring to a “cast force profile” (emphasis added)).⁴⁸

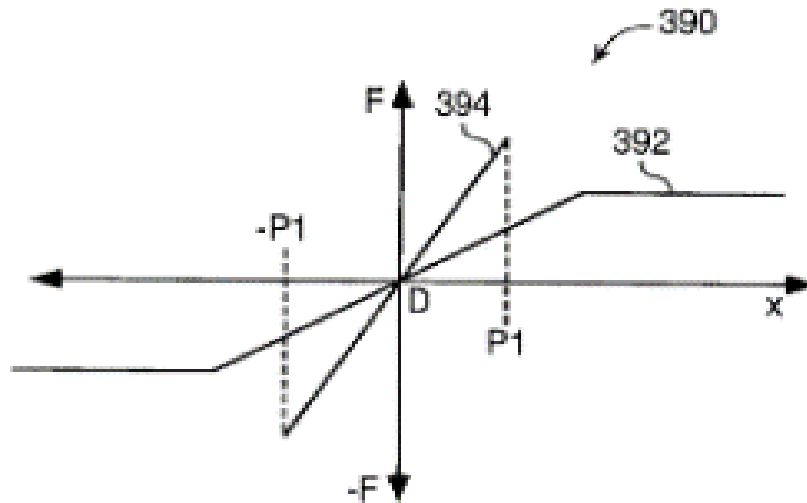


FIG. 8

91. With the “jog shuttle model,” “the force feedback knob is preferably provided with two spring effects” to “simulate a mechanical jog shuttle having mechanical springs.” [0116]. The first spring effect (“curve 392”) is “output over the entire [rotational] range of the knob” and has a “medium amount of stiffness.” [0116]. “The force resists motion away from the origin O and increases in magnitude as the knob is moved away from the origin until the saturation level is reached [*i.e.*, the curve flattens], at which point the force is no longer increased in magnitude but

⁴⁸ The descriptions of Figures 9 and 10 contain similar obvious typographical errors to the error noted above, such that ¶ [0120] refers to “FIG. 8” when describing Figure 9, and ¶ [0122] refers to “FIG. 9” when describing Figure 10.

still resists motion away from the origin.” [0116]. As seen above in Figure 8, a positive force is output when the knob is turned clockwise from the origin position whereas a negative force is output when the knob is turned counterclockwise from the origin position. Thus, the output force opposes the motion regardless of whether the knob is turned clockwise or counterclockwise.

92. The second effect (“curve 394”) “overlap[s] the first effect but is only in effect over a small range between positions $-P1$ and $P1$ around the origin position.” [0116]. This second spring, *i.e.*, curve 394, is “much stiffer than the first spring, requiring a greater amount of force from the user to overcome.” *Id.* This effect “provides a more ‘quality’ feel to the knob since the knob is less likely to feel loose to the user around the origin position.” *Id.*

93. Goldenberg’s jog shuttle model (*i.e.*, “force vs. position profile 390”) defines an “origin” position, which divides the knob’s rotational positions into two ranges. A first range of rotational positions to the right of the origin (**blue** annotation below, extending right from the origin) correspond to force sensations output on the knob that resist clockwise rotation and increase until a saturation level is reached, whereas a second range to the left of the origin (**orange** annotation below, extending left from the origin) corresponds to force sensations that resist counterclockwise rotation of the knob and increase until another saturation level is reached. [0115]-[0117].

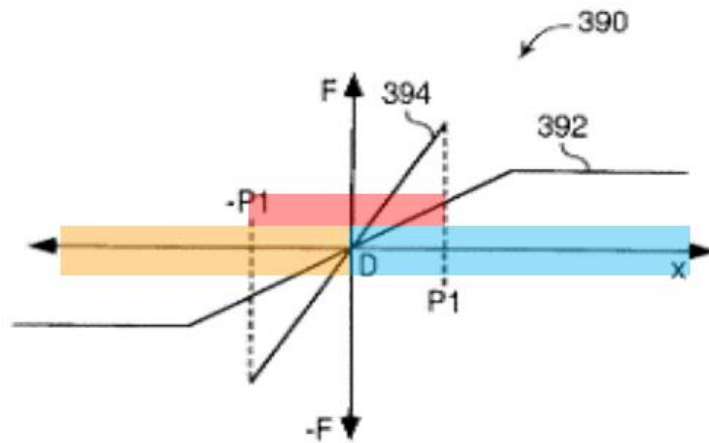


FIG. 8

[0115]-[0117].

94. Additionally, by also defining the band of positions between $-P1$ and $P1$, Figure 8's jog shuttle force model creates a third "small range...around the origin position" (**red** annotation above, between $-P1$ and $P1$), in which the magnitudes of the spring forces are greater than when the knob is positioned outside this range.

[0116].

i. [1A1]

“a primary range of positions”

95. Goldenberg’s “jog shuttle force model” defines “a *primary range of positions*.” In particular, the “*primary range*” includes the knob’s rotary positions clockwise from the origin which correspond to positions on the right of the origin in Figure 8 (**blue** annotation, extending right from the origin). See above §XI.A.1.

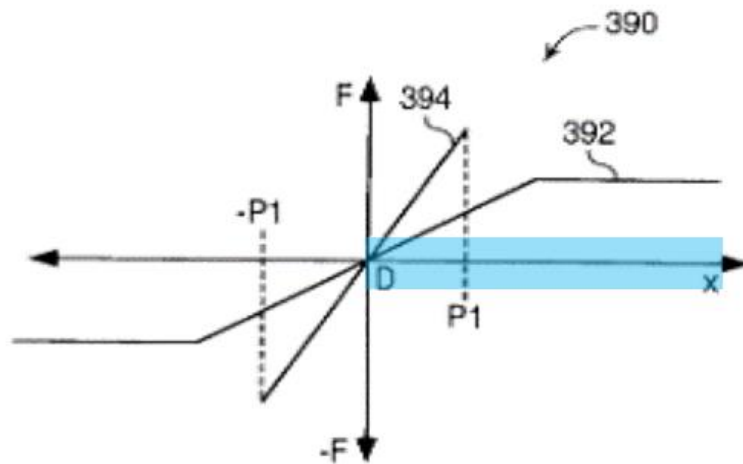


FIG. 8

[0115]-[0117].

ii. [1A2]

“a secondary range of positions”

96. Goldenberg’s “jog shuttle force model” defines “*a secondary range of positions.*” In particular, the “*secondary range*” includes the knob’s rotary positions counterclockwise of the origin which correspond to positions on the left of the origin in Figure 8 (**orange** annotation, extending left from the origin). *See above* §XI.A.1.

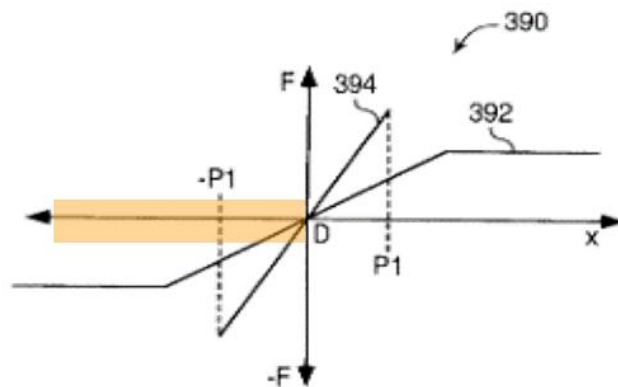


FIG. 8

[0115]-[0117].

iii. [1A3]

“a boundary range of positions wherein the boundary range of positions partially overlaps each of the primary range of positions and the secondary range of positions”

97. The claimed *“boundary range of positions”* is a range of positions that *“partially overlaps each of the primary...and the secondary range[s].”* The claimed *“boundary range”* need not be a unique range of positions, but can instead be made up partially or exclusively of positions that are in the primary range of positions and/or the secondary range of positions.

98. For example, when discussing Figure 2, the '907 Patent explains that *“primary range 210 may be extended to render haptic effects within secondary ranges 220A, 220B and/or boundary ranges 230A, 320B.”* EX1001, 5:23-25; FIG. 2. In order for primary range 210 to extend into, for example, secondary range 220A, the primary range would need to extend through the entirety of boundary range 230A. Thus, the boundary range here would exist entirely within the primary range.

99. Goldenberg's “jog shuttle force model” defines *“a boundary range of positions”* which is made up of positions that are in both the *“primary range”* and the *“secondary range.”* In particular, the knob's rotary positions between “positions –P1 and P1” (**red** annotation), which form “a small range...around the origin

position,” constitute “a *boundary range*” made up of positions to the right of the origin (the “*primary range*”), as well as positions to the left of the origin (the “*secondary range*”). [0116]; See above §XI.A.1.

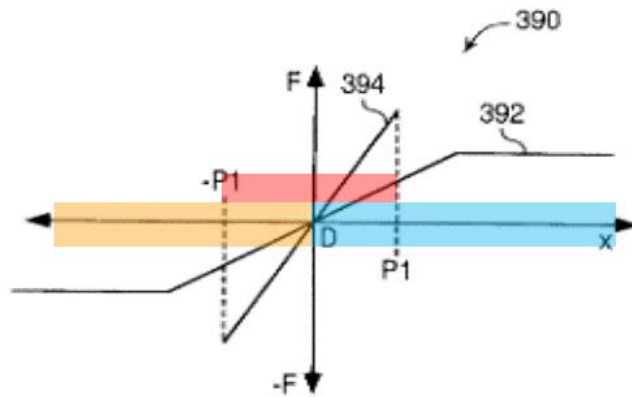


FIG. 8

[0115]-[0117].

100. As seen above, the “range” between “positions $-P1$ and $P1$ ” partially overlaps each of the “*primary range*” and “*second range*” of positions discussed for limitations [1A1]-[1A2]. Thus, Goldenberg’s “range” between “positions $-P1$ and $P1$ ” meets limitation [1A3]. *Id.*

c. [1B]

“rendering a haptic effect in response to an entry of the user input element to one or more positions within the boundary range of positions.”

101. As stated in the '907 Patent, and consistent with the understanding of a POSITA, “*haptic effects*” include “force feedback” (EX1001, 1:23-27). Goldenberg’s method provides such force feedback to its knob, including when it implements the jog shuttle model. Abstract (“The present invention provides haptic sensations for a haptic feedback device and especially for a rotational device such as a knob.”); [0007], [0009]; [0014] (“a method for providing a shuttle control using force feedback”); [0034]; [0041] (“knob 26 is preferably provided with force feedback”); [0115]-[0017].

102. Limitation [1B] requires that “*a haptic effect*” is rendered “*in response to an entry of the user input element to **one or more positions within** the boundary range of positions.*” Limitation [1B] does not require that the haptic effect be rendered in response to the user input element’s initial entry into the boundary range. Nor does [1B] require that haptic feedback be provided at every position in the boundary range. Rather, any position(s) anywhere within the boundary range—even a single position in the middle of the boundary range—is sufficient to meet [1B]. Thus, rendering a haptic effect in response to movement to or through any position(s) within the boundary range meets [1B].

103. Additionally, there is no requirement that the haptic effect of [1B] be distinct from a haptic effect rendered outside the boundary range (for example, in the primary or secondary range), nor that it be “new”—that is, different from a haptic

effect previously rendered inside the boundary range. Thus, rendering a “new” haptic effect upon entry into [1B]’s “*one or more positions within the boundary range*” is not required. Even a haptic effect which was in force prior to entry into the “*one or more positions*” would meet [1B], so long as it continues to be rendered when entry into the “*one or more positions*” is detected. However, even if Goldenberg were determined to be lacking “newness,” Goldenberg would still meet the claim’s requirements.

104. Goldenberg’s method “*render[s] a haptic effect in response to an entry of the user input element to one or more positions within the boundary range of positions.*” In particular, the second haptic effect (that is, the “stiffer” spring of “curve 394”) is provided to the control knob “*in response to entry*” of the knob to one or more positions between -P1 and P1. As discussed above (*See above ¶76*), the “*haptic effect*” that is “*render[ed]*” is a positive output force when the knob enters a position between the origin O and P1 (that is, when rotating clockwise), and/or a negative output force when the knob enters a position between the origin O and -P1 (that is, when rotating counterclockwise). [0116].

2. Claim 2

“*The method of claim 1, wherein one of the primary range of positions, the secondary range of positions, and the boundary range of positions is calculated*

based on a movement of the user input element from a maximum out position to a grounding position.”

105. A POSITA would have recognized that Goldenberg’s knob would either have an infinite range of rotational movement or a limited range of movement (for example, 180-degrees clockwise and 180-degrees counterclockwise). A POSITA would consider these to be the two design options that are plausible for a knob, as the range must necessarily be either infinite or finite. Furthermore, in designs where a knob is physically capable of an infinite range of motion, many common applications would still have called for limitations on the knob’s movement. For example, when a single knob is used both as a jog shuttle and to control audio volume, it would have been desirable to allow infinite range when the knob is used as a jog shuttle, but limited range when used for volume control. On this point, Goldenberg’s inclusion of the “barrier effect” of Figure 5B further illustrates that it was often desirable to limit a knob’s otherwise infinite range, and the barrier effect provides one possible way to accomplish this. As an example, the barrier effect uses strong output forces “to convey to the user that the knob has reached a limit” for a particular application ([0088]), even though the knob is “preferably a continuous rotational device having an infinite range of rotational motion” ([0044]). Thus, a POSITA would readily understand that even when a knob

had a potentially infinite range of motion, it would be a design choice to impose limitations on the range.

106. When implemented as a limited-range knob (either with structural limits/stops, or by force feedback limits such as Goldenberg's barrier effects), the knob's range would extend from a maximum position in the counterclockwise direction to a maximum position in the clockwise direction. These maxima would constitute "*maximum out*" and "*grounding*" positions, with the nomenclature depending only on the reference direction of movement chosen as a matter of the design. For example, depending on the choice of reference, when rotating clockwise, the "*maximum out*" position would be the furthest possible clockwise position, while the "*grounding*" position would be the farthest possible counterclockwise position.

107. In a limited-range implementation of Figure 8's jog shuttle force model⁴⁹, the origin O would be selected based on the clockwise and counterclockwise maxima. For example, the origin could be set either at a center point between the maxima (if a symmetrical profile were desired), or at another point

⁴⁹ In describing the various "force effects" or "force sensations" available for a knob (for example, the "spring force" of the jog shuttle force model, and the "obstructions (barriers)" of the barrier effect ([0072])) Goldenberg states that "any of these force sensations can be combined together for a single knob 26 to provide multiple simultaneous force effects." [0074]; see also, [0127].

(if any asymmetry were desired in the profile). The “*primary*” range (*i.e.*, the clockwise range) would then be calculated to extend between the clockwise maximum and the origin (which would have been selected based on both maxima), and the “*secondary*” range (*i.e.*, the counterclockwise range) would be calculated to extend between the counterclockwise maximum and the origin. Thus, both the “*primary*” and “*secondary*” ranges would be “*calculated based on a movement of the [knob] from a maximum out position to a grounding position*” (*i.e.*, based on a movement between the clockwise and counterclockwise maxima).

3. Claim 3

“The method of claim 1, wherein a profile for the user input element is calculated by mapping each position of the user input element to an analog to digital conversion value.”

108. The '907 Patent explains that after an input element is first initialized, a “profile” can be calculated to “set position and range information for the user input element[.]” EX1001, 9:44-57, Fig. 5. The “calculated profiles may map each position of the user input device to an ADC [analog to digital conversion] value,” such that each position of the input element is mapped to an ADC value between 0 and 255. EX1001, 5:45.

109. To provide force feedback on its knob, Goldenberg teaches the use of “force effect profiles” that map the knob’s physical position within its rotational freedom of movement to force magnitudes. [0116] (Figure 8 depicts “a force vs. position profile” that simulates a mechanical jog shuttle having two springs); claim 23 (“code to receive a signal associated with a displacement of a manipulandum from a predetermined position in a degree of freedom... and code to output a force signal, the force signal being associated with a resistive force, and a magnitude of the resistive force correlated with the displacement.”); [0009] (“The microprocessor receives knob position and direction signals from the knob sensor and sends appropriate force feedback control signals to the motor so that the motor provides forces on the knob.”); [0044].

110. To determine the knob’s position, Goldenberg teaches the use of “sensors 214” that “sense the position, motion, and/or other characteristics of knob 26...and provide signals to microprocessor 202 including information representative of those characteristics.” [0059]; *see also* [0053]; FIG. 3. Exemplary sensors include “optical encoders,” as well as “analog sensors such as potentiometers.” [0059]. Thus, Goldenberg calculates “*analog to digital conversion value[s]*,” as claimed, to be used with each “force effect profile” that its knob can execute, including the jog shuttle profile of Figure 8, using at least two possible arrangements:

a digital optical encoder, and an analog sensor in combination with an analog to digital converter (ADC). EX1016, [0059].

111. **Digital Optical Encoder:** Digital optical encoders like those Goldenberg discloses ([0059]) were conventional in 2014 and known to take as inputs analog values representing a device's position and output corresponding digital values. This is consistent with Goldenberg's disclosure that "sensor interface 208" receives "signals from a digital sensor such as an encoder and convert[s] the signals into a digital binary number." [0057]; *see also* FIG. 3. A POSITA would have understood that Goldenberg's "optical encoder" (in combination with sensor interface 208) mapped each physical position of the knob within its rotary degree of freedom to "*an analog to digital conversion value,*" as claimed.

112. **Analog Sensor:** Goldenberg also describes the conversion of analog signals from other sensors to digital values. "[T]o convert sensor signals to signals that can be interpreted by the microprocessor 202," Goldenberg states, "[a]n [ADC] can also be used." [0057]. A POSITA would have understood that an ADC would be used in conjunction with a position sensor that outputs an analog value (for example, "analog sensors such as potentiometers" ([0059])), to convert the analog sensor value to an "*analog to digital conversion value.*"

113. The analog to digital values that Goldenberg generates are used (or it would have been obvious to use them) to "calculate" each of Goldenberg's stored

“force profiles” because those profiles associate a force magnitude with a position of the knob. [0116] (describing the jog shuttle force model as a “force vs. position profile”). Stated differently, each ADC value (mapped to an associated position) would have been associated with a corresponding force that the actuator was to provide to the knob upon the knob’s entry into the associated/mapped position.

114. If Goldenberg is determined not to disclose claim 3 expressly, modifying Goldenberg’s force profiles to “*map[] each position of the user input element to an analog to digital conversion value*” would have been obvious because a POSITA would have recognized that Goldenberg’s profiles used position information to output detents at specific locations, for example, “a designated origin position” such as the origin O of Figure 8 under the control of a processor. [0009]; [0070]; [0116].

4. Claim 4

“The method of claim 3, wherein the profile for the user input element is an increasing profile or a decreasing profile.”

115. The ’907 patent explains that in calculating a profile for the user input element, an increasing or decreasing profile can be used. EX1001, 9:58-59. For example, “an increasing profile will produce a value [0,255]” in 8-bit ADC mapping when each position of the input element is mapped to an ADC value between 0 and

255. Conversely, “a decreasing profile will produce a value [255,0]” in 8-bit ADC mapping. EX1001, 9:58-63. In view of these teachings, a POSITA would not understand this claim to require there be both an increasing and a decreasing profile, only that there be at least one profile (or sub-profile) that is monotonic and not constant. A POSITA would also find it not completely clear from the claim language as to what it is about the profile that must increase (or decrease). In the following analysis, I have assumed the example given in the specification.

116. 8-bit ADC mapping was an established and well-known technique in the art. When using ADC mapping to create profiles for Goldenberg’s jog shuttle force model (*See above* §XI.A.4 (claim 3)), it would have been an obvious choice for a POSITA to implement ADC mapping in such a way that the ADC values were increasing or decreasing. This would have been a straightforward matter of design choice, as a POSITA would not have put the values in a jumbled order, nor would a POSITA have made the ADC output constant. Rather, a POSITA would have used a monotonic ordering, and only two plausible monotonic orderings exist: increasing or decreasing.

5. Claim 5

“The method of claim 1, wherein a normalized profile for the user input element is calculated by removing at least one of the secondary range of positions or the boundary range of positions from mapped analog to digital conversion values.”

117. The '907 patent explains that a “normalized profile may be calculated by removing secondary and/or boundary ranges from the ADC data,” *i.e.*, the ADC data of the originally calculated profile. EX1001, 9:65-67; *See above* §XI.A.4 (claim 3) (discussing calculated profiles). “For example, the calculated normalized profile...may map each position of the user input device, excluding secondary and/or boundary positions, to an ADC value between 0 and 255.” EX1001, 9:65-10:3.

118. A jog shuttle such as the ones described in Goldenberg was conventional to control scrolling speed and position in video editing and playback systems. *See*, for example, [0031]. When the jog shuttle is turned clockwise, the frames of a video are advanced forward. [0117]. The farther from the origin position the knob is turned, the faster the frames are scrolled forward. *Id.* As the jog shuttle is turned back counterclockwise, the advancement of the video frames slows down until the jog shuttle returns to the origin point, at which point the video frames will pause. *Id.* If the jog shuttle continues to be rotated counterclockwise past the origin position, the frames will begin to rewind (that is, advance backwards through the video frames). *Id.* Thus, in addition to the force profile shown in Figure 8, a POSITA would have understood that Goldenberg’s jog shuttle knob would be programmed with a functional profile. *See*, for example, [0117] (“The jog shuttle model can be used to scroll through a list of items or a sequence of items”); EX1017

5:62-63 (describing how the use of a control signal to effect different outputs is known in the art). Similar to the force profile, the functional profile would ordinarily associate each rotational position of the knob with a scroll speed. Indeed, a POSITA would have recognized that a scroll speed functional profile would typically be very similar to the force curve 392 of Figure 8, except that the vertical axis would be the functional output (that is, the output scroll speed), rather than the force output of Figure 8. For example, the modified Figure 8 below illustrates a generic functional profile for the scroll speed that a POSITA would have understood should be used with the force profile of Figure 8.

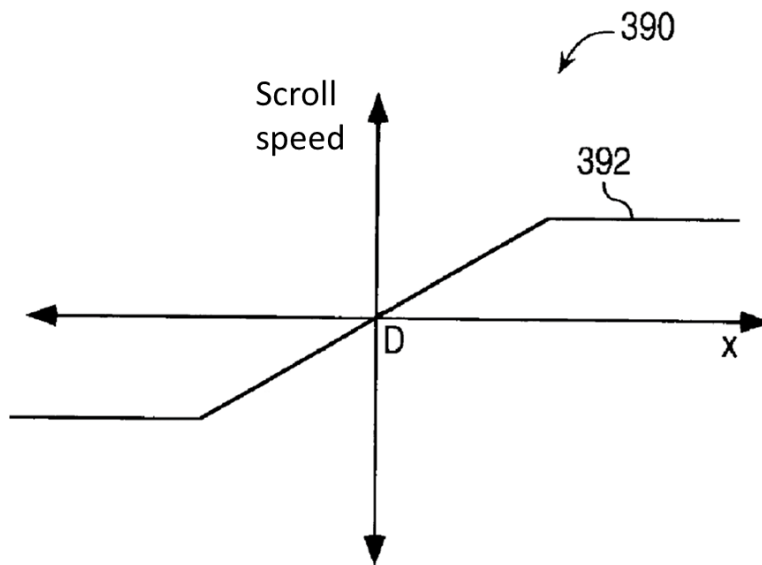


FIG. 8

Fig. 8 (Modified)

119. In addition to the above, a POSITA would have understood that output profiles (both the force output profile of Figure 8, and the functional output profile of the modified Figure 8 above) can be categorized as either uni-directional (or uni-lateral) or bi-directional (or bi-lateral). See EX1018, [0162] (describing uni-directional and bi-directional force profiles). As applied to rotational knobs, a profile is uni-directional where an output (for example, a force output or a functional output such as a scroll speed) is produced only when the knob is positioned in one direction relative to an origin (for example, clockwise or counterclockwise). Conversely, a profile is bi-directional where the output is produced when the knob is positioned in either of two directions relative to an origin.

120. In Goldenberg's Figure 8 jog shuttle force profile, one output (*i.e.*, a positive force) is produced when the knob is positioned clockwise from an origin position, and another output (*i.e.*, a negative force) is produced when the knob is positioned counterclockwise from the origin position. Similarly, a POSITA would have understood that the scroll speed functional profile which would be used with Figure 8 would likewise have been bilateral, such that turning the knob clockwise or counterclockwise would scroll the video frames forwards or backwards, respectively. Thus, Goldenberg's jog shuttle force profile is an example of a bi-directional (bi-lateral) force profile, which would be associated with a bi-directional scroll speed profile. [0115]-[0117]. However, Goldenberg also teaches that *uni-*

directional profiles were also suitable in some instances. For example, Goldenberg's Figures 5A-5B and 9 depict such uni-directional profiles.

121. In view of Goldenberg's disclosure of, as well as a POSITA's general familiarity with, both uni-directional and bi-directional profiles, a POSITA would have recognized as a readily-apparent design choice that Goldenberg's jog shuttle embodiment would have been improved if a user could optionally switch it from being bi-directional to uni-directional. In particular, a POSITA would have recognized that a jog shuttle could be improved if it had the ability to operate in a uni-directional mode such that it would only scroll through the frames and only provide force feedback, when the knob is turned in either a positive direction (*i.e.*, clockwise) or a negative direction (*i.e.*, counterclockwise). In other words, the jog shuttle would only scroll forward through the video frames and could not rewind in one mode, and would only rewind and could not move the frames forward in an alternate mode. [0115]-[0117].

122. When scrolling video frames in one direction, a user may wish to pause the scrolling. As stated above, this is done by turning the knob back to the origin position. However, a POSITA would have recognized that using a bi-directional profile would be accompanied by a risk that the user would accidentally turn past the origin, and thereby scroll the video in the opposite direction instead of pausing

the video.⁵⁰ A POSITA would further have understood that a uni-directional profile would eliminate this risk, allowing a user to immediately pause a video by turning the knob quickly to its origin position, or past its origin position, without accidentally reversing the scrolling. *Id.*

123. Permitting a user to change between a bi-directional and a uni-directional jog shuttle effect would have been consistent with Goldenberg's teachings that its knob can be used for multiple different functions, including rate control and position control functions. [0035]-[0040]; [0077] (“**A single knob** 26 can provide both rate control and position control over functions or graphical objects in different modes.”). Goldenberg also teaches that the selection between varying modes (for example, uni-directional clockwise, uni-directional counterclockwise, and bi-directional) would have been achieved by pushing or pulling the knob from its default position. [0040] (describing how a user can “select functions or settings” by pushing or pulling the knob); [0119] (describing how a user can “select or adjust a function of a device by providing a dual motion: a push of the knob to translate it along its axis of rotation, combined with a twist or rotation of the knob”); [0124].

⁵⁰ EX1111 (US 20110295395) includes teachings regarding “an additional problem in that, in the shuttle mode, unlike the jog mode, the playback position can be overly moved before stopping the playback, since it is necessary to rotate the dial to adjust to a stop position or to press a stop button between when a video image is found and when the playback is stopped.” [0005]

124. One obvious way to implement Figure 8's jog shuttle profile using uni-directional profiles is shown below:

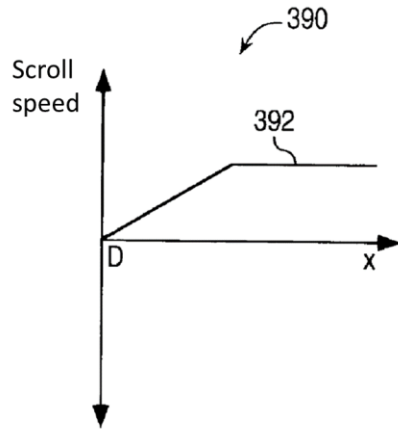


FIG. 8

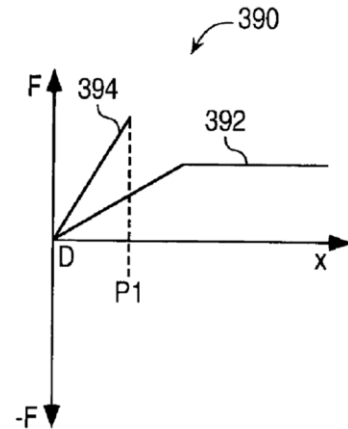


FIG. 8

Figure 8 as modified to show: a uni-directional scroll speed profile (left), and a corresponding uni-directional force profile (right)

See EX1016, FIGS. 5A-5B, FIG. 9; EX1018, [0162]; FIG. 10b.

125. In such an implementation, a “normalized” (relative to the bi-directional profile, or by being referenced to point “D”) uni-directional force profile for the knob would have been calculated by removing the counterclockwise positions of the knob from the original ADC data used to calculate the knob's profile for the bi-directional jog shuttle profile. That is, the exemplary uni-directional profile shown above would have been calculated “*by removing...the secondary range of positions,*” i.e., the positions counterclockwise of the origin, “*from mapped*

analog to digital conversion values,” as claimed. See above §XI.A.2.b.ii (Limitation [1A2]).

6. Claim 6

“The method of claim 1, further comprising monitoring a position of the user input element.”

126. Goldenberg discloses a “control system” for its knob. [0020]. That system includes a “sensor” that “provide[s] position...information” for the knob. [0044]; *see also* [0009], [0040], [0059], [0104], [0105]; *See above* §XI.A.4 (claim 3). The sensor (together with the processor) thus “monitor[s] a position of the user input element,” as claimed.

7. Claim 8

“A non-transitory computer readable storage medium...”

127. Independent claim 8 recites “a non-transitory computer readable storage medium [CRM] storing a program configured to be executed by a processor, the program comprising instructions for” carrying out the method of claim 1. Goldenberg discloses such a CRM.

128. Goldenberg’s force profiles (for example, the jog shuttle profile/model) are implemented by “microprocessor 202” which “process[es] sensor signals to

determine appropriate output actuator signals by following the instructions of a ‘force process’ that may be stored in local memory 206 and includes calculation instructions, formulas, force magnitudes (force profiles), and/or other data.” [0066]; *see also* FIG. 3 (depicting local microprocessor 202); [0073] (“force profiles can be stored in a memory device on the device and a particular set can be provided on the knob 26 by a microprocessor”). Goldenberg’s local memory 206, which can be RAM and/or ROM ([0056]), is “*a non-transitory computer readable storage medium storing a program configured to be executed by a processor,*” where the program is the set of software instructions executed by Goldenberg’s microprocessor to implement its force profiles. [0066].

129. The remaining processing steps of claim 8 are identical to the method steps recited in [1A]-[1B]. Therefore, the remainder of claim 8 is met and/or rendered obvious for the same reasons discussed in §§XI.A.2.b-c above.

8. Claim 9-13

130. Dependent claims 9-13 add the same limitations to claim 8 that dependent claims 2-6 add to claim 1, respectively. Goldenberg’s CRM stores a program comprising instructions for performing the steps recited in claims 10-13 for the same reasons Goldenberg meets and/or renders obvious claims 2-6. *See above* §§XI.A.3-7.

9. Claim 15

“A device, comprising...”

131. Independent claim 15 is substantially identical to independent claim 1 except that claim 15 recites “*a device*,” and the “*device*” comprises both “*a processor*” and “*a memory storing a program for execution by the processor, the program including instructions for*” carrying out a process identical to the method of claim 1.

132. In Goldenberg, the “control knob” is part of a “control panel 12 for an electronic **device**.” [0030]; *see also* [0018]; FIG. 1. The knob “control[s] various functions of the device.” *Id.* The “electronic device” can, for example, be “a controller for various automobile systems,” or it can be “a variety of other electronic or computer devices.” [0030]-[0031]. Goldenberg thus discloses “*a device*,” as claimed.

133. Goldenberg also teaches that its “controlled device includes an electronic portion having a local microprocessor 202...[and] local memory 206.” [0054]; *see also* FIG. 3. The memory 206 stores instructions, *i.e.*, “*program code*,” for performing the steps recited in [1A]-[1B] for the reasons discussed in connection with claim 8. [0066]; *See above* §XI.A.8.

134. Goldenberg thus discloses both “*a processor,*” and “*a memory,*” as claimed, and Goldenberg’s memory includes “*program code*” for performing the method of claim 1.

10. Claims 16-19

135. Dependent claims 16-19 add the same limitations to claim 15 that claims 2-3 and 5-6 added to claim 1, respectively. Therefore, Goldenberg meets claims 16-19 for the same reasons it meets and/or renders obvious claims 2-3 and 5-6. *See above* §§XI.A.3-4 and XI.A.6-7.

B. Ground 2: Claims 7, 14, and 20 are Obvious over Goldenberg in view of Cruz-Hernandez

136. Dependent claims 7, 14, and 20 limit independent claims 1, 8, and 15, respectively, by requiring “*adjusting a profile and a normalized profile of the user input element to adjust for a change to a resting position of the user input element.*”

137. The ’907 Patent explains that “after use...the user input devices may not return to the same resting position when the user interaction is removed.” EX1001, 10:5-8. When that happens, “the calculated profile and the calculated normalized profiles for such user input elements” may be adjusted so that “the changed resting position(s) may be accounted for while monitoring the position of the user input elements.” EX1001, 10:8-13.

138. As discussed below, Cruz-Hernandez teaches adjusting a profile for a user element to account for a change in its resting position, and a POSITA would have had reason to implement that technique in Goldenberg.

Cruz-Hernandez (EX1005)⁵¹

139. Goldenberg and Cruz-Hernandez are readily combined. Cruz-Hernandez discloses “haptic feedback interface devices,” which include an “object 20” that is “moveable in at least one degree of freedom” (for example, a knob). [0003], [0022], [0027]-[0028]. Cruz-Hernandez also discloses “control schemes for [providing] haptic feedback” to the object. [0002]. Many of Cruz-Hernandez’s “control schemes” create “simulated detent force profiles” or “simulated spring forces,” similar to several of the force profiles Goldenberg describes. [0028]; [0031]. For that matter, Cruz-Hernandez further explicitly incorporates by reference the application that published as Goldenberg. [0028].

140. In one embodiment, Cruz-Hernandez teaches a “**position reset**” function that can be used when, for example, simulating a detent. [0035]. As would have been known by a POSITA, detents are a type of force effect that includes forces output when an input element reaches a desired position in a range of motion (for example, when a knob is rotated to a desired position or is rotated by a desired distance), for example to indicate to the user that a certain position has been reached

⁵¹ Unless otherwise noted, citations in §XI.B are to Cruz-Hernandez (EX1005).

or distance has been covered. As Cruz-Hernandez teaches, when an actuator is used “to output detent forces, a user will often release the object or manipulandum when the object is positioned off the center of the detent. Without position reset, the first detent output when the object is next engaged is not consistent with other detent outputs because the object did not start in the center of the detent.” [0035] (emphasis added).

141. “To provide more consistent initial detent interaction,” Cruz-Hernandez teaches that “the position of the object is redefined to be the center of the detent after the user has released the object.” [0035]. When the user then re-engages the object to move it again after the “position reset,” the object is centered within the detent, even though it had been released off-center.

142. Although Cruz-Hernandez “primarily describe[s]...a simulated detent,” it also explains (and a POSITA would have understood) that its teachings can be applied to “a spring force” as well. [0051]; *see also* [0031] (“forces output can be... simulated spring forces”).

1. The Goldenberg-Cruz-Hernandez Combination

143. A POSITA would have recognized that Cruz-Hernandez’s “position reset” function would provide a “more consistent” feel to a knob’s simulated detent or spring effects when the knob is re-engaged after a period of inactivity. [0035]. “Without position reset, the first detent output when the object is next engaged [after

being at rest] is not consistent with other detent outputs because the object did not start in the center of the [first] detent.” [0035]. A POSITA would further have recognized that similar reasoning applies to spring force effects such as the one used in Goldenberg’s jog shuttle force model. EX1016, [0010]; [0115]; FIG. 8. Without position reset, if a user re-engaged a knob that simulates a spring, the knob would feel unrealistic because mechanical springs typically reset to their origin position when disengaged. A POSITA therefore would have recognized that Goldenberg’s control knob would benefit from Cruz-Hernandez’s position reset functionality. Such functionality would have made Goldenberg’s various force feedback effects—including the jog shuttle spring effect illustrated in Goldenberg’s Figure 8—feel more realistic and consistent. EX1005, [0035].

144. In this combination (“Goldenberg-Cruz-Hernandez”), when a user stops turning Goldenberg’s knob for a period of time, Goldenberg’s method would reset the origin position of Goldenberg’s spring effect (for example, Goldenberg’s origin position O) to the stopped position of the knob. The next time the knob is turned, it would start at the new origin position, even if the knob had been disengaged at some position to the left or right of the previous origin.

2. Claim 7

“The method of claim 1, further comprising adjusting a profile and a normalized profile of the user input element to adjust for a change to a resting position of the user input element.”

145. As discussed above at §§XI.A.4 and XI.A.6 (claims 3 and 5), Goldenberg discloses *“a profile...of the user input element”* (for example, a bi-directional profile (see above, §XI.A.7)) and *“a normalized profile of the user input element”* (for example, a uni-directional profile (see above, §XI.A.7)), as claimed. Further on this point, the *“profile”* and the *“normalized profile”* both include a center position (i.e., origin O) for a spring effect. EX1016, FIG. 8. Therefore, resetting the center position, as Cruz-Hernandez teaches, constitutes *“adjusting a profile and a normalized profile of the user input element,”* as claimed.

146. In Goldenberg-Cruz-Hernandez, the spring’s center position is reset *“to adjust for a change to a resting position of the user input element,”* as claimed. In use, the control knob is disengaged and re-engaged, resulting in repeated changes to its resting position. With each change, Cruz-Hernandez’s position reset function adjusts for the change by re-defining the origin position O at a new position, such that Goldenberg’s jog-shuttle spring effect starts at the new origin position. In other words, when the knob is re-engaged, it is centered at the origin of a new spring force profile, rather than starting at some position to the left or right of the origin in the

profile (which would result in the user encountering an unexpectedly greater spring force upon re-engaging the knob). EX1016, FIG. 8.

147. Adjusting both “*a profile*” (for example, a bi-directional profile—although I note that any profile meets this broad language, including a normalized profile) and “*a normalized profile*” (for example, a uni-directional profile) together when the origin position is changed because of a reset or anything else (since the change in origin position would affect multiple profiles), rather than adjusting only one of these, would have been an obvious design choice to a POSITA because it would be simpler, and less prone to errors or oversights in programming. A further motivation would be to avoid a potential lag in the knob’s responsiveness that would result from adjusting a profile every time the mode is changed.

148. Further on this point: even if a POSITA’s design choice were to adjust only one profile immediately while waiting to adjust the other profile(s) only if the user changed modes, the claim language would still be met when the user changed modes, as the claim does not require both profiles to be adjusted concurrently or in immediate succession.

149. Therefore, Goldenberg-Cruz-Hernandez meets each limitation of claim 7.

3. Claims 14 and 20

150. Dependent claims 14 and 20 recite the same “*resting position*” function as claim 7, but they depend from claims 13 and 19, respectively. As shown in Ground 1, Goldenberg discloses claims 13 and 19. Additionally, Goldenberg-Cruz-Hernandez meets the “*resting position*” limitations of claims 14 and 20 for substantially the same reasons that it meets the same limitations of claim 7. See *above* §XI.B.3.

C. Ground 3: Claims 1-4, 6, 8-11, 13, 15-17 and 19 Are Anticipated By and/or Obvious Over Rosenberg

Rosenberg (EX1017)⁵²

151. Rosenberg relates to “computer interface devices” that provide force feedback to users. [0002]. Rosenberg’s system includes an interface device 14, which includes a “user object 34.” [0062]. The user object can be a “steering wheel” ([0070]), a joystick, or any other device that may be grasped/contacted/controlled by a user. [0082]. A user “move[s] the object along provided degrees of freedom to interface with [a] host application program the user is viewing....” [0082].

152. Figure 1 (below) depicts a “control system 10...for an interface device controlled by a host computer system.” [0050]. As illustrated in Figure 1,

⁵² Unless otherwise noted, citations in §XI.C are to Rosenberg (EX1017).

Rosenberg's object 34 is coupled to "sensors 28, actuators 30, and microprocessor 26." [0068].

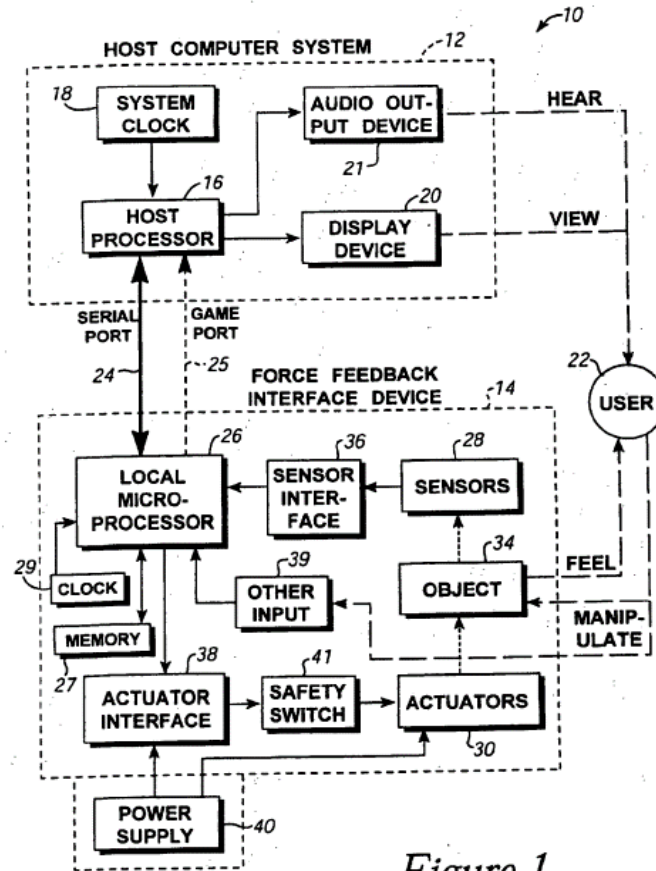


Figure 1

153. The sensors "sense the position, motion, and/or other characteristics of" object 34 ([0069]), and the actuators "transmit forces to user object 34...in response to signals received from [the] microprocessor." [0073]-[0076]; [0088]. The microprocessor may receive instructions from the host computer indicating what command signal(s) to send to the actuator (for example, in the "host-controlled" embodiment of Figure 4), or the microprocessor may send commands independently

to the actuator (for example, in the “reflex” embodiment of Figure 5). [0065]; [0088]; [0114].

154. Rosenberg’s system provides force feedback to the user object 34 using “force profile[s]” that are stored in memory. [0103]. The force profiles identify a force magnitude that is applied to object 34 based on the object’s particular position within its range of motion.

155. For example, Figures 10a-c illustrate “force versus displacement profiles” for a restoring force command. [0164]. “The restoring force indicates a resistance against commanding a velocity in a direction of motion.” [0167]; *see also* [0157] (describing “simulated inertias”). “A restoring force applied to user object 34 always points back towards an origin position O (or ‘neutral position’) of the user object.” [0165]. The restoring force can be implemented either with a deadband region (for example, Fig. 10c), or without a deadband region (for example, Fig. 10a). [0164]-[0166].

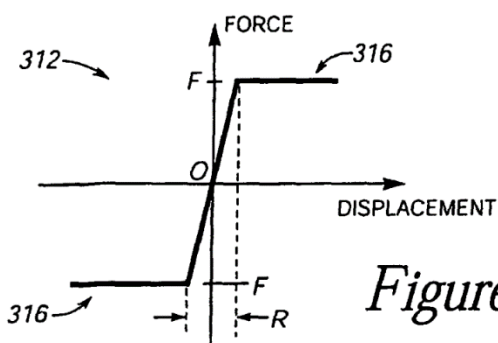


Figure 10a

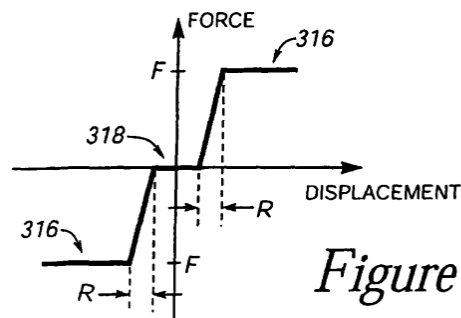


Figure 10c

156. In the non-deadband implementation of Figure 10a (above left), “[a]s the object is moved toward the origin position O, the applied force is constant until the user object is moved within a localized region R about the origin position. When the user object is in the localized region R, the applied force rapidly drops to zero or a small value.” [0165]. This provides a “restoring sensation” in that the object is constantly urged back to its origin position. [0165].

157. The deadband implementation shown in Figure 10c (above right) is similar, except that “the applied force is about zero in an extended [deadband] region 318, about the origin position.” [0166]. This effect allows the user to have some freedom to move object 34 within a short distance around the origin before the restoring force is applied. [0166].

1. Claim 1

a. [1PRE]

“A method for controlling a user input element associated with a haptic output device, the method comprising:”

158. Rosenberg’s method provides input to a video game using an interface device with a user-controllable object 34 such as a steering wheel or button. [0051]-[0052]; [0070]; [0082]. Rosenberg’s user object is a “user input element” as claimed. EX1001, 1:34-35, 4:32-33, 5:17-18; *see above*, §IX.A. Rosenberg teaches

methods for “controlling” the input device (user object) with different force commands.

159. Rosenberg’s user object further incorporates an actuator, which is a haptic output device as claimed. [0062]; FIG. 1; *see also* EX1001, 4:36-53. Rosenberg implements a method for “controlling” the “user input element” (i.e., the user object) and performing the steps recited by limitations [1A]-[1B] as detailed below.

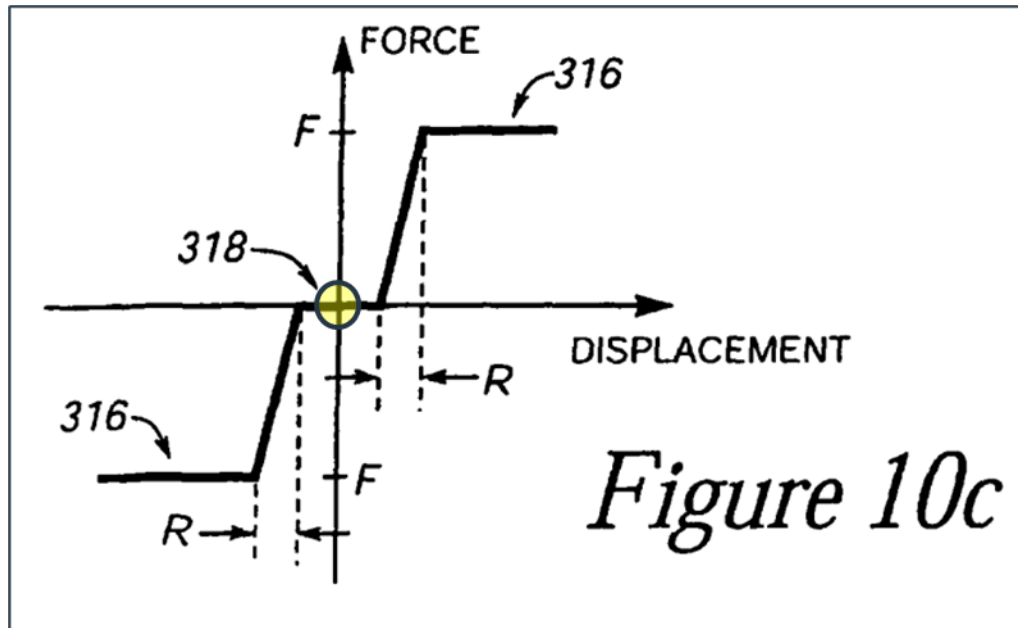
b. [1A]

“defining position and range information for the user input element associated with the haptic output device, including”

160. Rosenberg’s system and method implement force commands that define “position and range information” for the user input element—i.e., user object. In Figures 10a and 10c, the horizontal axis represents the displacement or “position” of the user object and includes the “origin position O.” [0165]. Furthermore, the positions along the horizontal axis are divided into various “range[s]”, as discussed in more detail below (for example, the “localized region R” ([0165]), “[r]egion 318,” which “is known as a ‘deadband’” ([0166]), etc.). Thus, at least Rosenberg’s restoring force command and its associated force profiles “defin[e] position and range information” as claimed.

i. Restoring Force Command With Deadband (Figure 10(c))

161. Rosenberg's restoring force command with a deadband region (Figure 10(c)) defines an origin (neutral) O position for the user object, circled below in yellow. [0165].



162. When the user object is moved outside of the origin position, Rosenberg's actuator exerts a restoring force on the user object that tends the object back to its origin position. [0165]. The "restoring force applied to user object 34 always points back toward" the origin position. [0165]. The exerted force is positive when the object moves in one direction (for example, to the right) and negative when the object moves in the opposite direction (for example, to the left). [0164], [0166].

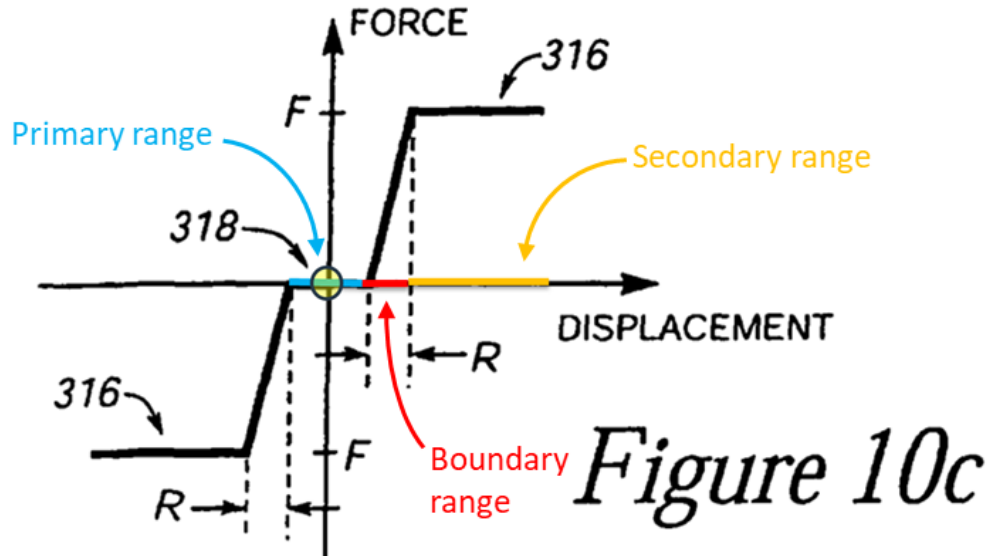
163. Starting from the farthest righthand displacement from the origin, in region 316, the "magnitude of the restoring force...generally remains constant."

[0165]. Within region 316, the constant magnitude “is preferably limited to about 75% of the maximum possible force output ... so that jolts and vibrations can be overlaid on top of the restoring sensation.” [0165].

164. Continuing from right to left along the horizontal axis, “[w]hen the object reaches” a “localized region R, the applied force rapidly drops to zero or a small value.” [0165].

165. Upon the user object’s entry into the deadband range of positions, the restoring force is reduced to a force that is “small or zero” ([0162]), and at the neutral (origin) position, the restoring force exerted is zero. [0165] (“The restoring forces then diminishes or vanishes as the object nears and reaches the origin position.”).

166. Rosenberg’s force restoring command with a deadband (Figure 10c, annotated below) defines the following position ranges: a deadzone (region 318, **blue** annotation below, the flat region surrounding the origin) that surrounds the origin position in which either no force or a small force is exerted on the user object, a constant force range of positions (region 316, **orange** annotation below, the flat region in the upper right quadrant) in which a constant force is exerted on the user object, and a “localized region” range of positions R (**red** annotation below, in the region R to the right of the origin) in which a changing force is exerted on the user object at a steep linear slope.



ii. Restoring Force Command Without Deadband (Figure 10(a), annotated)

167. Rosenberg's restoring force command *without* a deadband region (Figure 10a) exerts a bi-directional restoring force by which "the force on the right side of the vertical axis is applied in one direction along a degree of freedom, and the force on the left side of the vertical axis is applied in the opposite direction along that degree of freedom." [0164].

168. The no-deadband embodiment of Rosenberg's restoring force command includes: an origin position O; a localized region R, in which the magnitude of the force changes rapidly as the user object moves along its degree of freedom, and in which the sign of the force depends on which side of the origin position the user object is disposed; and a region 316, in which a constant maximum force is exerted, the sign of which is again determined by which side of the origin

the object is on. [0164]-[0165]. This is shown in Figure 10a, annotated below. Note that there is no deadband region.

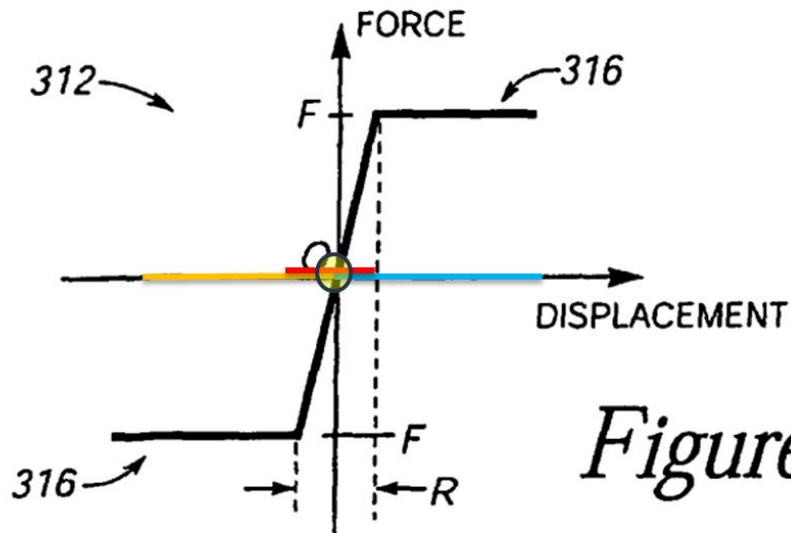


Figure 10a

169. In view of the above, a POSITA would recognize that Rosenberg's restoring force command without a deadband (Figure 10a) defines the following position ranges: a first range of positions in which a positive force (**blue** annotation above, extending right from the origin) is exerted on the user object; a second range of positions in which a negative force (**orange** annotation above, extending left from the origin) is exerted on the user object; and a localized region (**red** annotation above, within the region R surrounding the origin) that surrounds the origin, in which the force exerted is "rapidly" changing until the object reaches either its

neutral/origin position (moving in one direction), or the region 316 (moving in the other direction).

c. [1A1]-[1A3]

“a primary range of positions,” “a secondary range of positions,” and “a boundary range of positions, wherein the boundary range of positions partially overlaps each of the primary range of positions and the secondary range of positions”

170. Rosenberg’s restoring force command—with and without a deadband region—satisfies [1A1]-[1A3].

i. Restoring Force Command With Deadband (Figure 10c)

171. The restoring force command includes a deadband (or “deadzone”) range of positions (**blue** annotation, the flat region surrounding the origin). When the user object is within the deadband, the restoring force exerted on the user object is either low or zero. *See above* §XI.C.2.b.i.

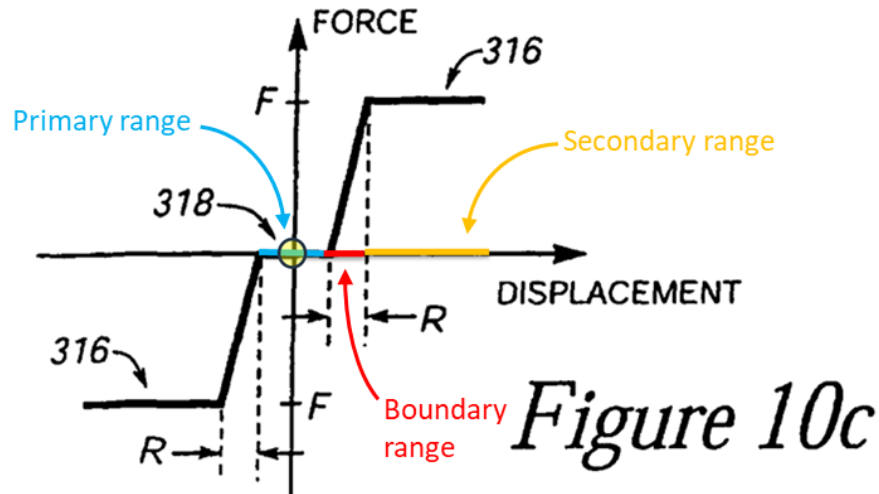


Figure 10c

172. In parallel litigation, the Patent Owner (“PO”) argues that a videogame trigger’s “deadzone...where no analog values will be sent...is just one example of a primary range of positions.” EX1015, 7. Under the Patent Owner’s interpretation of “*primary range of positions*,” the deadband range of positions (**blue** annotation, the flat region surrounding the origin) is “*a primary range of positions*,” even though a zero restoring force is exerted in the deadband.

173. The restoring force command also includes a range of positions (**region 316, orange** annotation, the flat region in the upper right quadrant) within which the restoring force is constant. See above §XI.C.2.b. In parallel litigation, PO argues that a videogame trigger’s end range “where the [same] maximum analog values will be sent once past this point” is “just one example of a secondary range of positions.” EX1015, 7. Thus, under the Patent Owner’s interpretation of “*secondary range of*

positions,” the region 316 of positions (**orange** annotation, the flat region in the upper right quadrant) is “*a secondary range of positions.*”

174. Finally, the restoring force command includes a localized region R (**red** annotation, the flat region in the lower left quadrant) in which a “rapidly” changing force is exerted until the object reaches either deadband 318 or region 316. See *above* §XI.C.2.b. In parallel litigation, PO argues that “a range of positions **between**” a primary range of positions and a secondary range of positions and that generates signals “outside the trigger’s deadzone” is “just one example of a boundary range of positions that partially overlaps each of the primary range of positions and the secondary range of positions.” EX1015, 7-9. Thus, under the Patent Owner’s interpretation, the range of positions within the localized region R is a “*boundary range of positions*” that partially overlaps each of the primary and secondary ranges, as claimed—*i.e.*, the localized region R overlaps the regions 316, 318 at the points where the lines in Figure 10c meet.

ii. Restoring Force Command With No Deadband (Figure 10(a))

175. As explained above at §XI.C.2.b.ii and illustrated below, the no-deadband embodiment of the restoring force command includes: an origin position O; a localized region R (where the force changes rapidly, and the sign of the force is determined by which side of the origin the user object is on); and a region 316

(where a constant maximum force is exerted, and the sign of the force is determined by which side of the origin the user object is on). [0164]-[0165].

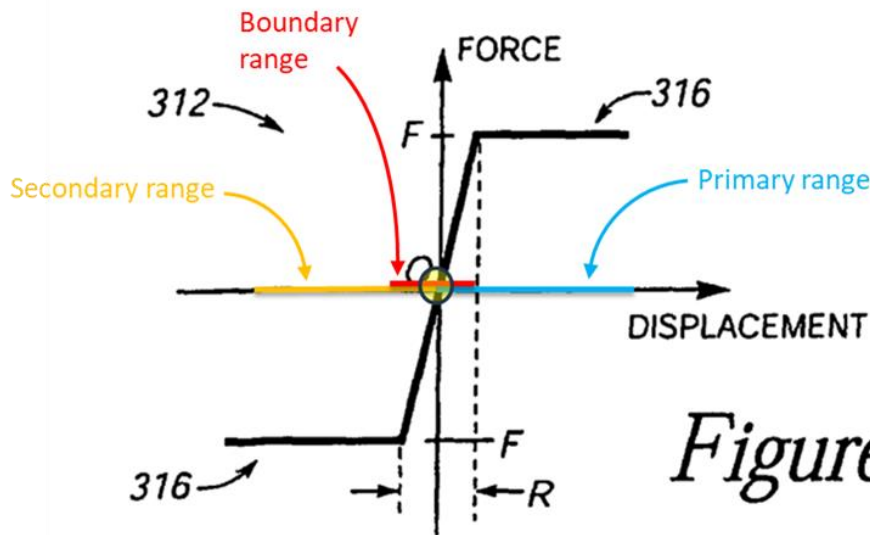


Figure 10a

176. Rosenberg’s restoring force command without a deadband (Figure 10a, annotated above) defines a “*primary range of positions*” as claimed by defining a range of positions (**blue** annotation, extending right from the origin) in which a positive force is exerted on the user object. Rosenberg’s restoring force command without a deadband also defines a “*secondary range of positions*” as claimed by defining a range of positions (**orange** annotation, extending left from the origin) in which a negative force is exerted on the user object.

177. Finally, Rosenberg’s force restoring command without a deadband defines a “*boundary range of positions*” as claimed by defining the range of positions in the localized region (**red**) that surrounds the origin. The localized region

“partially overlaps each of the primary range of positions and the secondary range of positions” as claimed because the localized region extends in both directions and partially overlaps with the each of the *“primary”* (positive) and *“secondary”* (negative) ranges of positions.

d. [1B]

“rendering a haptic effect in response to an entry of the user input element to one or more positions within the boundary range of positions.”

178. Rosenberg’s restoring force command—with and without a deadband region—satisfies [1B]. As a preliminary matter, all of Rosenberg’s restoring force embodiments exert “restoring force” feedback (a type of haptic feedback) with an actuator. [0011]; [0073]-[0077]; [0164]-[0166].

i. Restoring Force Command With Deadband (Figure 10(c))

179. As discussed above, in Rosenberg’s deadband restoring force command embodiment, localized region R is the claimed *“boundary range of positions.”* See above §XI.C.2.c.i. In the localized region R (i.e., the *“boundary range of positions”*), Rosenberg’s method exerts a “rapidly” changing restoring force. [0165]. In other words, there a steep change in force results from a change in position within the localized region R.

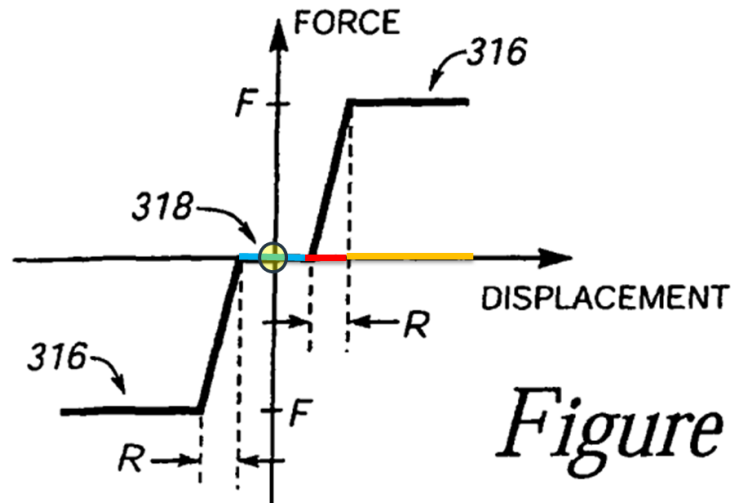


Figure 10c

180. Thus, Rosenberg outputs restoring force feedback (a type of “*haptic effect*”) when the user object enters any position within the boundary range. As explained in §XI.A.2.c, rendering haptic feedback in response to entry of the user input element (*i.e.*, Rosenberg’s user object) into *any* position within the boundary range satisfies [1B].

ii. Restoring Force Command With No Deadband (Figure 10(a))

181. In Rosenberg’s non-deadband embodiment of the restoring force command, the localized region R is the claimed “*boundary range of positions.*” See *above* §XI.C.2.c.ii.

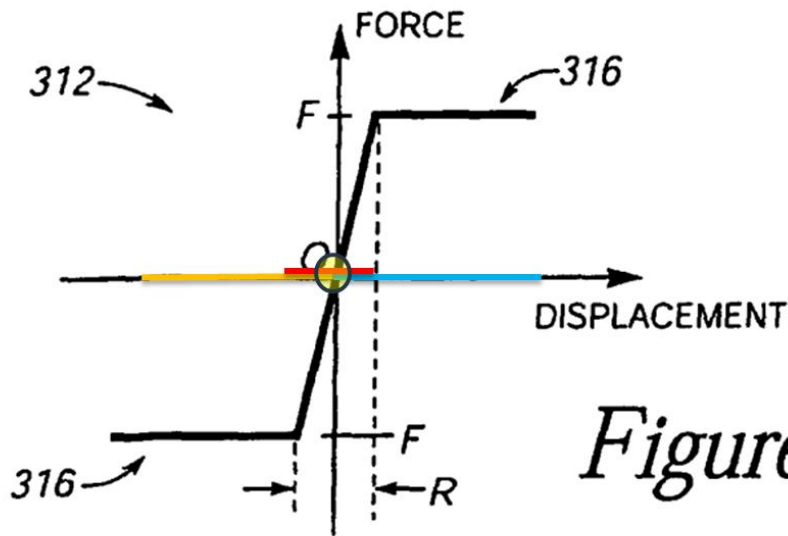


Figure 10a

182. In localized region R—i.e., the claimed boundary range of positions—Rosenberg’s method exerts a “rapidly” changing restoring force (i.e., a steep change in force results from a change in position). [0165]. Thus, in the no-deadband restoring force command embodiment, Rosenberg outputs restoring force feedback (“a haptic effect”) when the user object enters any position within the boundary range. This satisfies [1B]. See above §XI.F.1.c.

2. Claim 2

“The method of claim 1, wherein one of the primary range of positions, the secondary range of positions, and the boundary range of positions is calculated based on a movement of the user input element from a maximum out position to a grounding position.”

183. Rosenberg teaches that its user object 34 can take the form of any device “that may be grasped or otherwise contacted or controlled by a user” such as a button ([0082]) or trigger ([0081], [0220]). A POSITA would have understood that the typical degree of freedom for buttons and triggers (such as those found on videogame controllers) includes a “*maximum out position*” (i.e., the farthest position to which the button or trigger can extend outwards), and “*a grounding position*” (i.e., the farthest position to which the button or trigger can be pressed downwards or inwards).

184. Accordingly, when creating the “force versus displacement profiles” shown in Figures 10a and 10c, Rosenberg’s method inherently requires that the total potential range of displacement for a button or trigger be calculated, including all positions extending from “*a maximum out position*” to “*a grounding position.*” The primary, secondary, and boundary ranges defined within Rosenberg’s “force versus displacement profiles” are calculated within the limits of this total potential range, and are therefore “*calculated based on a movement of the user input element from a maximum out position to a grounding position*” as claimed.

3. Claim 3

“*The method of claim 1, wherein a profile for the user input element is calculated by mapping each position of the user input element to an analog to digital conversion value.*”

185. To provide force feedback on its control knob, Rosenberg teaches the use of “force profiles” that map the user object’s physical positions to forces to be output onto the object. [0164] (describing force profiles as “***force versus displacement*** profiles”); [0168] (same). Exemplary “force profiles” are depicted in Rosenberg’s Figures 10a-10c, and each maps a position (*i.e.*, its “displacement” within its degree of freedom/range of motion) of the object to a particular magnitude and sign for a force that is to be output onto the object as a result of the user object entering the corresponding position. [0029]; [0164].

186. Rosenberg determines and monitors the position of its user object by using “sensors 28” that “sense the position, motion, and/or other characteristics of a user object 34 of the interface device along one or more degrees of freedom and provide signals to microprocessor 26 including information representative of those characteristics.” [0069]; *see also* [0020]; FIG. 1. Exemplary sensors include “optical encoders” which cooperate with “sensor interface 208 to convert sensor signals to signals that can be interpreted by the microprocessor 26....” [0070]. Sensors can also take the form of “analog sensors” and an “analog to digital converter (ADC)” that “can convert the analog signal to a digital signal that is received and interpreted by microprocessor 26....” [0071]. Thus, Rosenberg calculates “*analog to digital conversion value[s]*” to be used with each “force

profile,” including the profiles depicted in Figures 10a and 10c, using at least two possible arrangements: a digital optical encoder, and an analog sensor in combination with an analog to digital converter (ADC).

187. **Digital Optical Encoder:** Digital optical encoders like those Rosenberg discloses ([0069]) were conventional in 2014 and known to take as inputs analog values representing the position of a device and output corresponding digital values. This is consistent with Rosenberg disclosure that the optical encoder “provides an electrical signal” to a “sensor interface” that then “convert[s] sensor signals to signals that can be interpreted by the microprocessor 26 and/or host computer system 12.” [0070]. A POSITA would have understood that Rosenberg’s “optical encoder” (in combination with a sensor interface) mapped each physical position of control knob within its rotary degree of freedom to “*an analog to digital conversion value,*” as claimed.

188. **Analog Sensor:** Rosenberg also describes the conversion of analog signals from other sensors to digital values. “An analog to digital converter (ADC) can convert the analog signal to a digital signal that is received and interpreted by microprocessor 26 and/or host computer system 12, as is well known to those skilled in the art.” [0071]. Thus, a POSITA would have understood that an ADC would be used in conjunction with a position sensor that outputs an analog value (for example,

“an analog sensor” ([0071])) to convert the analog sensor value to an “*analog to digital conversion value*.”

189. Thus, analog-to-digital conversion values are generated by Rosenberg’s “optical encoder” (in combination with a sensor interface) and/or “analog sensor” (in combination with an ADC). These values are then used (or it would have been obvious to use them) to “*calculate*” each of Rosenberg’s stored “force profiles” because those profiles associate force output values with the displacement of an object within its freedom of movement. [0164]; Figs. 10a-10c. Stated differently, each ADC value (mapped to an associated position) would have been associated with a corresponding force that the actuator was to provide to object 34 upon the object’s entry into the associated/mapped position.

190. If Rosenberg is found to not explicitly disclose claim 3, implementing Rosenberg’s force profiles so that they included “*mapping each position of the user input element to an analog to digital conversion value*” would have been obvious and conventional because the physical position of the user input element is an analog value and Rosenberg’s force profiles are used by Rosenberg’s processor which a POSITA would have understood to have operated on digital values.

191. Also on this point, Rosenberg’s sensors are substantively the same as those disclosed in Goldenberg and perform the same analog-to-digital position-mapping function that Goldenberg’s sensors perform. *See above* §XI.A.4.

Rosenberg thus uses its sensors to perform the method of claim 3 for the same reasons that Goldenberg uses its sensors to do so. *See above* §XI.A.4. Alternatively, implementing Rosenberg such that it uses its sensors to perform the method of claim 3 would have been obvious for the same reasons it would have been obvious to implement Goldenberg to perform claim 3's method.

4. Claim 4

“The method of claim 3, wherein the profile for the user input element is an increasing profile or a decreasing profile.”

192. As explained above at §XI.A.5 (claim 4), 8-bit ADC mapping was well-known. Creating increasing or decreasing ADC values for Rosenberg's force vs. displacement profiles (*See above* §XI.C.4 (claim 3)) would have been a matter of straightforward design, because a POSITA would not have put the values in a jumbled order. Rather, a monotonic ordering would have been obvious. Only two plausible monotonic orderings exist: increasing or decreasing.

5. Claim 6

“The method of claim 1, further comprising monitoring a position of the user input element.”

193. Rosenberg satisfies claim 1, and further uses sensors to monitor the position of the user object (i.e., the “*user input element*”), as claimed. [0068].

6. Claim 8

“*A non-transitory computer readable storage medium...*”

194. Independent claim 8 recites “*a non-transitory computer readable storage medium [CRM] storing a program configured to be executed by a processor, the program comprising instructions for*” carrying out the method of claim 1. Rosenberg discloses such a CRM.

195. Rosenberg’s force profiles, including the restoring force commands of Figures 10a and 10c, can be implemented by a “local microprocessor 26” that “read[s] sensor signals and calculat[es] appropriate forces from those sensor signal.” [0063]. “Local memory 27, such as RAM and/or ROM, is preferably coupled to microprocessor 26 in interface device 14 to store instructions for microprocessor 26 and store temporary and other data.” [0063].

196. Rosenberg’s local memory 27, which can be RAM and/or ROM ([0063]), is “*a non-transitory computer readable storage medium storing a program configured to be executed by a processor,*” where the program is the set of software instructions executed by Rosenberg’s microprocessor to implement its force profiles. [0125] (explaining local microprocessor causes actuator to output forces

based on “reflex processes” that are “stored local to microprocessor 26 in, for example, memory 27 such as RAM or ROM” and include “algorithms, stored force profiles or values, conditions, etc.”); [0178] (explaining a “force profile” is “stored in memory”); [0280] (“The assigned force ranges, magnitudes and models can also be stored in memory 27....”).

197. The steps recited in the remaining limitations of claim 8 are identical to the method steps recited in [1A]-[1B], and are met and/or rendered obvious by for the same reasons discussed in §§XI.C.2.b-d above.

7. Claim 9-11 and 13

198. Dependent claims 9-11 and 13 add the same limitations to claim 8 that dependent claims 2-4 and 6 add to claim 1, respectively. Rosenberg’s CRM stores a program comprising instructions for performing the steps recited in claims 9-11 and 13 for the same reasons Rosenberg meets and/or renders obvious claims 2-4 and 6. *See above* §§XI.C.3-6.

8. Claim 15

“A device, comprising...”

199. Independent claim 15 is substantially identical to independent claim 1 except that claim 15 recites “a device,” and the “device” comprises both “a processor” and “a memory storing a program for execution by the processor, the

program including instructions for” carrying out a process identical to the method of claim 1.

200. Rosenberg’s object 34 is part of an “interface device” that “outputs the indication of movement [of the object] to the computer system.” [0011]. The “interface device” (element 14) is depicted below in Figure 1 and is “a device,” as claimed.

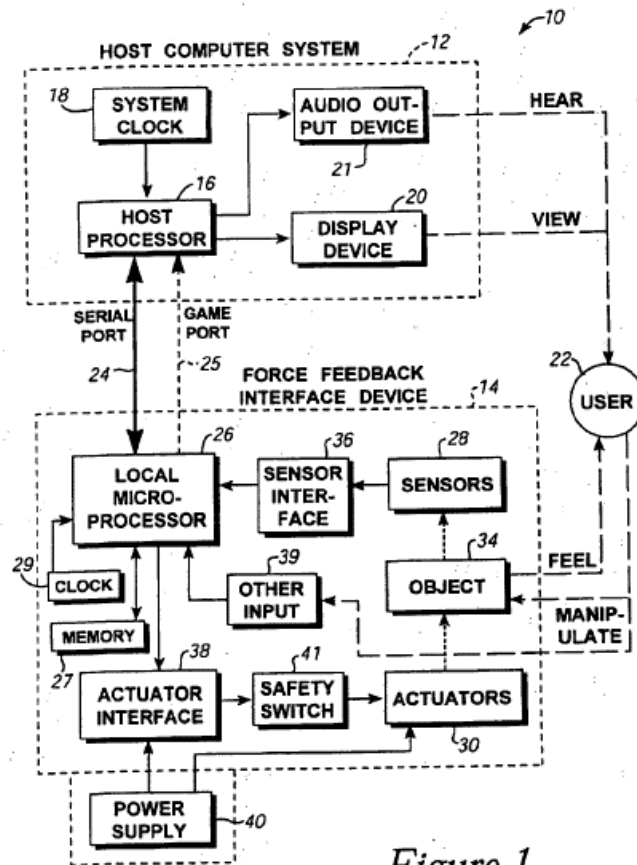


Figure 1

201. Rosenberg teaches (and Figure 1 above shows) that the interface device includes a local microprocessor 26 ([0062]-[0063]) and a local memory 27 ([0063]).

The memory 27 stores instructions (*i.e.*, “*program code*”) for performing the steps recited in [1A]-[1B] for the reasons discussed in connection with claim 8. [0066]; *see also See above §XI.C.7.*

202. Rosenberg thus discloses both “*a processor*,” and “*a memory*,” as claimed, and Rosenberg’s memory includes “*program code*” for performing the method of claim 1.

9. Claim 16-17 and 19

203. Dependent claims 16-17 and 19 adds the same limitation to claim 15 that claims 2-3 and 6 added to claim 1. Rosenberg meets claims 16-17 and 19 for substantially the same reasons it meets and/or renders obvious claims 2-3 and 6. *See above §§XI.C.3-4 and XI.C.6.*

D. Ground 4: Claims 5, 12, and 18 are Obvious Over Roberts and Rosenberg

Roberts⁵³

204. Roberts discloses a videogame steering wheel. 2:63-3:10; FIG. 1. In an embodiment, the steering wheel has a total range of motion of 270 degrees. 5:31-33. A potentiometer connected to the wheel’s shaft determines the wheel’s position and outputs a digital “zero” signal to a controller when the wheel is turned to its furthest left physical limit, and a digital “high signal” when the wheel is turned to its

⁵³ Citations in §XI.D are to Roberts (EX1018) unless otherwise noted.

furthest right physical limit. 5:27-30. The potentiometer thus provides a controller with a digital signal corresponding to the position of the wheel within its 270 degrees of range of motion. 5:5:23-40.

205. Roberts further discloses that a user can set a right and left “end-of-range of position” that “results in a maximum (or minimum, whatever the case may be) control signal in the game even though the input device can still be moved more, beyond the end-of-range position, until it hits the physical limit of its movement.” 5:37-41; *see also* 6:2-52. These end-of-range positions may differ from the physical limits of the steering wheel. 5:35-37. In other words, the end-of-range positions may define a range of movement (for example, 240 degrees of motion) that is narrower than the wheel’s full physical range of motion. *Id.*

206. Once end-of-range positions have been set, “the controller 52 continually monitors the current position of the” steering wheel to determine “where the current position is relative to the two end-of-range positions recorded in memory,” and then “outputs a control signal representative of the correct direction.” 6:53-58. When the wheel’s position moves “[a]t and beyond the end-of-range positions, the maximum control signal...is generated.” 7:49-52. This is seen in Figure 4(a) below where the maximum control signal is designated as 100% on the vertical axis:

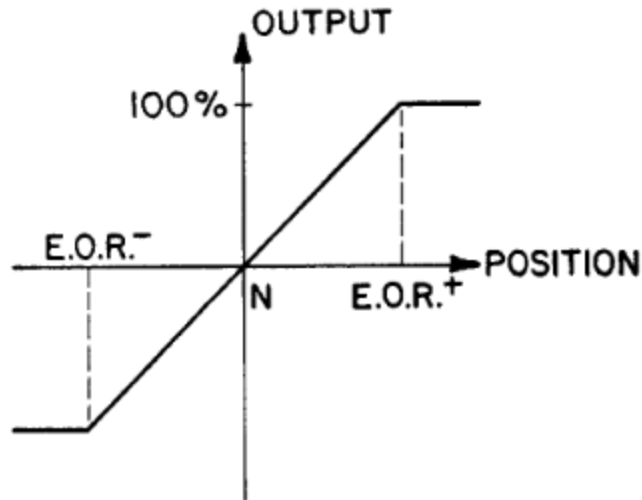


FIG. 4(a)

207. In addition, Roberts teaches that a user can set a dead zone at or around the steering wheel's neutral position. 7:66-8:37. A deadzone around the neutral position is shown below in Figure 4(c), between positions DZ^- and DZ^+ :

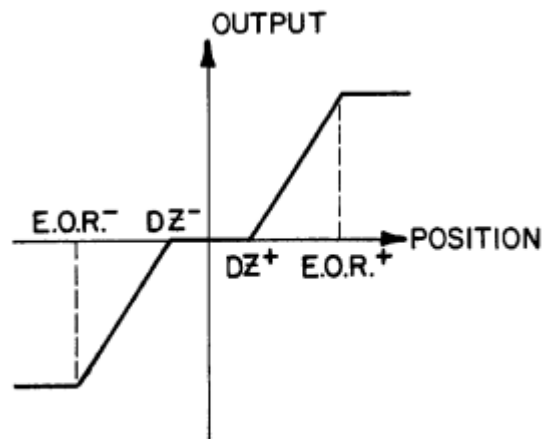


FIG. 4(c)

208. Roberts leaves it to a POSITA to determine how the videogame system uses the control signal. 5:62-64 (“The reaction of a game due to the control signal

is something that is known in the art and need not be further elaborated herein.”). However, Roberts provides examples in which the control signal is used to provide visual feedback “so that the player knows” how certain information or conditions have changed a result of the player’s movement of the steering wheel (for example, a series of LEDs “can be illuminated . . . to show the current steering position”). 4:67-5:5.

1. The Roberts-Rosenberg Combination

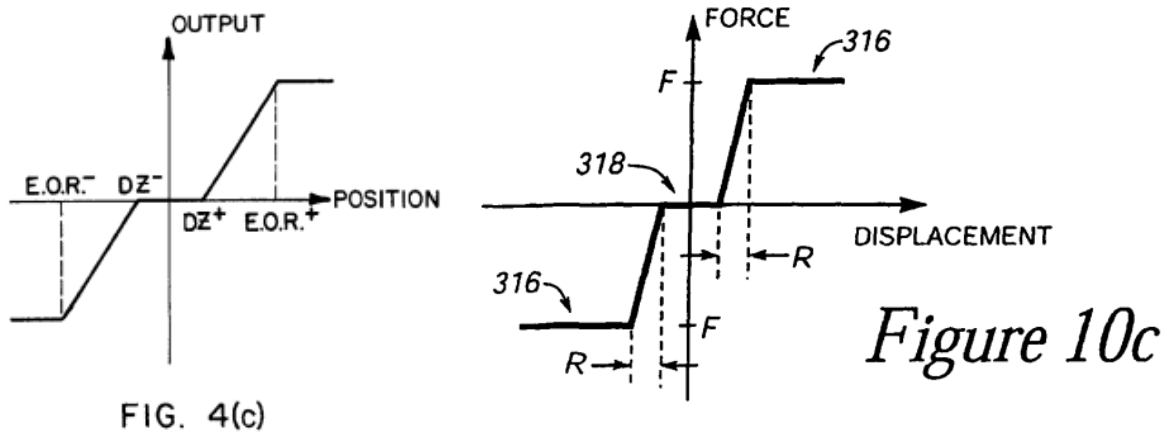
209. Roberts and Rosenberg are readily combined. As an initial matter, both teach input devices that **(a)** utilize position sensors, **(b)** can be a steering wheel, **(c)** have a neutral or origin position, **(d)** output a signal based on the device’s positioning, and **(e)** can have a deadzone/deadband around the neutral or origin position. Roberts and Rosenberg also both provide feedback based on the steering wheel’s position, with Roberts’s feedback being visual feedback and Rosenberg’s being tactile feedback (including restorative force feedback communicated via actuators coupled to the steering wheel). *See above* §XI.C.1 (describing Rosenberg).

210. A POSITA would have been motivated to implement Roberts’s system such that its steering wheel was provided with an actuator that outputs the restoring spring forces that are illustrated in Rosenberg’s Figure 10c. EX1017, [0164]-[0167]. For example, a POSITA would have been motivated to provide Roberts’s steering wheel with force feedback to provide well-known benefits of such feedback,

including providing a more realistic sensory user experience and providing the user with tactile feedback on the steering wheel's position. EX1005, [0003]-[0004]; EX1007, [0024]. Restoring forces such as spring forces were also well-known in the art, including from steering wheel devices from the 1950's.

211. Additionally, Roberts expressly states that “[s]pring or ***other mechanisms*** (not shown) can tend the input device toward its neutral position.” EX1018, 3:49-50. A POSITA would have understood that Rosenberg's restoring force via an actuator would be a desirable and suitable design choice for another “mechanism” that “tend[s]” the steering wheel toward its neutral position. Indeed, Rosenberg teaches using such forces for the same purpose. EX1017, [0164]-[0167].

212. Further on this point, in combining Rosenberg's restoring force with Roberts's steering wheel, a POSITA would have recognized that Roberts (Figure 4(c)) and Rosenberg (Figure 10c) disclose similar embodiments that have a deadzone/deadband. This is readily apparent from a comparison of the two figures.



Roberts, Fig. 4C (left); Rosenberg, Fig. 10c (right)

213. A POSITA would have known that Roberts's deadzone embodiment could easily be modified to implement Rosenberg's deadband restoring force profile. For example, in one obvious implementation, the "control signal" that Robert's controller outputs based on the steering wheel's position within its range of motion would have been used to determine the steering wheel's "displacement" for use with Rosenberg's "force versus displacement profile[s]" (for example, Figure 10c). EX1018, 3:20-44; EX1017, [0164]. That is, Roberts's "control signal" would indicate the steering wheel's displacement and would be used to determine how much of Rosenberg's restoring force to output to the wheel.

214. In combining Rosenberg and Roberts, a POSITA would have maintained Roberts's capability to set end-of-range positions for the Roberts-Rosenberg steering wheel that differ from the physical limits of the steering wheel. EX1018, 5:16-41. A POSITA would have retained this capability because Roberts

teaches that it allow users to, for example, “maximize their enjoyment and success in the game.” EX1018, 1:23-33. A POSITA would have expected to succeed in doing so because such a modification could be accomplished by coupling Roberts’s steering wheel to an actuator, as taught by Rosenberg, and using routine computer engineering skills to utilize Roberts’s control signal with the force effect profile depicted in Rosenberg’s Figure 10c.

2. Claim 5

“The method of claim 1, wherein a normalized profile for the user input element is calculated by removing at least one of the secondary range of positions or the boundary range of positions from mapped analog to digital conversion values.”

215. Claim 5 is dependent on claim 1. For purposes of Ground 4, and for the reasons discussed above (*see above* §XI.C.2), the Patent Owner’s interpretation of claim 1 is taught by Rosenberg’s deadband restoring force profile depicted in Rosenberg’s Figure 10c. *See, for example, EX1017 [0164]-[0166]; see also, ¶¶173-175 above.*

216. Claim 5 adds to claim 1 a step of calculating a normalized profile “*by removing at least one of the secondary range of positions or the boundary range of positions from mapped analog to digital conversion values.*” According to the Patent, “the calculated normalized profile... may map each position of the user input

device, excluding secondary and/or boundary positions, to an ADC value between 0 and 255.” EX1001, 9:65-10:3.

217. A POSITA would have understood that calculating a normalized profile in this manner refers to mapping each position in the normalized ranges (for example, at least the primary range, but excluding the boundary range and/or the secondary range) to an ADC value (for example, between 0 and 255). Doing so “removes” the excluded range(s) (*i.e.*, the boundary range and/or the secondary range) because no ADC value is mapped for the positions within the excluded range(s).

218. Roberts-Rosenberg calculates a normalized profile in the same manner described in the '907 patent: by removing a range from the mapped ADC values. As an initial matter, Roberts-Rosenberg may implement an analog sensor as taught by Rosenberg. EX1017, [0071]. In such implementations, “[a]n analog to digital converter (ADC) can convert the analog signal to a digital signal that is received and interpreted by microprocessor 26 and/or host computer system 12, as is well known to those skilled in the art.” EX1017, [0071]; *see also*, §XI.C.4 *above*.

219. As discussed in §XI.D.1 *above*, Roberts-Rosenberg implements Rosenberg’s deadband restoring force profile depicted in Rosenberg’s Figure 10c. As illustrated immediately below and discussed above at §XI.C.2.c.i Rosenberg’s Figure 10c includes “*a secondary range of positions*” (as that term is interpreted by

the Patent Owner), which is defined by “range 316.” EX1017, [0165]; *see above* §XI.C.2.c.i.

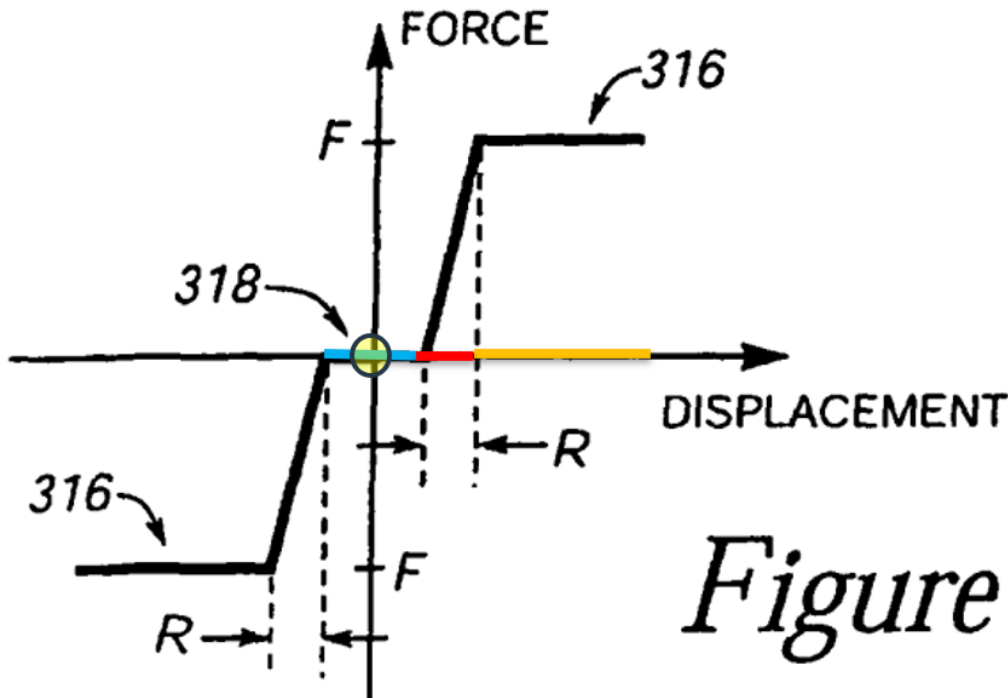


Figure 10c

In this secondary range of positions, Roberts-Rosenberg’s wheel outputs a constant near-maximum restoring force as discussed in §XI.C.1. EX1017, [0165]-[0166].

220. In Roberts-Rosenberg, the regions 316 would be defined when a user sets the rightmost and leftmost end-of-range positions as taught by Roberts. A POSITA would understand this to be a normalization, for example to the rightmost and/or leftmost positions as references. Once the two regions 316 have been defined by the user, Roberts-Rosenberg would then calculate position values for the steering wheel between the two regions 316, with each position value mapped to a corresponding position. This calculation and mapping results in “a normalized

profile” for the wheel being “calculating by removing at least...the secondary range of positions...from mapped analog to digital conversion values,” under the Patent Owner’s interpretation of the claims. EX1018, 6:53-62 (explaining how the wheel’s position between the user-set end-of-range positions is determined via interpolation or via “a look-up table that is generated based upon values of the end-of-range positions”).

3. Claim 12

221. Dependent claim 12 adds the same limitation to claim 8 that dependent claim 5 adds to claim 1. Roberts-Rosenberg would have used Roberts’ CRM (computer readable storage medium) , which satisfies claim 8 (*see above* §XI.C.7). The CRM would have stored a program which included instructions for performing the steps recited in claim 12 for the same reasons that Roberts-Rosenberg renders obvious the method steps of claim 5. *See above* §XI.D.3.

4. Claim 18

222. Dependent claim 18 adds the same limitation to claim 15 that dependent claims 5 adds to claim 1. Roberts-Rosenberg would have used Rosenberg’s device (implemented as Roberts’ steering wheel), which satisfies claim 15 (*See above* §XI.C.9). The device would have stored a program comprising instructions for performing the steps recited in claim 18 for the same reasons that Roberts-Rosenberg renders obvious the method steps of claim 5. *See above* §XI.D.3.

E. Ground 5: Claims 7, 14 and 20 Are Obvious Over Roberts in view of Rosenberg and Cruz-Hernandez

223. Claim 7 adds to claim 1 the additional method step of “*adjusting a profile and a normalized profile of the user input element to adjust for a change to a resting position of the user input element.*” This additional step accounts for a change to the user input device’s resting position during use. EX1001, 10:5-13.

224. As discussed above at §XI.B.1, Cruz-Hernandez teaches a “position reset” function that can be used when simulating a detent or spring effect. EX1005, [0031]; [0035]; [0051]. Cruz-Hernandez teaches that this function is useful for any interface object that provides haptic feedback to a user including a “wheel.” EX1005, [0027]-[0028].

225. “To provide more consistent” interaction with the interface object, Cruz-Hernandez teaches that “the position of the object is redefined to be the center of the detent after the user has released the object.” EX1005, [0035]. When, after a period of non-use, the user re-engages the object to move it again after the “position reset,” the object is centered within the detent again even though it had been released off-center. Cruz-Hernandez teaches (and a POSITA would have understood) that although Cruz-Hernandez “primarily describe[s]...a simulated detent,” its teachings can be applied to “a spring force” as well. EX1005, [0051]; *see also* §XI.B.1 above.

1. The Roberts-Rosenberg-Cruz-Hernandez Combination

226. Roberts-Rosenberg's wheel "can have physical stops that prevent it from rotating" beyond a certain point, or "it can be designed to have infinite rotation." 3:26-29. As explained in Ground 4, Roberts-Rosenberg's steering wheel would have used actuators that simulate a restoring force that, in addition to providing a user with force feedback, would also "tend" the steering wheel "toward its neutral position." EX1018, 3:49-50; *see above* §XI.D.2.

227. In view of Cruz-Hernandez, a POSITA would have recognized that there was a potential for a user to disengage the steering wheel before the actuators returned the wheel to its absolute neutral position. EX1005, [0035]. A POSITA would have understood that such an off-neutral release could lead to one or both of two outcomes which would motivate a POSITA to implement Cruz-Hernandez's position reset function.

228. First, in view of the infinite rotational freedom of Roberts-Rosenberg, a POSITA would recognize that a user may release the steering wheel at a point that is several revolutions away from the neutral position (for example, 360°, 720°, etc.). In such instances, Roberts-Rosenberg's restoring force would need to move the wheel several rotations back to return to the neutral position. A POSITA would have appreciated that such behavior would likely have been detrimental to a user's use of the system. In recognition of this possibility, a POSITA would have been motivated

to prevent the unnecessary rotation of the steering wheel by the restoring force, to ensure that when the user next engages with the steering wheel, the wheel begins at its absolute neutral position. For example, if a wheel is at a position turned 720° or more when a game ends and the wheel is released, a POSITA would have viewed it as inefficient for the restoring force to return the wheel through two full revolutions or more to its previous neutral position. Rather, a POSITA would have been motivated to allow the neutral position to be reset at a current position after the wheel has been released. To accomplish this, a POSITA readily would have considered adding Cruz-Hernandez's "position reset" functionality to the Roberts-Rosenberg device.

229. Second, a POSITA would have understood that any electro-mechanical system has some degree of imprecision or "play" in the components. In a case where a user releases the Roberts-Rosenberg wheel off-neutral, this "play" may cause the actuators to output a restoring force that returns the wheel back to a position that is *close* to the original absolute neutral position, but is still off-neutral by some degree. For example, small imprecisions, mechanical slippage, friction, electronic signal drift, imperfect mechanical or electronic repeatability, aging and/or wear effects, and/or other factors affecting the position sensor(s), the actuator(s), or other components may cause the wheel to come to rest several degrees away from the nominal absolute neutral position. This teaching is present in Roberts's disclosure

that “[s]prings or other mechanisms ... can tend the input device toward its neutral position” (EX1018, 3:49 (emphasis added)) and in Rosenberg’s disclosure that a “restoring force applied to user object 34 always points back towards an origin position” (EX1017, [0165] (emphasis added)). The emphasized language in these teachings carries connotations of imprecision, demonstrating that a POSITA would not have expected an input device to always be returned precisely to its nominal origin position. Further, such “imprecisions” were well known in the art. Thus, when the user re-engages the wheel, the off-neutral or off-center position may cause the user’s interaction with the wheel (or some aspect of gameplay that is controlled by the wheel), to be inconsistent with their expectations (for example, if a user thinks the wheel is centered when it is not, then the user may over-turn or under-turn the wheel upon re-engaging). Therefore, a POSITA would have been motivated for this additional reason to allow the neutral position of Roberts-Rosenberg’s steering wheel to be reset using Cruz-Hernandez’s “position reset” functionality.

230. In both of the above scenarios, adding Cruz-Hernandez’s position reset function to the Roberts-Rosenberg steering wheel would have beneficially “provide[d] more consistent” user interaction with the device (EX1005, [0035]), which is consistent with Roberts’s intent to make steering wheels that “maximize” user “enjoyment and success in the game” (EX1018, 1:28-33).

231. In Roberts-Rosenberg-Cruz-Hernandez, the software instructions that the steering wheel's processor executes would include Cruz-Hernandez's "position reset" functionality such that when the steering wheel is disengaged for a period of time, the steering wheel's neutral position would be set as the then-current resting position of the steering wheel. A POSITA would have expected to succeed in implementing this combination because the modification could be accomplished using routine computer engineering skills.

2. Claim 7

"The method of claim 1, further comprising adjusting a profile and a normalized profile of the user input element to adjust for a change to a resting position of the user input element."

232. The steering wheel of Roberts-Rosenberg-Cruz-Hernandez meets claim 1 for the same reasons the steering wheel of Roberts-Rosenberg does. *See above* §XI.D.3 (claim 5). Furthermore, the steering wheel of Roberts-Rosenberg-Cruz-Hernandez teaches "*a profile...of the user input element*" (for example, a profile in which the user may or may not have selected the rightmost and leftmost end-of-range positions; *see* EX1018, 3:20-38 (explaining that a maximum/minimum control signal may be output when the wheel reaches a physical stop, rather than a user-selected end-of-range position)) and "*a normalized profile of the user input element*"

(for example, a profile after the user has selected the rightmost and leftmost end-of-range positions; see EX1018, 6:22-62 (explaining the configuration mode in which the end-of-range positions are selected)). See above, §XI.D.2.

233. Implemented to perform Cruz-Hernandez's position reset functionality when the steering wheel is not used for a period of time, the steering wheel of Roberts-Rosenberg-Cruz-Hernandez would adjust Rosenberg's restoring spring force profile to account for a new neutral position, which would require adjusting all other position ranges relative to the new neutral position.

234. Adjusting both "*a profile*" (which, as noted in §XI.B.2 above, includes any profile, regardless of whether it is normalized or not) and "*a normalized profile*" would have been an obvious design choice in view of the "different modes of operation" for the input device. EX1018, 5:3. Further on this point, I note that any adjustment to the profiles to adjust for a change in a resting position would meet the requirements of the claim.

235. A POSITA would have understood that the wheel's "different modes of operation" may include various profiles for various game modes, each of which may be "normalized" to an original nominal zero position. As one example of different modes of operation, "a plurality of sensitivities" may be present to allow different sensitivities for different vehicles within a driving game. EX1018, 1:58. If the nominal zero position is reset in one mode of operation/profile setting (for

example, for a change in game mode or game conditions, after a pause in gameplay, when powering the system on/off, or for any other reason), then a POSITA would reasonably adjust *all* of the profiles for the new origin instead of adjusting only the current profile. This would have been an obvious design choice to a POSITA because it would be simpler, and less prone to errors or oversights in programming. Thus, multiple profiles would have been “*adjusted*,” and at least one of them would have been normalized based on user-selected end-of-range positions.

236. Further on this point: as noted in §XI.B.2 above, even if only the current profile were adjusted in an initial adjustment, claim 7 would still be met when a subsequent adjustment occurred, as the claim does not require the two profiles to be adjusted within any particular timeframe.

237. [RESERVED]

238. [RESERVED]

239. Thus, Roberts-Rosenberg-Cruz-Hernandez renders obvious “*adjusting a profile and a normalized profile of the user input element to adjust for a change to a resting position of the user input element*” as claimed.

3. Claim 14

240. The steering wheel of Roberts-Rosenberg-Cruz-Hernandez meets claim 8 for the reasons the steering wheel of Roberts-Rosenberg does. *See above* §XI.D.4 (claim 12).

241. Dependent claim 14 adds the same limitation to claim 13 (which is dependent upon independent claim 8) that dependent claim 7 adds to claim 1. Implemented in view of Cruz-Hernandez to include Cruz-Hernandez's "reset" functionality, Roberts-Rosenberg's CRM (§XI.D.4 (claim 12)) would have stored a program comprising instructions for performing the steps recited in claim 14 for the same reasons Roberts-Rosenberg-Cruz-Hernandez renders obvious claim 7. *See above* §XI.E.2.

4. Claim 20

242. Dependent claim 20 adds the same limitation to claim 15 that dependent claim 7 adds to claim 1. Implemented in view of Cruz-Hernandez to include Cruz-Hernandez's "reset" functionality, Roberts-Rosenberg's device (*See above* §XI.D.5 (claim 18)) would have stored a program comprising instructions for performing the steps recited in claim 20 for the same reasons Roberts-Rosenberg-Cruz-Hernandez renders obvious claim 7. *See above* §XI.E.2.

F. Ground 6: Claims 1, 3-4, 6, 8, 10-11, 13, 15, 17, and 19 Are Anticipated By and/or Obvious Over Levin

Levin (EX1006)⁵⁴

243. Levin discloses a device with a control panel with which a driver can interact to control various systems of a car, such as its stereo or HVAC system.

⁵⁴ Unless otherwise noted, citations in §XI.F are to Levin (EX1006).

[0024], [0027]-[0030]. As shown in Figure 1, Levin's device includes "[c]ontrol knobs 18" that incorporate force feedback using an actuator. [0030], [0047].

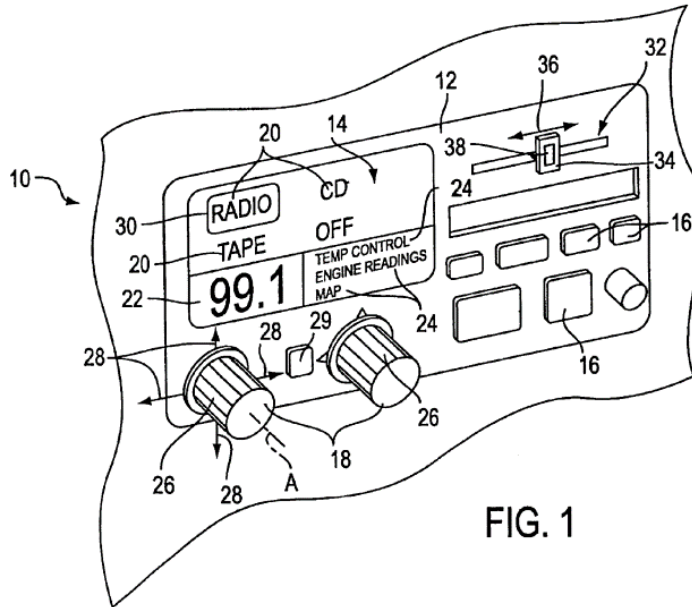


FIG. 1

244. A user turns the control knob to adjust a system setting, such as a temperature set point. [0030]; [0037]-[0039]; FIG. 2. As the knob is turned, "force detents" are output to the knob via an actuator to "indicate particular settings or how far the knob has rotated." [0038]. For example, "[t]emperature can preferably be adjusted by rotating knob 18, where force detents indicate each temperature setting." [0039]; *see also* [0048]. Using "force detents" allows a user to "feel" a change without needing to "look at the display." [0039].

245. Levin's Figures 6A-6D illustrate force profiles for detent effects. Force feedback may be provided when the control knob is moved to positions "within a range of [a] first detent" or "within a range of [a] second detent." [0009]. In the

implementation of Figure 6B, “[a] portion of the range of the first detent overlaps a portion of the range of the second detent.” [0009].

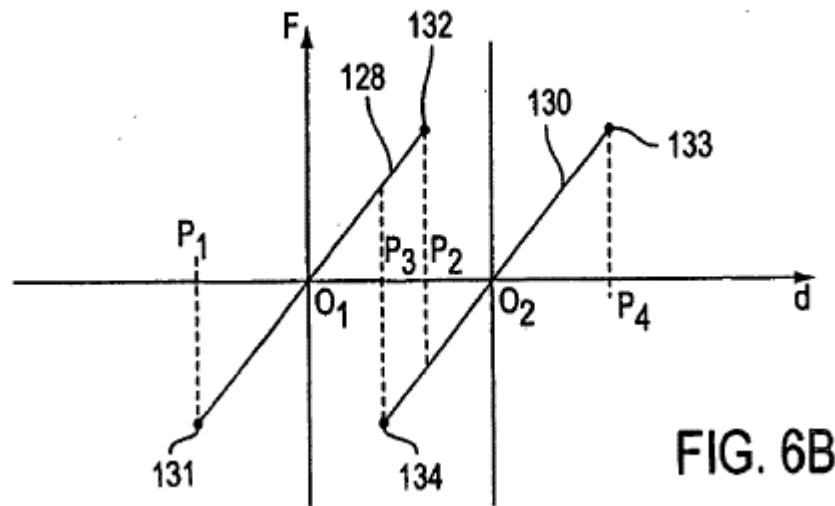


FIG. 6B

246. Figure 6B’s force detent profile has primary and secondary ranges of positions associated with the first detent 128 (**blue** annotation below, between points P_1 and P_2) and the second detent 130 (**orange** annotation below, between points P_3 and P_4), respectively. A boundary range of positions overlaps with the primary and secondary ranges, namely the “overlap” range of positions (**red** annotation below, between points P_3 and P_2):

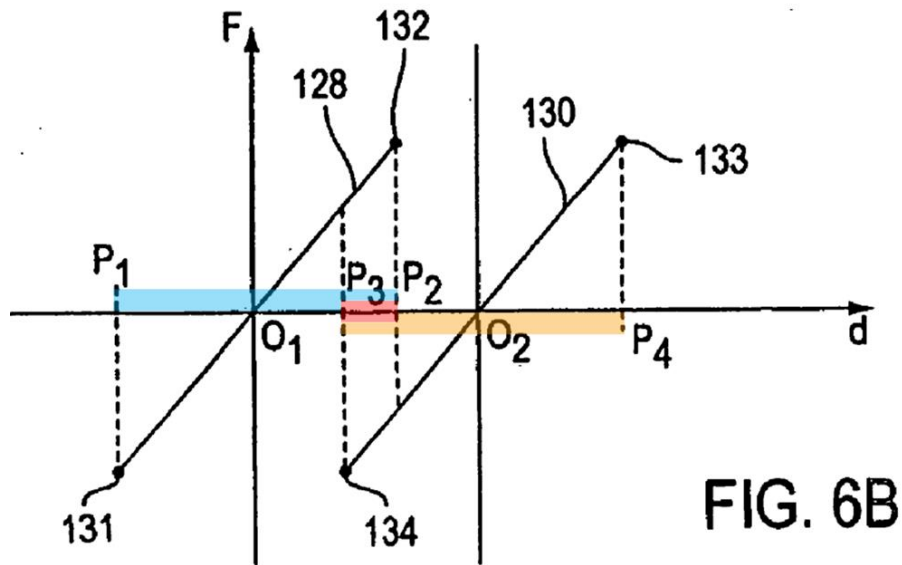


FIG. 6B

247. As discussed below, Levin anticipates and/or renders obvious most of the challenged claims.

1. Claim 1

a. [1PRE]

“A method for controlling a user input element associated with a haptic output device, the method comprising:”

248. Levin’s “control knob 18” is a “*user input element*” because a user interacts with it to provide control input to an electronic device (for example, a car radio). [0024]-[0027]; [0030]; FIG. 1; *see above* §XI.F.1.

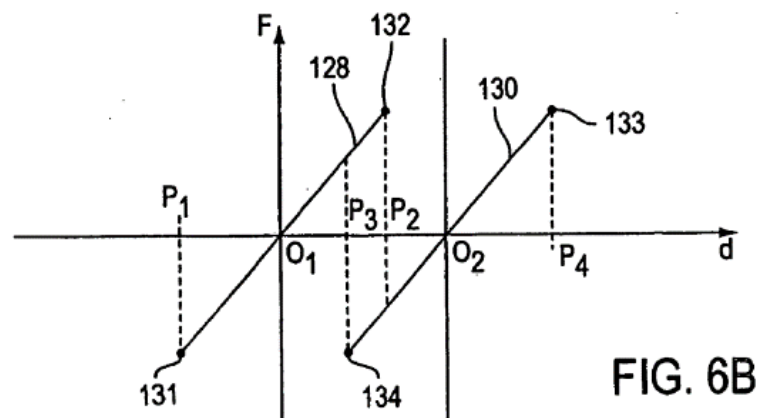
249. Levin’s control knob is associated with a “*haptic output device*” as claimed because the control knob is coupled with an actuator ([0003], [0006]-[0010], [0047]), which is a “*haptic output device*.” EX1001, 4:36-53.

250. Levin discloses methods for controlling the “*user input element*” (for example, control knob) by providing haptic feedback to the knob via the associated actuator. See [Sections 1A-1B].

b. [1A]

“defining position and range information for the user input element associated with the haptic output device, including”

251. Levin’s method uses “detent force profiles,” which are pre-defined force effects stored in a memory. [0049], [0067]. The detent force profiles define the forces output at various “position[s] of the moved user object (knob) in a degree of freedom.” [0067]; [0031]-[0032]. Figure 6B depicts six positions within the knob’s degree of freedom: P_1 - P_4 and O_1 - O_2 , with the latter two indicating the positions of a first detent and a second detent ([0067], [0070]):



252. Levin's detent force profiles define ranges, including "a range of the first detent" (between P_1 and P_2 , forming detent curve 128) and "a range of [a] second detent" (between P_3 and P_4 , forming detent curve 130). [0009]; [0070]. Figure 6B also depicts Levin's "overlapped zone" ("between positions P_3 and P_2 ," where detent curves 128 and 130 overlap [0070]).

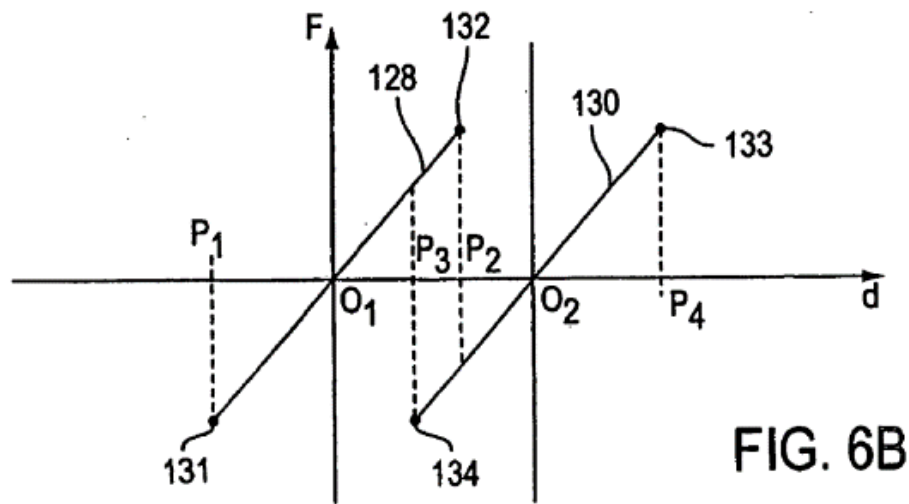
253. Levin's detent force profiles "*defin[e] position and range information for the user input element associated with the haptic output device,*" as claimed.

i. [1A1]

"a primary range of positions"

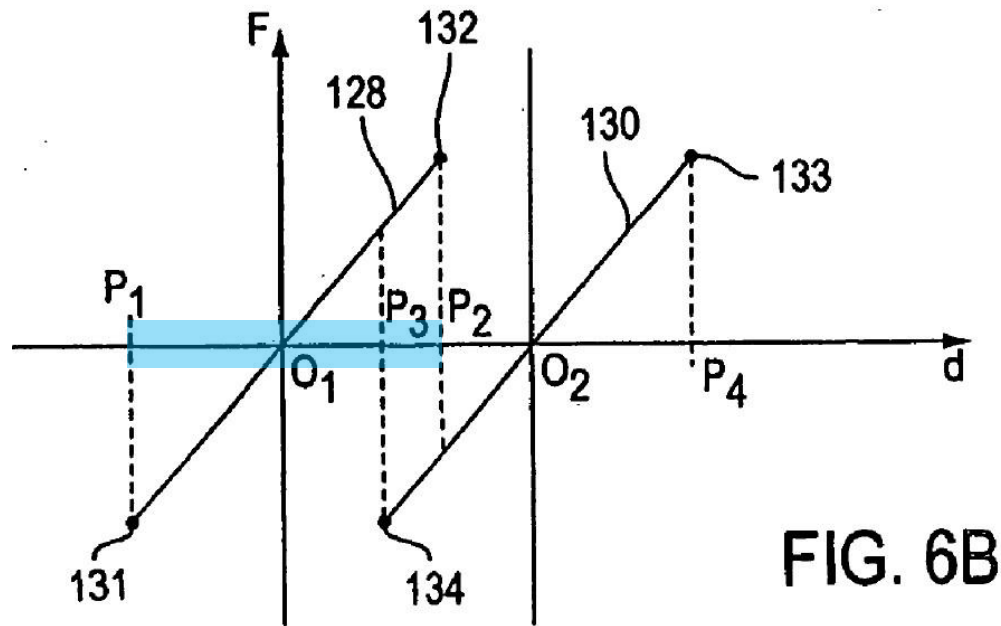
254. Levin's actuator outputs forces of varying magnitude on the control knob in a rotary degree of freedom when the knob rotates through various position ranges, including a "*primary range of positions*" as claimed. [0006], [0009]-[0011], [0067]-[0073].

255. Levin's detent force profile of Figure 6B defines a "*primary range of positions.*" In Figure 6B, the knob position is represented on horizontal axis d , while the magnitude of the output force is represented on vertical axis F . [0067]-[0070]. "[A] positive F value indicates a force in one direction, and a negative F value indicates force in the opposite direction." [0067]. "Origin position[s]" O_1 and O_2 are positions of the first and second detents, respectively. [0009], [0067]-[0070].



256. The first force curve 128 is the diagonal line extending from point 131 (at knob position P_1) to point 132 (at knob position P_2) that depicts the force magnitude output for first detent O_1 . [0070]. The second force curve (130) is the diagonal line from point 134 (at knob position P_3) to point 133 (at knob position P_4) that depicts the force output for the second detent O_2 . [0070].

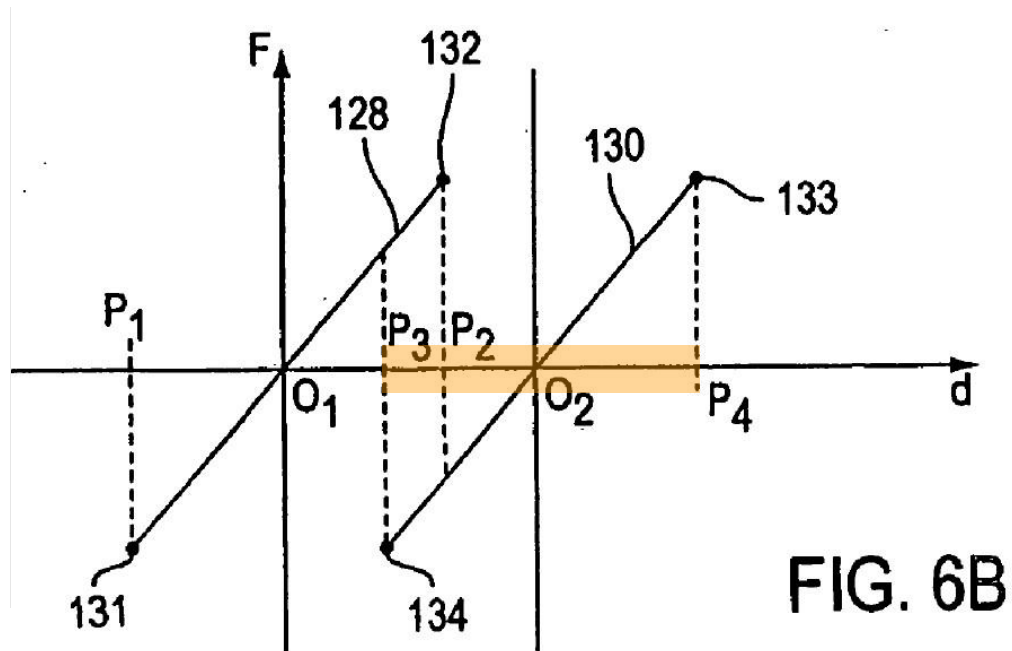
257. Levin's range of positions from P_1 to P_2 (**blue** annotation below; the "range of the first detent" ([0009])) surrounding first detent O_1 and corresponding to the first force curve 128 is a "*primary range of positions*" as claimed because it is a range of positions within which the object moves and experiences a force of changing magnitude along the first force curve. [0009], [0067]-[0070].



ii. [1A2]

“a secondary range of positions”

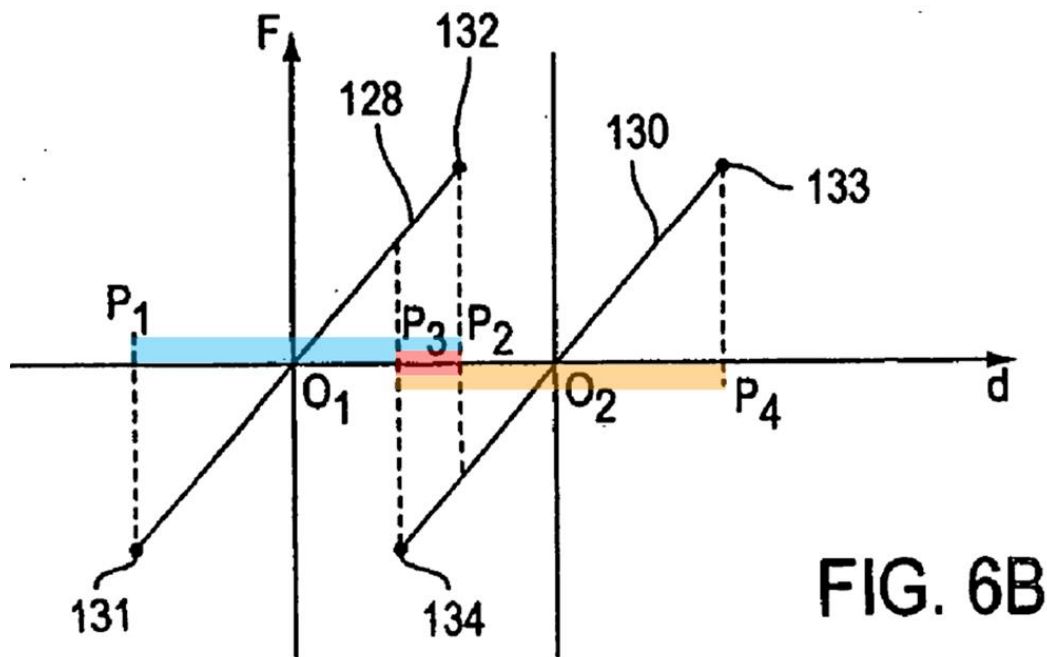
258. Levin’s range of positions from P_3 to P_4 (**orange** annotation below; the “range of the second detent” ([0009])) surrounding the second detent O_2 and corresponding to the second force curve 130 is a “*secondary range of positions*” as claimed because it is a range of positions within which the object moves and experiences a force of changing magnitude along the second force curve. [0009], [0067]-[0070].



iii. [1A3]

“a boundary range of positions wherein the boundary range of positions partially overlaps each of the primary range of positions and the secondary range of positions”

259. Levin’s force profile includes an “overlapped zone” between positions P_3 and P_2 (**red** annotation below). [0070]; Fig. 6B; [0009] (“A portion of the range of the first detent overlaps a portion of the range of the second detent.”); [0011].



260. Levin's "overlapped zone" (**red** annotation, between points P₃ and P₂) partially overlaps range P₁ to P₂ of the first detent O₁ (**blue** annotation, between points P₁ and P₂) (i.e., the "primary range of positions") and partially overlaps the range P₃ to P₄ of the second detent O₂ (**orange** annotation, between points P₃ and P₄) (i.e., the "secondary range of positions"). Thus, Levin's "overlapped zone" is a "boundary range of positions" that "partially overlaps each of the primary range of positions and the secondary range of positions" as claimed.

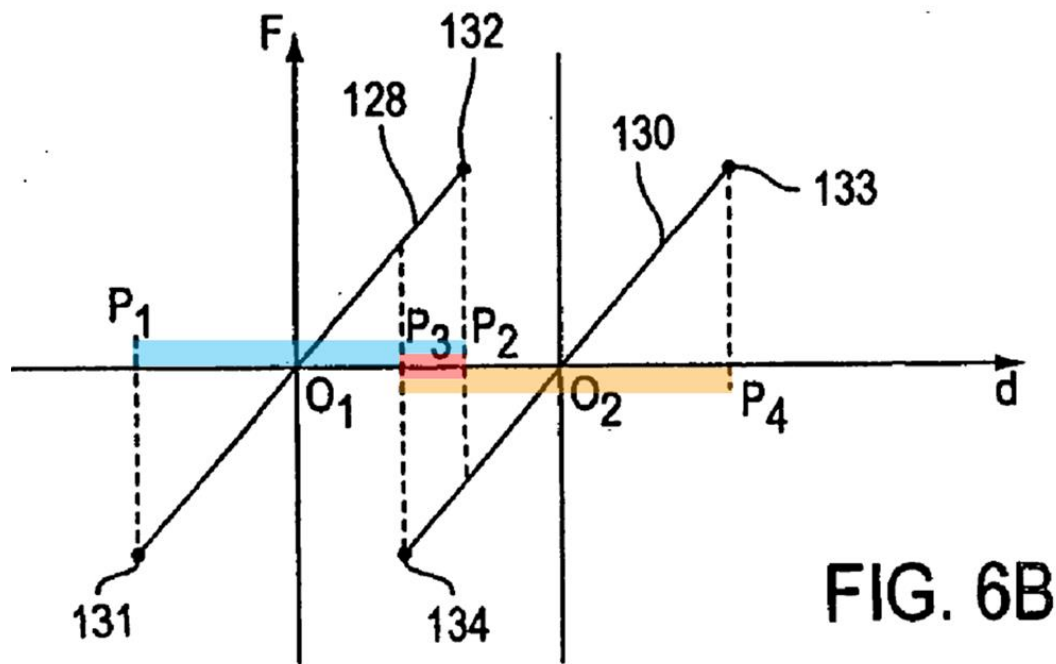
c. [1B]

"rendering a haptic effect in response to an entry of the user input element to one or more positions within the boundary range of positions."

261. Levin's method provides force feedback (a haptic effect) to its control knobs via an actuator as the knob moves through the positions in its primary, secondary, and boundary ranges. See, for example, Title, Abstract, [0002]-[0011], [0047]-[0049], [0067]-[0071], [0086], [0094]. Although Levin provides force feedback in each range of positions, nothing in claim 1 or the specification precludes rendering haptic effects in the primary and secondary ranges in addition to rendering a haptic effect in the boundary range. Further, as noted above, rendering a haptic effect in response to movement to or through any position(s) within the boundary range meets [1B]. See above §XI.A.2.c.

262. The force curves in Figures 6B-6D illustrate the magnitude and direction of the force feedback provided to the knob as it rotates, including as it rotates through Levin's overlapped zone ("*boundary range of positions*" as described above). See above §§XI.F.1 and XI.F.2.b.iii; [0069]-[0070].

263. As discussed above at §XI.F.2.b.iii, Levin's Figure 6B (annotated below) illustrates "two detent curves 128 and 130" that partially overlap between positions P_3 and P_2 as shown below. [0070].



264. Levin's Figure 6C (annotated below) illustrates the force feedback that occurs when the control knob is moved clockwise (for example, from position O_1 toward position O_2). [0071]. As seen below, Levin's actuator outputs force feedback of increasing magnitude as the position of the knob rotates in one direction through positions in the overlapped zone from position 128 to position 132, at which point the actuator outputs a force of a lesser magnitude and in the opposite direction (illustrated by the yellow circle at point 135). [0070]-[0071], [0073]. The force (depicted as 0.5M in the example shown) is of a "lesser magnitude" than the force that would be output at the start of the second force curve if there were no overlapped zone. [0073]. "The use of a lesser magnitude at the beginning of the

second detent [when there is an overlapped zone] reduces the tendency of the user to unintentionally skip past a second detent....” [0073].

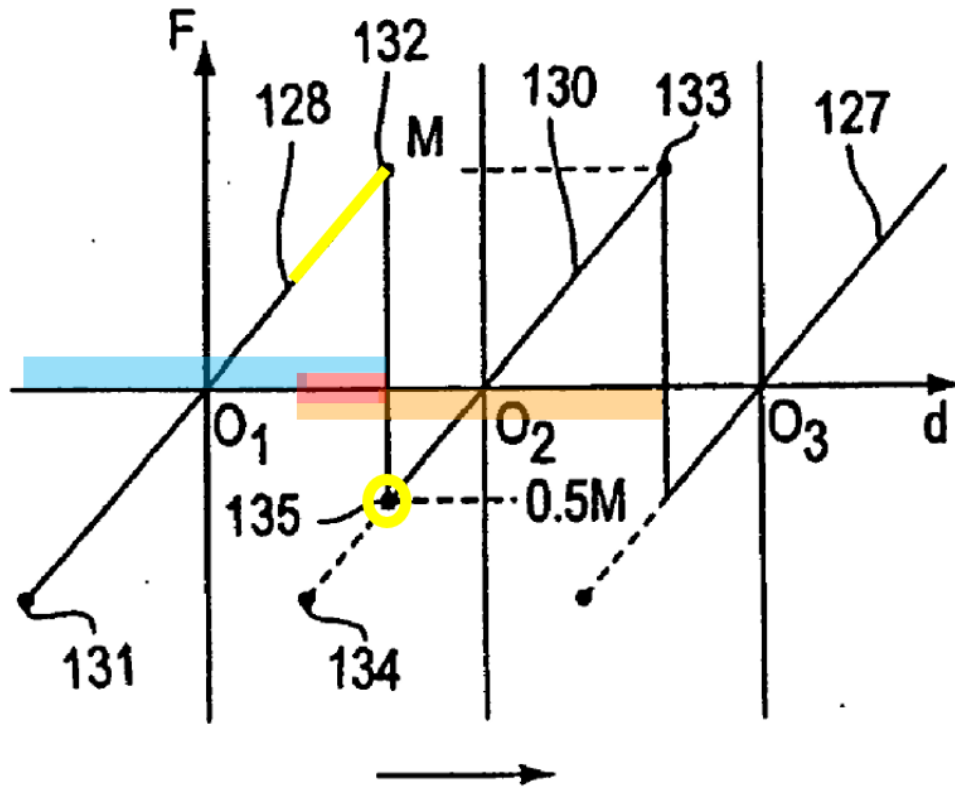


FIG. 6C

265. Levin's Figure 6D (annotated below) illustrates the force feedback that occurs when the control knob is moved counterclockwise (for example, from position O₂ toward position O₁). [0072]. As seen below, Levin's actuator outputs force feedback of increasing magnitude as the position of the knob rotates counterclockwise through positions in the overlapped zone from P₂ (not depicted but shown in FIG. 6B as directly below position 132) to position 134, at which point the

actuator outputs a force of a lesser magnitude and in the opposite direction (illustrated by the yellow circle at point 136). [0070]-[0071], [0073].

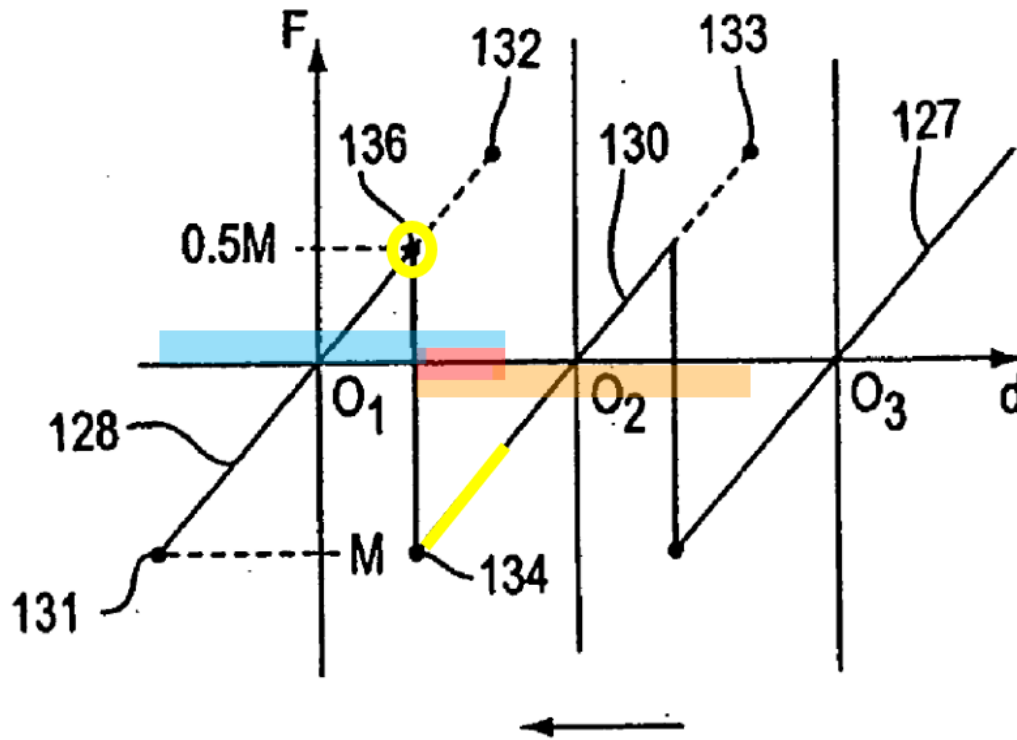


FIG. 6D

266. Levin's method therefore "*renders a haptic effect*" (the force feedback depicted in yellow in the annotated figures above) "*in response to an entry of the user input element to one or more positions within the boundary range of positions,*" as claimed. Specifically, it renders gradually increasing force feedback as the knob moves (clockwise or counterclockwise) through initial positions of the boundary

range, and then renders force feedback of a lesser magnitude and in the opposition direction when the knob moves to an end position of the boundary range.

2. Claim 3

“The method of claim 1, wherein a profile for the user input element is calculated by mapping each position of the user input element to an analog to digital conversion value.”

267. To provide force feedback on its knob, Levin uses “detent force profiles” that map the knob’s physical position within its rotational degree of freedom to force magnitudes that are to be output onto the knob. [0067] (describing “detent force profiles” as comprising force magnitudes output based on the “distance or position” of the knob “in a degree of freedom”); [0075]; [0082]. Force detent profiles are depicted in Levin’s Figures 6A-6D. Each profile maps a position of the knob to a corresponding force magnitude that is output onto the knob. [0021]-[0022].

268. Levin determines the knob’s position using “sensors 214” to “sense the position” of “knob 26 along one or more degrees of freedom,” and provides that information to microprocessor 202. [0093]; [0023]; FIG. 8. Exemplary sensors include “optical encoders” and “analog sensors” ([0093]) which cooperate with a “sensor interface 208” and/or “analog to digital converter (ADC)” to generate digital

values to be “interpreted by the microprocessor 202” ([0090]). Thus, Levin calculates “*analog to digital conversion value[s]*” to be used with each “force detent profile,” including the profile of Figure 6B, using at least two possible arrangements: a digital optical encoder, and an analog sensor in combination with an analog to digital converter (ADC).

269. **Digital Optical Encoder:** Digital optical encoders like those Levin discloses ([0047]) were conventional in 2014 and known to take as inputs analog values representing the position of a device and output corresponding digital values. This is consistent with Levin’s disclosure that “sensor interface 208” (shown above) receives “signals from a digital sensor such as an encoder and convert[s] the signals into a digital binary number.” [0090]. A POSITA would have understood that Levin’s “optical encoder” (in combination with sensor interface 208) mapped each physical position of control knob within its rotary degree of freedom to “*an analog to digital conversion value,*” as claimed.

270. **Analog Sensor:** Levin also describes the conversion of analog signals from other sensors to digital values. “[T]o convert sensor signals to signals that can be interpreted by the microprocessor 202,” Levin states, “[a]n [ADC] can also be used.” [0090]. A POSITA would have understood that an ADC would be used in conjunction with a position sensor that outputs an analog value (for example,

“analog sensors such as potentiometers” ([0093])), to convert the analog sensor value to an “*analog to digital conversion value*.”

271. Thus, analog-to-digital conversion values are generated by Levin’s “optical encoder” (in combination with sensor interface 208) and/or “analog sensor” (in combination with an ADC and/or sensor interface 208). These values are then used (or it would have been obvious to use them) to “*calculate*” each of Levin’s stored “detent force profiles” because those profiles associate force magnitude with “the distance or position of the moved user object (knob) in a degree of freedom.” [0067]; FIGS. 6A-6D. Stated differently, each ADC value (mapped to an associated position) would have been associated with a corresponding force that the actuator was to provide to the knob upon the knob’s entry into the associated/mapped position.

272. If Levin is found to not explicitly disclose claim 3, implementing Levin’s detent force profiles so that they included “*mapping each position of the user input element to an analog to digital conversion value*” would have been obvious and conventional because the physical position of the user input element is an analog value and Levin’s force profiles are used by Levin’s processor which a POSITA would have understood to have operated on digital values.

273. Additionally, Levin’s sensors are substantively the same as those disclosed in Goldenberg and perform the same analog-to-digital position-mapping

function that Goldenberg's sensors perform. *See above* §XI.A.4. Levin thus uses its sensors to perform the method of claim 3 for the same reasons that Goldenberg uses its sensors to do so. *See above* §XI.A.4. Alternatively, implementing Levin such that it uses its sensors to perform the method of claim 3 would have been obvious for the same reasons it would have been obvious to implement Goldenberg to perform claim 3's method.

3. Claim 4

“The method of claim 3, wherein the profile for the user input element is an increasing profile or a decreasing profile.”

274. As explained above at §XI.A.5 (claim 4), 8-bit ADC mapping was well-known. Creating increasing or decreasing ADC values for Levin's force profiles (*see above* §XI.F.3 (claim 3)) would have been a matter of straightforward design. A POSITA would not have put the values in a jumbled order, but in a monotonic order. Only two plausible monotonic orderings exist: increasing or decreasing.

4. Claim 6

“The method of claim 1, further comprising monitoring a position of the user input element.”

275. Levin discloses “*monitoring a position of the user input element,*” as claimed. For example, Levin’s sensor (discussed above at §XI.F.3 (claim 3)) can “sense a range of positions of the knob 18 or a continuous motion of the knob....” [0043].

5. Claim 8

“*A non-transitory computer readable storage medium...*”

276. Independent claim 8 recites “*a non-transitory computer readable storage medium [CRM] storing a program configured to be executed by a processor, the program comprising instructions for*” carrying out claim 1’s method. Levin discloses such a CRM.

277. Levin’s “[d]etent force profiles can be implemented by a microprocessor or other controller based on instructions stored in a computer readable medium” (EX1006, [0067]) which can be a “[l]ocal memory 206, such as RAM and/or ROM, ... to store instructions for microprocessor 202.” EX1006, [0089], Fig. 8. Levin’s local memory is “*a non-transitory computer readable storage medium storing a program configured to be executed by a processor,*” where the program is the set of software instructions executed by Levin’s microprocessor to implement Levin’s detent force profiles. [0101].

278. The steps recited in the remaining limitations of claim 8 are identical to the method steps recited in [1A]-[1B], and are met and/or rendered obvious by for the same reasons discussed in §§XI.F.2.b-c above.

6. Claims 10-11 and 13

279. Dependent claims 10-11 and 13 add the same limitation to claim 8 that dependent claims 3-4 and 6 add to claim 1, respectively. Levin's CRM (computer readable storage medium) stores a program comprising instructions for performing the steps recited in claims 10-11 and 13 for the same reasons Levin meets and/or renders obvious claims 3-4 and 6. *See above* §XI.F.3-5.

7. Claim 15

"A device, comprising..."

280. Independent claim 15 is substantially identical to independent claim 1 except that claim 15 recites "*a device*," and that "*device*" comprises both "*a processor*" and "*a memory storing a program for execution by the processor, the program including instructions for*" carrying out a process identical to claim 1's method.

281. As seen in Levin's Figure 1, Levin discloses a device 10 that includes an automotive control panel 12. [0024]. Levin also describes other "devices," including "a video game console" or "a controller" for such a console. [0026].

282. Levin's device 10 includes the microprocessor 202 and memory 206 discussed in connection with claim 8. [0086]-[0087], FIG. 8. The memory 206 stores instructions for performing the steps recited in [1A]-[1B] for the reasons discussed in connection with claim 8. [0049]; *see above* §XI.F.6.

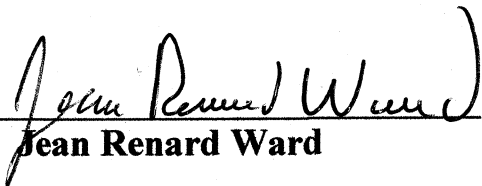
8. Claims 17 and 19

283. Dependent claims 17 and 19 add the same limitation to claim 15 that claims 3 and 6 added to claim 1, respectively. Levin meets claims 17 and 19 for the reasons it meets and/or renders obvious claims 3 and 6. *See above* §§XI.F.3 and XI.F.5.

I declare that all statements made herein of my own knowledge are true, 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 are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

I declare under penalty of perjury that the foregoing is true and correct.

Dated: 22-March-2024



Jean Renard Ward

U.S. PATENT NO. 10,627,907 CLAIM LIST

Claim 1
[1PRE] A method for controlling a user input element associated with a haptic output device, the method comprising:
[1A] defining position and range information for the user input element associated with the haptic output device, including
[1A1] a primary range of positions,
[1A2] a secondary range of positions, and
[1A3] a boundary range of positions, wherein the boundary range of positions partially overlaps each of the primary range of positions and the secondary range of positions; and
[1B] rendering a haptic effect in response to an entry of the user input element to one or more positions within the boundary range of positions.
Claim 2
The method of claim 1, wherein one of the primary range of positions, the secondary range of positions, and the boundary range of positions is calculated based on a movement of the user input element from a maximum out position to a grounding position.
Claim 3
The method of claim 1, wherein a profile for the user input element is calculated by mapping each position of the user input element to an analog to digital conversion value.
Claim 4
The method of claim 3, wherein the profile for the user input element is an increasing profile or a decreasing profile.
Claim 5
The method of claim 1, wherein a normalized profile for the user input element is calculated by removing at least one of the secondary range of positions or the boundary range of positions from mapped analog to digital conversion values.
Claim 6
The method of claim 1, further comprising monitoring a position of the user input element.
Claim 7

The method of claim 1, further comprising adjusting a profile and a normalized profile of the user input element to adjust for a change to a resting position of the user input element.

Claim 8

[8PRE] A non-transitory computer readable storage medium storing a program configured to be executed by a processor, the program comprising instructions for:

[8A] defining position and range information for the user input element associated with the haptic output device, including

[8A1] a primary range of positions,

[8A2] a secondary range of positions, and

[8A3] a boundary range of positions, wherein the boundary range of positions partially overlaps each of the primary range of positions and the secondary range of positions; and

[8B] rendering a haptic effect in response to an entry of the user input element to one or more positions within the boundary range of positions.

Claim 9

The non-transitory computer readable storage medium of claim 8, wherein one of the primary range of positions, the secondary range of positions, and the boundary range of positions is calculated based on a movement of the user input element from a maximum out position to a grounding position.

Claim 10

The non-transitory computer readable storage medium of claim 8, wherein a profile for the user input element is calculated by mapping each position of the user input element to an analog to digital conversion value.

Claim 11

The non-transitory computer readable storage medium of claim 10, wherein the profile for the user input element is an increasing profile or a decreasing profile.

Claim 12

The non-transitory computer readable storage medium of claim 8, wherein a normalized profile for the user input element is calculated by removing at least one of the secondary range of positions or the boundary range of positions from mapped analog to digital conversion values.

Claim 13

The non-transitory computer readable storage medium of claim 8, further comprising instructions for monitoring a position of the user input element.

Claim 14

The non-transitory computer readable storage medium of claim 13, further comprising instructions for adjusting a profile and a normalized profile of the user input element to adjust for a change to a resting position of the user input element.

Claim 15

[15PRE] A device comprising:

[15A] a processor; and

[15B] a memory storing a program for execution by the processor, the program including instructions for:

[15C] defining position and range information for the user input element associated with the haptic output device, including

[15C1] a primary range of positions,

[15C2] a secondary range of positions, and

[15C3] a boundary range of positions, wherein the boundary range of positions partially overlaps each of the primary range of positions and the secondary range of positions; and

[15D] rendering a haptic effect in response to an entry of the user input element to one or more positions within the boundary range of positions.

Claim 16

The device of claim 15, wherein one of the primary range of positions, the secondary range of positions, and the boundary range of positions is calculated based on a movement of the user input element from a maximum out position to a grounding position.

Claim 17

The device of claim 15, wherein a profile for the user input element is calculated by mapping each position of the user input element to an analog to digital conversion value.

Claim 18

The device of claim 15, wherein a normalized profile for the user input element is calculated by removing at least one of the secondary range of positions or the boundary range of positions from mapped analog to digital conversion values.

Claim 19

The device of claim 15, further comprising instructions for monitoring a position of the user input element.

Claim 20

The device of claim 19, further comprising instructions for adjusting a profile and a normalized profile of the user input element to adjust for a change to a resting position of the user input element.