

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Title: TRANSMISSION-GUARD SYSTEM AND METHOD FOR
AN INDUCTIVE POWER SUPPLY

DECLARATION OF DR. GARY L. WOODS

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I, Gary L. Woods, Ph.D., declare as follows:

I. INTRODUCTION

1. I have been retained as a technical expert by counsel on behalf of Anker Innovations Ltd. (“Anker” or “Petitioner”). I understand that Anker is requesting that the Patent Trial and Appeal Board (“PTAB”) institute an *inter partes* review (“IPR”) proceeding with respect to U.S. Patent No. 9,048,696 (“the ’696 patent”) (EX1001).

2. I have been asked to provide my independent analysis of the ’696 patent in light of certain prior art publications, and I have done so based on my personal knowledge and experience. As detailed below (and demonstrated in my CV attached here), I am familiar with the technology described in the ’696 patent, and I am also familiar with the knowledge of a person of ordinary skill in the art with respect to this technology both as of the filing date of the ’696 Patent (January 10, 2014) and as of the earliest alleged priority date of the ’696 patent (March 17, 2008).

3. I am not, and never have been, an employee of Anker. I received no compensation for this declaration beyond my normal hourly compensation based on my time actually spent analyzing the ’696 patent, the prior art publications cited below, and various issues related thereto. I will not receive any added compensation based on the outcome of any IPR or other proceeding involving the ’696 patent.

II. QUALIFICATIONS

4. In formulating my independent analysis of the '696 patent, I have relied on my knowledge, training, and experience in the relevant field, which I have summarized below.

5. I have over 25 years of professional experience working with electronic circuit design, battery technology, and mobile electronic devices. I have applied these technologies in a variety of contexts, including among others, the design of wireless electrical charger devices and rechargeable mobile devices. Further, I have authored numerous published technical papers, and I am a named inventor on at least 16 U.S. patents.

6. Since 2008, I have been employed as a Professor in the Practice in the Department of Electrical and Computer Engineering at Rice University in Houston, Texas. Since 2020, my title has been Distinguished Professor in the Practice. Before that, I worked as a postdoctoral fellow at the University of California, Santa Barbara (1996-1998); at Intel Corporation (1998-2000); at Spectralane Inc. (2000-2002); at Optonics (later Credence Systems Corp.) (2003-2006); and as an independent consultant (2006-present). In the summers of 1988 and 1989 I worked at Texas Instruments.

7. My educational background includes undergraduate degrees in Physics and Electrical Engineering from Rice University in 1988 and an MS (1991) and

Ph.D. (1997) in Applied Physics from Stanford University.

8. I am familiar with patents both as an inventor and as Chief Technology Officer in charge of the patent portfolio of a company I co-founded, Spectralane. I am an inventor on at least 16 issued patents in the U.S., of which most are related to design, testing, and manufacture of electronic circuits. My CV attached to this declaration contains a list of patents on which I am a named inventor or co-inventor.

9. With regard to wireless electronic charger devices specifically, I have worked on a number of design projects at Rice in this field. Many of them were year-long capstone design projects, where I was the technical mentor on the project. I have worked on projects involving charging cellphones with supercapacitors and with human-powered generators, and harvesting energy from a shock absorber. Additionally, other projects focused on the design of wireless charging devices, including wireless power delivery for transcutaneous charging of biomedical implants, wirelessly powering a CO₂ sensor for the International Space Station, and others.

10. I have supervised a number of capstone projects involving significant wireless aspects, including wirelessly powering a multi-element pacemaker; an 11 GHz real-time 4x4 imaging radar array; sending video over cellphone links for ambulance telemedicine; ultra-low power wireless EEG transmission; several off grid internet-of-things (IOT) systems; and several wirelessly transmitting medical

devices.

11. Outside of capstone projects, I have been involved in research activities related to this case including developing an experimental setup with the highest magnetic field in Texas, developing a solar-powered, IOT flood-sensor network for Houston, and developing a terahertz generation and detection system. I have also been involved in research activities related to wireless charging technology, including collaborations with Prof. Joseph Cavallaro in Electrical and Computer Engineering at Rice University and with Dr. Mehdi Razavi, a cardiologist at the Texas Heart Institute.

12. In my educational activities at Rice University, I regularly teach a laboratory course that includes the design of circuits for rechargeable battery technology, wireless electronic charger devices, and protection circuits for such batteries and/or devices. I also mentor the Rice Electric Vehicle Team, whose project includes wireless telemetry, and the Rice Wind Power Team, whose project includes charging a battery.

13. For these reasons, I believe that I have a detailed understanding of the state of the art during the relevant period, as well as a sound basis for opining how persons of skill in the art at that time would understand the technical issues in this proceeding related to the '696 patent.

14. Additional details about my employment history, fields of expertise, and publications are included in my curriculum vitae (attached as Appendix A).

III. LEGAL PRINCIPLES

15. In forming my analysis and conclusions expressed in this declaration, I have applied the legal principles described in the following paragraphs, which were provided to me by counsel for the Petitioner.

A. Anticipation

16. I have been informed that a patent claim is unpatentable as anticipated under 35 U.S.C. § 102 if each and every element of a claim is found either explicitly or inherently in a single prior art reference. Under the principles of inherency, if the prior art necessarily functions in accordance with, or necessarily includes the claimed elements, it anticipates.

B. Obviousness

17. I have been informed that a patent claim is invalid as “obvious” in light of one or more prior art references if it would have been obvious to a person of ordinary skill in the art at the time of the alleged invention (“POSITA”), taking into account (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so called “secondary considerations” of non-obviousness, which include: (i) “long felt need” for the claimed invention, (ii) commercial success attributable to the claimed

invention, (iii) unexpected results of the claimed invention, and (iv) “copying” of the claimed invention by others.

18. While I do not know the exact date that the alleged invention of the '696 patent was made, I do know that the '696 patent's earliest claimed priority date is March 17, 2008. For purposes of my obviousness analysis in Grounds 1A- 2B (Sections VIII-XI), I have applied a date of March 17, 2008 as the date of the alleged invention, although in many cases the same analysis would hold true even if the date of the alleged invention were earlier.

19. I have been informed that a claim can be obvious in light of a single prior art reference or multiple prior art references. To be obvious in light of a single prior art reference or multiple prior art references, there must be a reason that would have prompted a POSITA to modify or supplement the single prior art reference, or to combine two or more references, in a manner that provides the elements of the claimed invention. This reason may come from a teaching, suggestion, or motivation to combine, or may come from the reference(s) themselves, the knowledge or “common sense” of a POSITA, or from the nature of the problem to be solved, and this reason may be explicit or implicit from the prior art as a whole. I have been informed that, under the law, the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield

predictable results. I also understand it is improper to rely on hindsight in making the obviousness determination.

IV. PERSON OF ORDINARY SKILL IN THE ART

20. Based on my knowledge and experience in the field and my review of the '696 patent and its file history, I believe that a POSITA would have had a bachelor's degree or higher in electrical engineering, at least three years of experience designing or researching electronic circuits, and familiarity with power electronics and inductive power transfer circuits. I base this opinion on my experience collaborating with, consulting, and managing technical teams of engineers and technicians working on the design and development of electronic circuits, including power electronics and inductive power transfer circuits (e.g., wireless charging devices). Accordingly, my analysis and conclusions expressed herein are based on the perspective of a POSITA having this level of knowledge and skill. My education, technical expertise and personal knowledge discussed in Section II demonstrate that I meet the qualifications of a POSITA.

V. MATERIALS CONSIDERED

21. My analysis in this declaration is based on my understanding of a POSITA's knowledge and experience with the design and development of electronic circuits, including power electronics and inductive power transfer circuits (e.g., wireless charging devices). Based on my above-described qualifications in Section

II, I am an expert in the field of technology of the '696 patent. Also, based on my experiences detailed above, I understand and know of the capabilities of persons of ordinary skill in this field. While the designs of wireless chargers and other electronic circuits to which I have contributed were substantially more sophisticated than the technology described in the '696 patent, many of the underlying circuit components and design principles are the same.

22. As part of my independent analysis for this declaration, I have considered the following: the '696 patent (EX1001) and its prosecution history (EX1002); the background knowledge/technologies that were commonly known to a POSITA; my own knowledge and experience gained from my work in the field; my experience in teaching and advising others in this field; and my experience working with others involved in this field. In addition, I have analyzed the following publications and materials:

EX1004	U.S. Pub. No. 2008/0197804 (“Onishi”)
EX1005	U.S. Pat. No. 7,211,986 (“Flowerdew”)
EX1006	U.S. Pub. No. 2007/0236169 (“Purdy”)
EX1007	U.S. Pub. No. 2007/0279002 (“Partovi”)
EX1008	U.S. Pub. No. 2008/0079392 (“Baarman392”)
EX1009	Excerpts from Ronald J. Tocci et al., Digital Systems: Principles and Applications, Pearson Education International, 10 th Edition (2007) (“Tocci”)

EX1010	U.S. Pub. 2009/0212736 (“Baarman736”)
EX1018	PCT Publication No. WO2006/031133 (“Malpas”)

23. Note that my citations to patent literature in this declaration refer to the column/line numbers or paragraph numbers in those documents. Note also that all emphasis (bold/italics/underline) in any quoted text has been added unless indicated otherwise.

24. Although this declaration refers to selected portions of the cited references, it should be understood that these are examples, and that a POSITA would have viewed the references cited herein in their entirety and in combination with other references cited herein or cited within the references themselves. The references used in this declaration, therefore, should be viewed as being incorporated herein in their entireties.

VI. THE '696 PATENT

A. Overview of the '696 Patent (EX1001)

25. The '696 patent is titled “Transmission-Guard System and Method for an Inductive Power Supply.” EX1001, 1. According to the patent’s background description, “[i]nductive power coupling, as known in the art, allows energy to be transferred from a power supply to an electric load without connecting wires.” *Id.*, 1:27-29. In such a system, “[a] power supply is wired to a primary coil and an

oscillating electric potential is applied across the primary coil, thereby inducing an oscillating magnetic field.” *Id.*, 1:29-32. “The oscillating magnetic field may induce an oscillating electrical current in a secondary coil placed close to the primary coil” and “[i]n this way, electrical energy may be transmitted from the primary coil to the secondary coil by electromagnetic induction without the two coils being conductively connected.” *Id.*, 1:32-37.

26. The specification further explains that “[t]he strength of an induced voltage in the secondary inductor of an inductive couple varies according to the oscillating frequency of the electrical potential provided to the primary inductor.” EX1001, 19:52-55. “The induced voltage is strongest when the oscillating frequency equals the resonant frequency of the system,” which “depends upon the inductance L and the capacitance C of the system.” *Id.*, 19:55-58. The specification observes, however, that it can be difficult to maintain a system at the resonant frequency because “the resonant frequency ... may fluctuate during power transmission, for example in response to changing environmental conditions or variations in alignment between primary and secondary coils.” *Id.*, 19:66-20:3. Accordingly, the ’204 patent proposed a system in which “the driver ... is configured and operable to transmit a driving voltage which oscillates at a transmission frequency which is substantially different from the resonant frequency of the inductive couple.” *Id.*, 21:16-20. For example, as shown in FIG. 6b (reproduced

below), the transmission frequency of the inductive power outlet is set to a frequency f_t offset from the characteristic resonant frequency f_R :

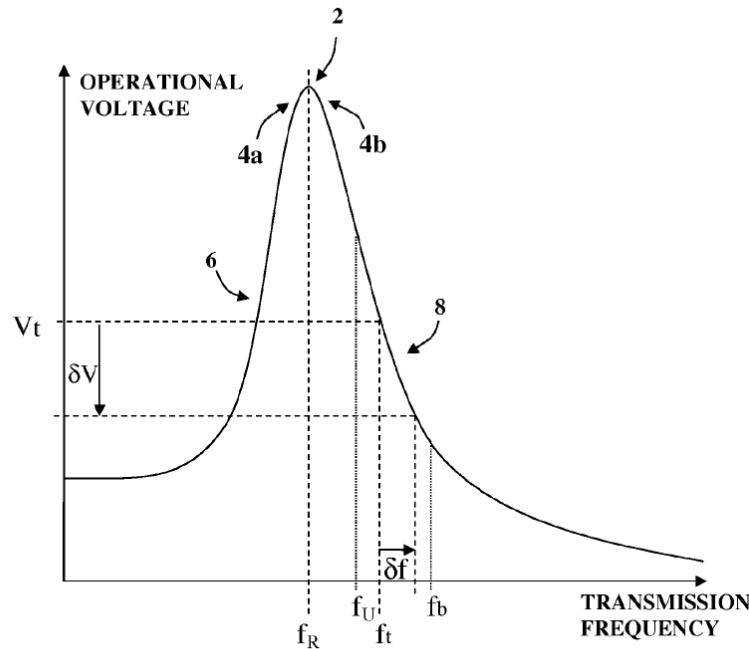


Fig. 6b

EX1001, FIG. 6b; *see also id.*, 21:1-65.

27. As shown in FIG. 6b, “the transmission frequency is selected to lie within one of the near-linear regions 6, 8 where the slope of the frequency-amplitude graph is less steep” than it is near the resonant frequency. EX1001, 21:20-23. “Consequently, the system has a much larger tolerance of variations such as lateral movement” between the primary and secondary inductive coils. *Id.*, 21:44-46; *see also id.*, 21:56-65, 20:43-62 and FIG. 6a (depicting one embodiment of the disclosed inductive power transfer system 6100).

28. The specification also states that a “communication channel” can be

provided between the secondary unit and the primary unit (i.e., the inductive power outlet). EX1001, 21:66-22:1. The communication channel “may be used to communicate required operating parameters which, for example, may indicate the transmission frequency required by the electric load [] to the driver.” *Id.*, 22:1-5. FIG. 6d (below) depicts a flowchart of a “power regulation method” that makes use of such a communication channel to provide feedback signals from the secondary unit to the inductive power outlet. *Id.*, 22:45-64. In this method, “when the power received by the load is too high, a series of feedback signals of [a] first type S_a will be transmitted until the power is reduced into the acceptable range.” *Id.*, 22:66-23:2. “Likewise when the power received by the load is too low, a series of feedback signals of the second type S_b will be transmitted until the power is increased into the acceptable range.” *Id.*, 23:2-5.

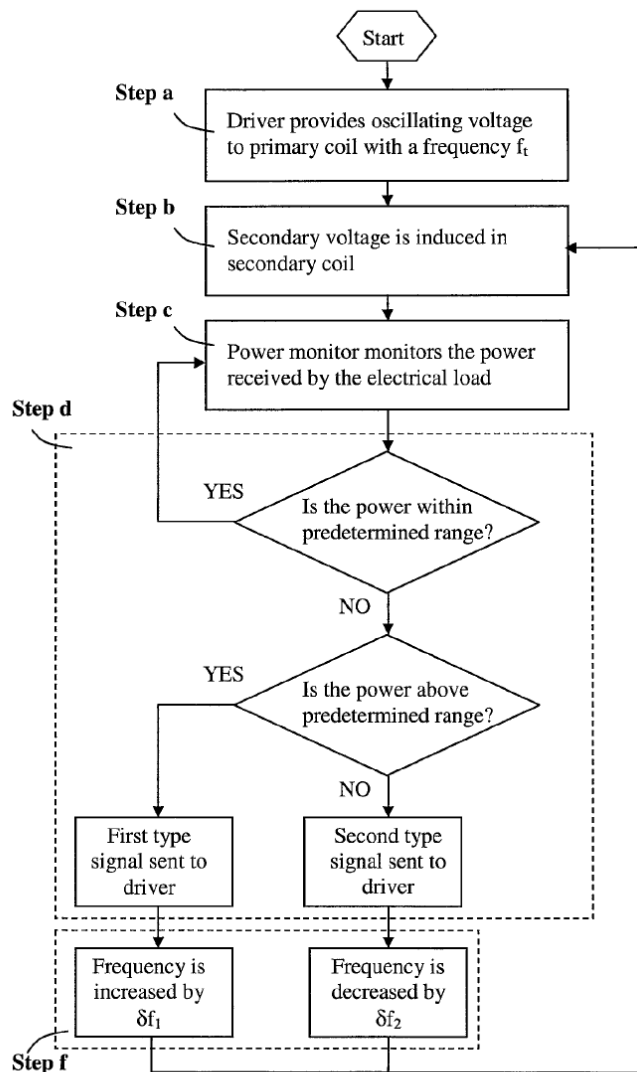


Fig. 6d

EX1001, FIG. 6d.

29. The specification also discloses that an “alignment mechanism” can be provided “to facilitate the alignment of the secondary inductor 320 with the primary inductor 22 thereby improving the efficiency of the inductive transfer system 100.” EX1001, 10:3-6. The “alignment mechanism may include tactile, visual and/or audible indications.” *Id.*, 10:11-12. One described example of such an “alignment

mechanism” includes “a primary magnetic element” in the inductive outlet to cooperate with “a secondary magnetic element” in the power adaptor. EX1001, 17:28-31.

B. The Prosecution History of the '696 Patent

30. The '696 patent was filed January 10, 2014, and claims priority to several earlier-filed applications, the earliest filed March 17, 2008. EX1001, 1.

31. Based on my review of the file history (EX1002), I understand that the Examiner issued two Office actions during prosecution of the application that would later issue as the '696 patent. In a first Office action dated September 30, 2014, the Examiner rejected the originally submitted claims as obvious over Malpas (EX1018), and further indicated that the term “significantly” as recited in independent claim 1 was indefinite. EX1002, 129-130. The applicant responded by amending the claims to require a “a transmission frequency substantially different from said characteristic resonant frequency of said inductive couple.” *Id.*, 106-109. The applicant argued that Malpas was distinguishable because “Malpas describes systems at which the transmission frequency is selected to be as close as possible to the resonant natural frequency” and teaches away from claim 1, “in which the transmission frequency is deliberately selected to be substantially different from the characteristic resonant frequency of the inductive couple.” *Id.*, 111-115.

32. In a second (final) Office action dated January 20, 2015, the Examiner found that the applicant's amendments and arguments in reply to the first action failed to overcome Malpas. EX1002, 87-93. The Examiner then conducted an interview with the applicant's representative on February 26, 2015, where agreement was reached that the claim language that recites "substantially different from said characteristic resonant frequency of said inductive couple" would overcome the rejection of record. *Id.*, 76-77. The applicant replied to the final action with an argument that Malpas uses "a transmission frequency at or near to the resonant frequency of the pick-up" in contrast to the claims "wherein the transmission frequency is selected to be different from the characteristic frequency of the inductive couple formed between the primary and secondary coils." *Id.* 69-71. The applicant also submitted remarks regarding the scope of this phrase, which I have addressed in further detail in the claim construction section below. *Below*, Section VII.

33. The Examiner issued a notice of allowance on April 8, 2015. EX1002, 44-48. The Examiner stated no reasons for allowance in the notice. *Id.*

C. The Issued Claims of the '696 Patent

34. Counsel has asked me to consider the validity of claims 1-7 and 9-14 (the "Challenged Claims") of the '696 patent. The following chart provides a listing

of the elements in each of the Challenged Claims, which I refer to throughout my analysis herein:

Claim Element	Language
[1.P]	An inductive power outlet operable to transfer power to an inductive power receiver, said inductive power outlet comprising:
[1.1]	a platform for supporting said inductive power receiver;
[1.2]	at least one primary inductive coil embedded in said platform;
[1.3]	an alignment mechanism configured to facilitate alignment between said primary inductive outlet and said inductive power receiver,
[1.4]	such that an inductive couple is formed between said primary inductive coil and a secondary inductive coil of said inductive power receiver, said inductive couple having a characteristic resonant frequency; and
[1.5]	a driving circuit wired to said primary inductive coil,
[1.6]	said driving circuit comprising a switching unit configured and operable to provide an oscillating driving voltage across said primary inductive coil such that a secondary voltage is induced in the secondary inductive coil;
[1.7]	wherein said driving circuit is configured and operable to produce said oscillating driving voltage at a transmission frequency substantially different from said characteristic resonant frequency of said inductive couple.
[2.P]	The inductive power outlet of claim 1 said inductive power outlet comprising a signal detector adapted to detect a first signal and a second signal, and said driver is configured to:
[2.1]	increase said transmission frequency when said first signal is

Claim Element	Language
	detected by the detector, and
[2.2]	decrease said transmission frequency when said second signal is detected by the detector.
[3]	The inductive power outlet of claim 1 said driver being configured to adjust said transmission frequency in response to feedback signals.
[4]	The inductive power outlet of claim 3 wherein said feedback signals carry data pertaining to the operational parameters of said electric load.
[5]	The inductive power outlet of claim 4 wherein said operational parameters are selected from the group consisting of: required operating voltage for said electric load; required operating current for said electric load; required operating temperature for said electric load; required operating power for said electric load; measured operating voltage for said electric load; measured operating current for said electric load; measured operating temperature for said electric load; measured operating power for said electric load; power delivered to said primary inductive coil; power received by said secondary inductive coil, and a user identification code.
[6]	The inductive power outlet of claim 2 wherein said detector is selected from the list comprising optical detectors, radio receivers, audio detectors and voltage peak detectors.
[7]	The inductive power outlet of claim 1 wherein said driver further comprises a voltage monitor for monitoring the amplitude of a primary voltage across said primary coil.
[9]	The inductive power outlet of claim 1 comprising a power converter selected from the group comprising: a transformer, a DC-to-DC converter, an AC-to-DC converter, an AC-to-AC converter, a flyback transformer, a flyback converter, a full-bridge converter, a half-bridge converter and a forward

Claim Element	Language
	converter.
[10]	The inductive power outlet of claim 1 incorporated into at least one application selected from a group consisting of: inductive chargers, inductive power adaptors, power tools, kitchen appliances, bathroom appliances, computers, media players, office equipment, implanted devices, pace makers, trackers and RFID tags.
[11]	The inductive power outlet of claim 1 wherein said alignment mechanism comprises a first magnetic element configured to engage a second magnetic element associated with the power receiver.
[12]	The inductive power outlet of claim 1 wherein said alignment mechanism comprises an audible indication.
[13]	The inductive power outlet of claim 1 wherein said alignment mechanism comprises a visual indication.
[14]	The inductive power outlet of claim 1 wherein said alignment mechanism comprises a tactile indication.

D. The '696 Patent's Priority Date

35. The '696 patent was filed January 10, 2014, and claims priority to several earlier-filed applications, the earliest filed March 17, 2008. EX1001, 1. I have been instructed by counsel for Anker to treat March 17, 2008 as the priority date of the Challenged Claims, and I have done so throughout my analysis in this declaration. To be clear, I have not independently assessed the priority date of any of the Challenged Claims and I have not formed an opinion as to the correct priority

date of any claim of the '696 patent. At counsel's instruction, I have nonetheless treated each of the references cited in Grounds 1A-2B (i.e., Onishi, Flowerdew, Partovi, Baarman³⁹², and Tocci) as prior art for purposes of my analysis in this declaration.

VII. CLAIM CONSTRUCTION

36. I understand that, in an IPR proceeding, the terms appearing in patent claims are interpreted according to their "ordinary and customary meaning," which is often referred to as the *Phillips* standard. In determining the ordinary and customary meaning, I understand that the words of a claim are first given their plain meaning that those words would have had to a POSITA. I also understand that the structure of the claims, the specification and file history may be used to better construe a claim. Moreover, I understand that even treatises and dictionaries may be used, albeit under limited circumstances, to determine the meaning attributed by a person of ordinary skill in the art to a claim term.

37. Here, the phrase "substantially different" in independent claim 1 (Element [1.7]) was expressly addressed during prosecution of the '696 patent. For that reason, I have addressed what is encompassed by this claim phrase in further detail below.

38. Independent claim 1 recites "a transmission frequency substantially different from [a] characteristic resonant frequency of [an] inductive couple."

EX1001, 28:35-46. Based on my review, the specification and file history of the '696 patent inform what must fall within the scope of these claim elements.

39. In relevant part, the specification discloses, for example, that:

It is a particular feature of embodiments of the current invention that the driver 6230 (FIG. 6 a) is configured and operable to transmit a driving voltage which oscillates at a transmission frequency which is substantially different from the resonant frequency of the inductive couple. **Preferably the transmission frequency is selected to lie within one of the near-linear regions 6, 8 where the slope of the frequency-amplitude graph is less steep.**

...

Referring back to FIG. 6 b, **the frequency of transmission is selected to be in the approximately linear region 8 of the curve between a lower frequency value of f_L , and an upper frequency value of f_U .** A transmission frequency f_t , higher than the resonant frequency f_R of the system, produces an induced voltage of V_t .

EX1001, 21:16-23, 21:56-65. FIG. 6b, below, shows the transmission frequency f_t in the near-linear region 8 apart from the resonant frequency f_R :

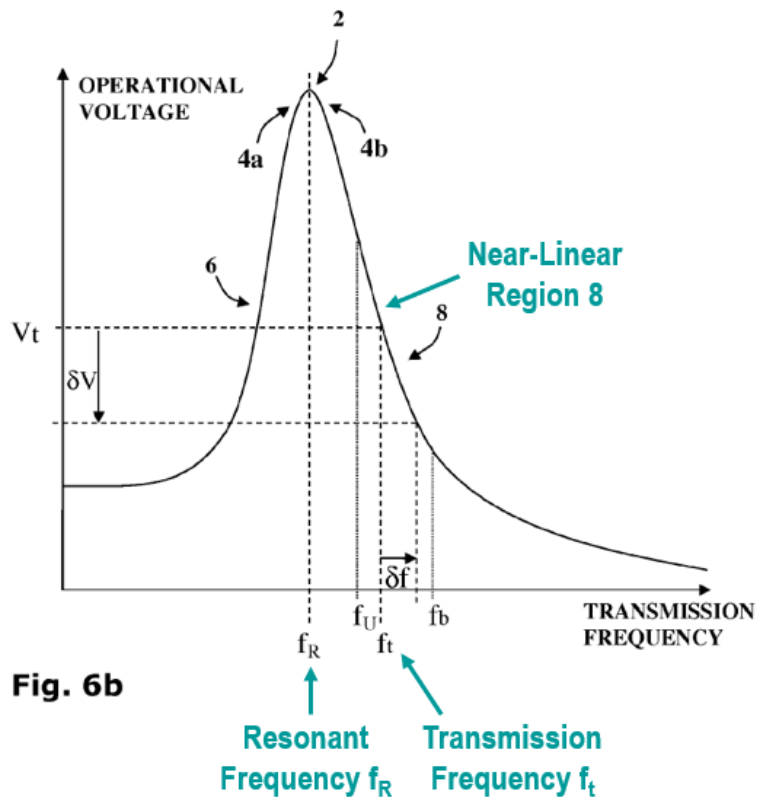


Fig. 6b

EX1001, FIG. 6b (annotated).

40. Moreover, during prosecution, Patent Owner argued in a response to the final office action dated January 20, 2015 that:

As such, one having ordinary skill in the art would appreciate that the term “substantially different from said characteristic resonant frequency” recited in claims 1 and 17, in view of at least Fig. 6b, should be interpreted to mean that the frequency of the driving voltage is selected so as to lie within one of the near-linear regions of a frequency-amplitude graph associated with the inductive couple.

EX1002, 70.

41. Based on my review, the specification and file history confirm that “a transmission frequency substantially different from [a] characteristic resonant frequency of [an] inductive couple” must at least encompass the frequencies within one of the near-linear regions of the frequency-amplitude graph. For example, the frequencies indicated by reference numerals 6 and 8 in FIG. 6b of the ’696 patent are non-resonant transmission frequencies “substantially different” from the characteristic reference frequency.

42. Each of Grounds 1A-2B include references that expressly disclose and/or align with FIG. 6b’s preferred embodiment of a transmission frequency that is “substantially different” from a characteristic resonant frequency.

43. Based on my review, Grounds 1A-2B below respectively anticipate or render obvious the Challenged Claims under any construction that is consistent with the specification and file history of the ’696 patent.

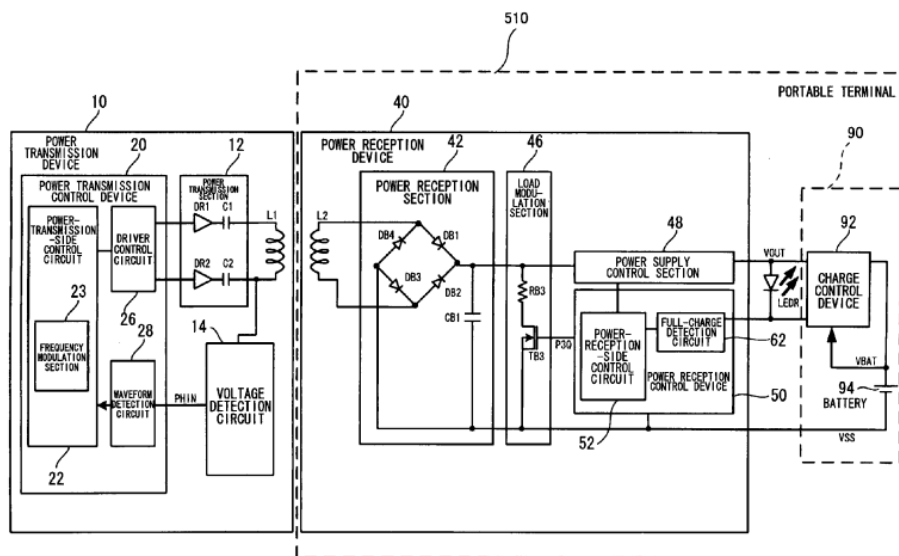
VIII. ANALYSIS – OBVIOUSNESS BASED ON ONISHI AND FLOWERDEW (GROUND 1A)

A. Onishi (EX1004)

44. Onishi describes techniques for transmitting power from a charger to a portable telephone. EX1004, [0126]. The charger includes a power transmission device (device 10) and the portable telephone includes a power reception device

(device 40). EX1004, [0125], *Abstract*. The power transmission device transmits power to the power reception device inductively through electromagnetic coupling of a primary coil in the power transmission device to a secondary coil in the power reception device. EX1004, [0128], FIGS. 2, 5.

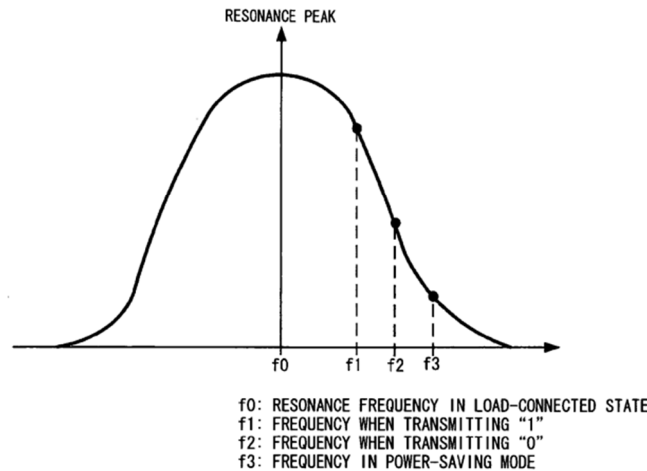
FIG. 5



EX1004, FIG. 5.

45. FIG. 4, reproduced below, depicts a power-transfer curve that illustrates how the level of power transfer from the primary coil to the secondary coil varies as a function of the drive frequency applied to the primary coil. FIG. 4. EX1004, [0180], FIG. 4. As shown in FIG. 4, power transfer is maximized at the resonant frequency f_0 and decreases at non-resonant frequencies (e.g., f_1 , f_2 , and f_3). EX1004, [0180]-[0181], FIG. 4.

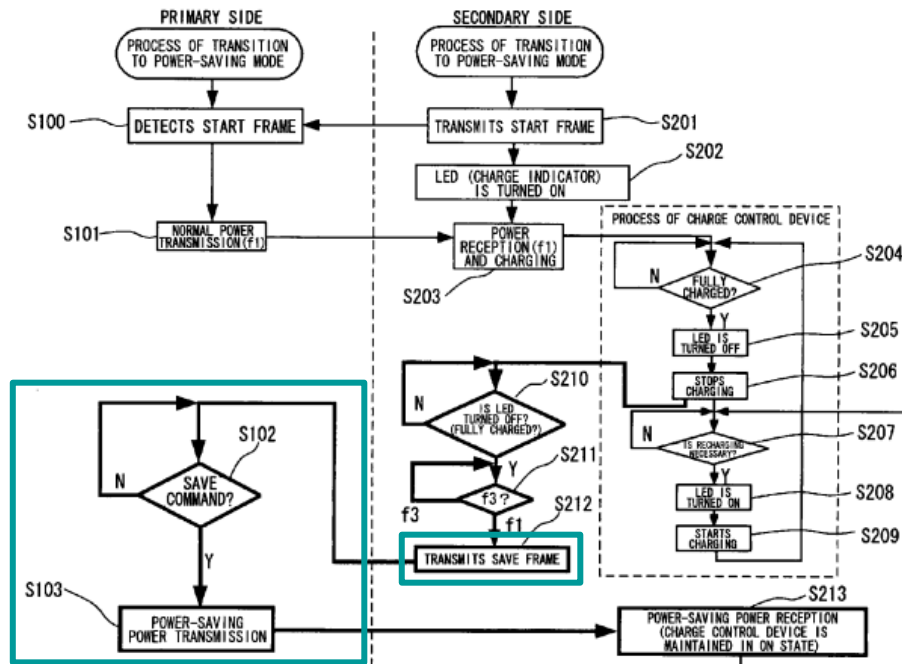
FIG. 4



EX1004, FIG. 4.

46. Onishi's power-transmission-side control device adjusts a transmission frequency to control the power transmitted to the power reception device based on detected signals from the power reception device. EX1004, [0142], [0196], [0215], [0223]-[0225]. A control circuit 22 in the power transmission device can "detect [a] save command transmitted from the secondary-side instrument (step S102), and starts power-saving power transmission (power transmission frequency f3) (step S103)." EX1004, [0215], FIG. 7, *see also* EX1004, [0226], FIG. 9. As shown in FIG. 4 above, switching to the power-saving power transmission mode involves increasing the transmission frequency, .e.g., from "f1" to "f3." EX1004, FIG. 4.

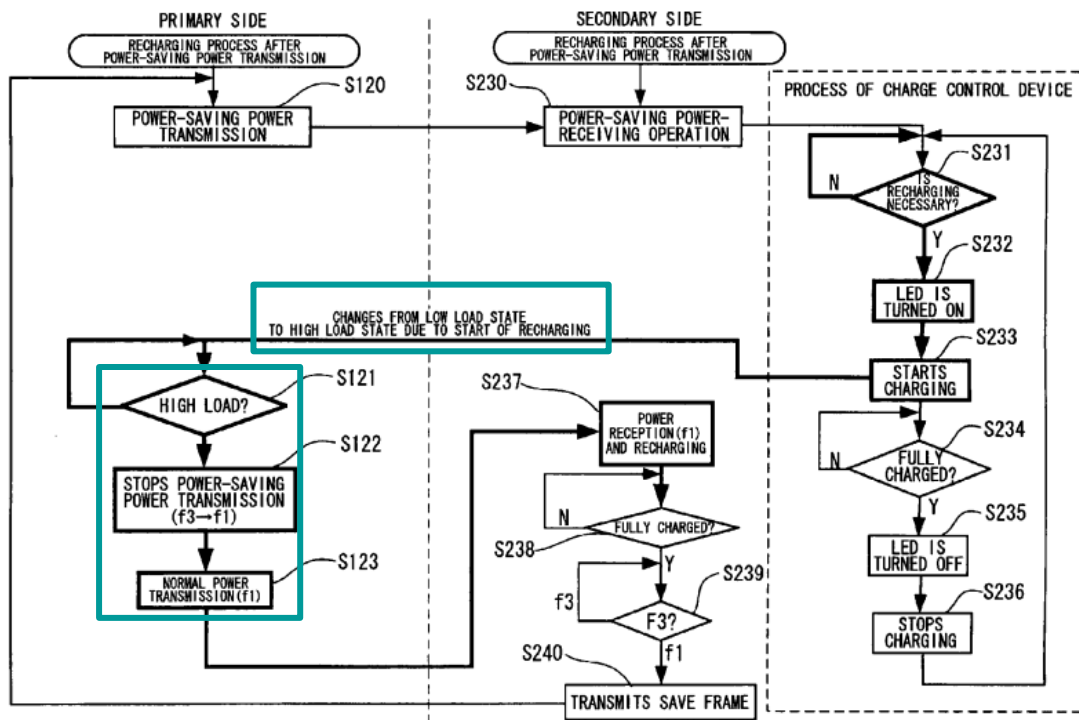
FIG. 7



EX1004, FIG. 7 (annotated).

47. Further, Onishi discloses that “[w]hen the load state of the power reception device 40 has changed from a low-load state to a high-load state due to recharging, the power transmission control device 20 quickly detects a change in load state (step S121), immediately changes power transmission from power-saving power transmission to normal power transmission (step S122).” EX1004, [0225], FIG. 9. As shown in FIG. 4, switching to the charging mode involves decreasing the transmission frequency, e.g., from “f3” to “f1.” EX1004, FIG. 4.

FIG. 9



EX1004, FIG. 9 (annotated).

B. Flowerdew (EX1005)

48. Flowerdew describes conventional inductive charging systems that include an alignment mechanism (to align the coils) to advantageously “make the efficiency of power transfer as high as possible.” EX1005 2:59-3:14, FIG. 1. Flowerdew further describes a charger having shaped surface features that “may be optimized for the alignment of some subset of items” placed on the surface to receive power. EX1005, 7:52-61; ; *see also id.*, 4:42-59, 7:33-60, 15:18-53, 11:25-44 (“geometrically advantageous” and a dished surface with “preferential stable

orientation”), FIGS. 5, 7, 9-10. Flowerdew also describes a charger having “one or more markers indicating a preferred alignment and/or orientation for items.” *Id.*, 7:52-61, 11:25-44 (“directional logo” to indicate “a preferred orientation” so that the “coupling is maximized”).

C. Predictable Combination of Onishi and Flowerdew

49. Based upon my knowledge and experience in the field of the ’696 patent and my review of Onishi and Flowerdew, it is clear that a POSITA would have been motivated to implement Onishi’s charger to include an alignment mechanism (e.g., a shaped surface feature, directional logos/markers, or both) as suggested by Flowerdew to achieve known benefits at the time. To start, Onishi’s charger itself includes a “cradle” to support the power reception device, which at least suggests the use of a mechanical alignment mechanism. EX1004, [0039], [0120], [0124]-[0131], [0174], FIG. 1A; *see also id.*, [0161] (describing circuitry in the power reception device that determines “whether or not the positional relationship between the primary coil L1 and the secondary coil L2 is appropriate”). Onishi describes the resonance characteristics of the primary coil and the secondary coil. FIG. 4. EX1004, [0180]-[0181], FIG. 4.

50. Even if Onishi does not expressly describe the use of a conventional “alignment mechanism,” such a feature was commonly implemented in similar wireless charging systems to achieve several known benefits. For example,

Flowerdew plainly suggests using alignment mechanisms such as shaped surface features and directional logos/markers to promote alignment of the coils of the charger and device. EX1005 7:52-61, 11:25-44, 2:59-3:14.

51. There are several rationales that would have prompted the POSITA to pursue a combination based on Onishi in view of Flowerdew in which Onishi's charger would include an alignment mechanism (e.g., a shaped surface feature, directional logos/markers, or both) as suggested by Flowerdew for purposes of achieving known benefits. I provide an exemplary discussion of various reasons below, each of which independently supports the predictability and known advantages of the combination.

52. First, a POSITA would have been motivated to implement Onishi in a manner that includes an alignment mechanism as suggested by Flowerdew (e.g., a dished recess or other shaped surface feature, a directional logo/marker, or both) so that the primary and secondary coils would be more readily "optimized" for alignment and the inductive "coupling is maximized." EX1005, 7:52-61, 11:25-44, 2:59-3:14 ("make transfer efficiency as high as possible"). Indeed, the efficiency of the inductive couple between the primary and secondary coils would have predictably increased by using such a conventional option.

53. Second, a POSITA would have been motivated to implement the Onishi-Flowerdew combination to advantageously improve user convenience when

placing the rechargeable device on the charger platform. *See* EX1005, 11:25-44 and 7:52-61. Implementing such conventional improvements in Onishi's charger would have benefited the user both in terms of automatically guiding the rechargeable device toward a more optimized and stable position for charging and conveniently confirming a visual indication of a preferred orientation (without requiring tedious adjustments each time). *See* EX1005, 11:25-44 ("geometrically advantageous," "tend to create a preferential stable orientation," and "'utilized to indicate a preferred orientation"), 7:52-61 ("indicating a preferred alignment").

54. Third, Flowerdew expressly suggests a known technique to address a conventional problem of aligning the primary and secondary coils in a wireless charger system in a rapid and error-free manner. Onishi describes a wireless charger system that inductively couples a primary coil with a secondary coil (of a portable device) but does not *expressly* detail a solution for promoting alignment of the coils. EX1004, [0124]-[0131], [0180]-[0181], FIGS. 1A-2, 5. Flowerdew suggests a known technique to do so. EX1005, 7:52-61, 11:25-44, 2:59-3:14. The Onishi-Flowerdew combination thus entails no more than the application of a known technique (e.g., Flowerdew's suggested alignment mechanisms) to address a known problem (e.g., diminished charging efficiency resulting misaligned charging coils) using prior art elements according to their established functions. In this context, a POSITA would have found the combination to be obvious.

55. Based upon my knowledge and experience in this field and my review of the relatively straightforward and predictable structures in Onishi and Flowerdew, it is clear that a POSITA would have possessed the level of skill necessary to implement this combination and would have had a reasonable expectation of success implementing the combination, especially given the overlapping technologies of Onishi and Flowerdew. Indeed, both references are directed to wireless charging systems with an inductive coupling between primary and secondary coils, with Flowerdew suggesting a number of conventional options for facilitating alignment. *See, e.g.*, EX1004, [0010], [0124]-[0131]; EX1005, 4:29-41, 7:33-61, 11:25-44.

D. Application of the Predictable Onishi-Flowerdew Combination

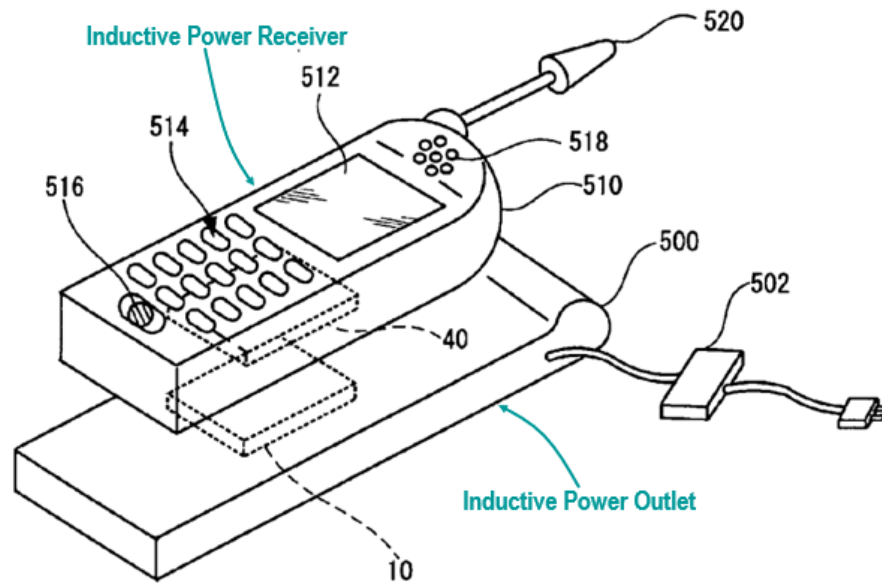
Claim 1

Element [1.P]: An inductive power outlet operable to transfer power to an inductive power receiver, said inductive power outlet comprising

56. The Onishi-Flowerdew combination provides Element [1.P]. For example, Onishi discloses “a charger 500 (cradle) (i.e., electronic instrument)” (**inductive power outlet**) that includes a power transmission device 10 and a “portable telephone 510 (i.e., electronic instrument)” (**inductive power receiver**) that includes a power reception device 40”. EX1004, [0124]-[0131] (“The power supplied to the charger 500 is transmitted from the power transmission device 10 to the power reception device 40 by means of non-contact power transmission”),

[0031] (“the charger 500 shown in FIG. 1A includes at least the power transmission device 10 shown in FIG. 2”), FIGS. 1A, 2, 5.

FIG. 1A



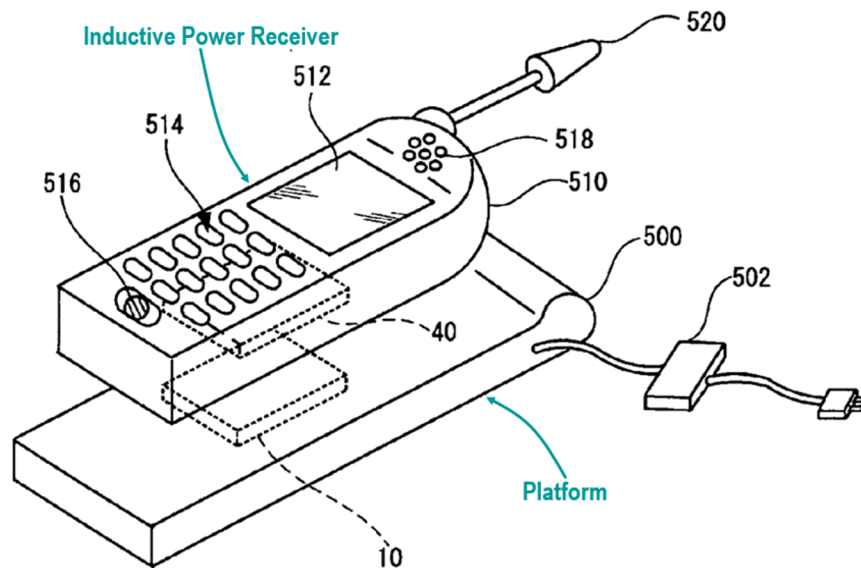
EX1004, FIG. 1A (annotated).

57. Onishi explains that “non-contact power transmission (contactless power transmission) utilizes electromagnetic induction to enable power transmission without metal-to-metal contact.” *Id.*, [0003], [0128] (“power transmission from the power transmission device 10 to the power reception device 40 is implemented by electromagnetically coupling a primary coil L1 (power-transmission-side coil) provided in the power transmission device 10 and a secondary coil L2 (power-receiving-side coil) provided in the power reception device 40 to form a power transmission transformer”), [0137].

Element [1.1]: a platform for supporting said inductive power receiver

58. The Onishi-Flowerdew combination provides Element [1.1]. For example, Onishi discloses that the charger/cradle (**inductive power outlet**) includes an exterior housing (**platform**) for supporting the portable telephone or other electronic instrument (**inductive power receiver**). EX1004, [0039], [0124]-[0126], [0137], [0174], [0180], FIG. 1A. The housing of Onishi's charger/cradle includes a flat, elevated surface on which the portable telephone or other electronic instrument can be placed for charging, and further provides an interior space occupied by charging electronics (e.g., power transmission device 10) in a configuration substantially like platform 202 in the '696 patent. EX1001, 9:9-25, FIG. 1A.

FIG. 1A



EX1004, FIG. 1A (annotated).

***Element [1.2]: at least one primary inductive coil
embedded in said platform***

59. The Onishi-Flowerdew combination provides [1.2]. For example, Onishi discloses that charger/cradle's power transmission device 10 includes "a primary coil L1 (power-transmission-side coil)" (**at least one primary inductive coil**). EX1004, [0128], FIG. 2. As depicted in FIG. 1A (reproduced above in Element [1.1]), power transmission device 10 including primary coil L1 is embedded within the exterior housing (**platform**) of the charger/cradle (**inductive power outlet**). EX1004 [0125], [0128], FIGs. 1A-2; *see also* [0131], [0137] ("when power transmission is necessary, the portable telephone 510 is placed on the charger 500 so that a magnetic flux of the primary coil L1 passes through the secondary coil L2."), [0174], [0180].

***Element [1.3]: an alignment mechanism configured to
facilitate alignment between said primary
inductive outlet and said inductive power
receiver***

60. The Onishi-Flowerdew combination provides Element [1.3] for at least the reasons that I addressed above in the overview of the combination. *See above*, Section VIII.C. For example, even if Onishi did not expressly describe the use of a conventional "alignment mechanism," such a feature was commonly implemented in similar wireless charging systems to achieve known benefits, as suggested by Flowerdew. *Above*, Section VIII.C. Again, the Onishi-Flowerdew combination

would have implemented Onishi's charger/cradle in a manner that includes an alignment mechanism as suggested by Flowerdew (e.g., a dished recess or other shaped surface feature, a directional logo/marker, or a combination thereof) so that Onishi's charger 500 (**primary inductive outlet**) having the primary coil L1 (**primary inductive coil**) and Onishi's portable telephone or other electronic instrument (**inductive power receiver**) containing a power reception device (e.g., device 40) having a secondary coil L2 (**secondary inductive coil**) would be more readily "optimized" for alignment and the inductive "coupling is maximized." *Id.* (articulating multiple known benefits); EX1005, 7:52-61, 11:25-44, 2:59-3:14.

*Element [1.4]: such that an inductive couple is formed
 between said primary inductive coil and a
 secondary inductive coil of said inductive
 power receiver, said inductive couple
 having a characteristic resonant frequency*

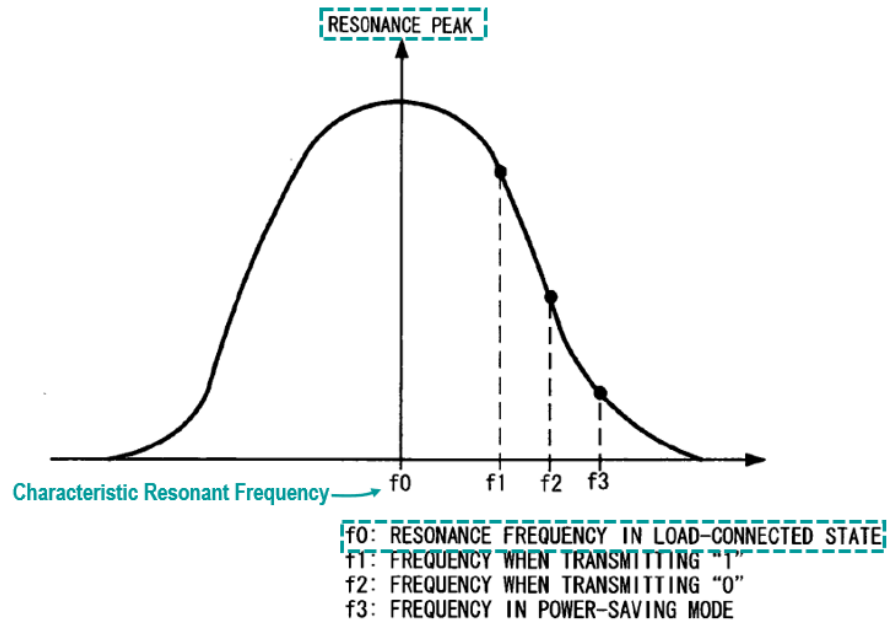
61. The Onishi-Flowerdew combination provides Element [1.4]. The alignment mechanism in the predictable combination would further improve/enhance consistency for Onishi's inductive coupling of coils L1 and L2 having a characteristic resonant frequency (e.g., frequency F0). EX1004, [0128]-[0133], [0180]-[0181], FIGS. 2, 4, 5. For example, Onishi discloses that primary coil L1 (**primary inductive coil**) in power transmission device 10 forms an inductive couple with a secondary coil L2 (**secondary inductive coil**) in power reception device 40:

The primary coil L1 (power-transmission-side coil) is **electromagnetically coupled** with the secondary coil L2 (power-receiving-side coil) to form a power transmission transformer. For example, when power transmission is necessary, the portable telephone 510 is placed on the charger 500 so that a magnetic flux of the primary coil L1 passes through the secondary coil L2, as shown in FIGS. 1A and 1B.

EX1004, [0137] (emphasis added); *see also id.*, [0003], [0125], [0128], FIGS. 2, 5.

62. Onishi further discloses that the inductive couple between primary coil L1 and secondary coil L2 has a characteristic resonant frequency “ f_0 ”, indicated by the “RESONANCE PEAK” in FIG. 4:

FIG. 4



EX1004, FIG. 4 (annotated); *see also id.*, [0171] (“the power value of the resonant circuit becomes a maximum at the resonance peak, and decreases as the resonance frequency moves away from the resonance peak”), [0053], [0180].

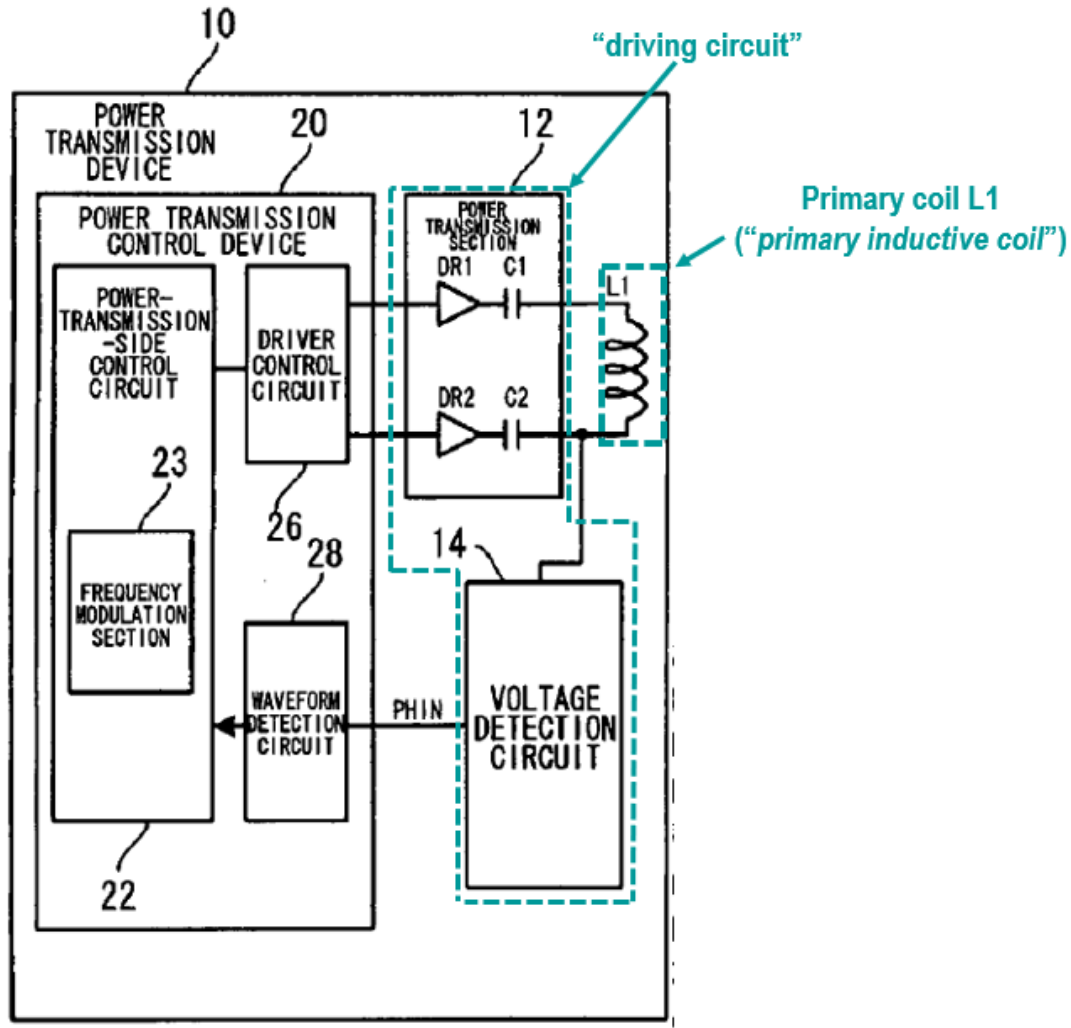
Element [1.5]: a driving circuit wired to said primary inductive coil

63. The Onishi-Flowerdew combination provides Element [1.5]. For example, Onishi discloses a power transmission section 12 which, in connection with at least voltage detection circuit 14, provides the claimed “**driving circuit**” wired to primary coil L1 (**primary inductive coil**). EX1004, [0132]-[0139], [0197]-[0200], FIGS. 2, 5. Onishi states “[t]he power transmission section 12 may include

a first power transmission driver which drives one end of the primary coil L1, a second power transmission driver which drives the other end of the primary coil L1.” EX1004, [0135], [0143] (“primary coil L1 (power-transmission-side coil) is electromagnetically coupled with the secondary coil L2 (power-receiving-side coil) to form a power transmission transformer”), FIGS. 2, 5, 6. “Each of the first and second power transmission drivers included in the power transmission section 12 is an inverter circuit (or buffer circuit) which includes a power MOS transistor, for example, and is controlled by a driver control circuit 26 of the power transmission control device 20.” *Id.*, [0136], [0197] (“The power transmission section 12 generates an alternating-current voltage and drives the primary coil (L1).”).

64. Dependent claim 7 clarifies that the scope of the claimed “driving circuit” is not restricted solely to the circuit component that directly drives the primary inductive coil; rather, it can also include, for example, a “voltage monitor” for monitoring the amplitude of a primary voltage across the primary coil. EX1001, Cl. 7. In this context, Onishi’s power transmission section 12 together with at least the voltage detection circuit 14 (which provides a corresponding “voltage monitor[ing]” function) collectively provide the claimed “**driving circuit.**” *Infra*, Claim [7]; EX1004, [0139], [0197]-[0200], [0224], FIGS. 2, 5-6. A POSITA would have understood that, while not necessary to meet claims 1 or 7, the additional components from Onishi’s power transmission device 10 would also fall within the

scope of the claimed “**driving circuit**” including driver control circuit 26, control circuit 22, oscillation circuit 24, and waveform detection circuit 28.



EX1004, FIG. 5 (cropped, annotated).

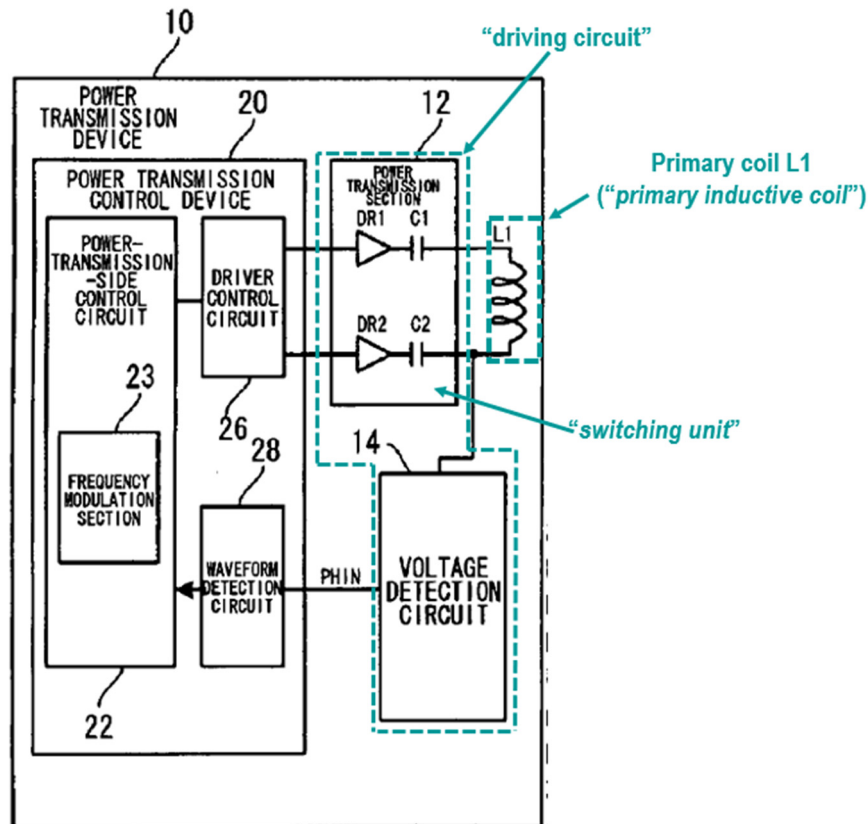
65. Here, the **driving circuit** includes at least the control circuit 22, driver control circuit 26, power transmission section 12 and the voltage detection circuit 14. Element [1.4] requires that the scope of the claimed **driving circuit** is not restricted solely to the circuit component that directly drives the primary inductive

coil; rather, it also includes, for example, a “switching unit.” EX1001, Cl. 1. The specification of the ‘696 patent also makes it clear that the driving circuitry can include “a microcontroller.” *Id.* 22:40-44. In this context, Onishi’s power transmission section 12 together with at least the control circuit 22 (which provides a corresponding microcontroller), the driver control circuit 26 (which provides a corresponding switching unit) collectively provide the claimed **driving circuit**. *Infra*, Element [1.4], Claim [6]; EX1004, [0136], [0139], [0141]-[0143], [0159], [0196]-[0200], [0215], [0224], FIGS. 2, 5-6.

Element [1.6]: said driving circuit comprising a switching unit configured and operable to provide an oscillating driving voltage across said primary inductive coil such that a secondary voltage is induced in the secondary inductive coil

66. The Onishi-Flowerdew combination provides Element [1.6]. Indeed, Onishi provides a “**switching unit**” of the claimed “**driving circuit**” configured and operable to provide an oscillating driving voltage across primary coil L1 such that a secondary voltage is induced in secondary coil L2. For example, Onishi discloses that power transmission section 12 “generates an alternating-current voltage at a given frequency during power transmission.” EX1004, [0132]; *see also id.*, [0133]-[0136], FIGS. 2, 4. Additionally, “power transmission section 12” includes a “first power transmission driver which drives one end of the primary coil L1, [and the]

second power transmission driver which drives the other end of the primary coil L1.” EX1004, [0135]. “The primary coil L1 (power-transmission-side coil) is electromagnetically coupled with the secondary coil L2 (power-receiving-side coil) to form a power transmission transformer.” EX1004 [0137]. “Each of the first and second power transmission drivers included in the power transmission section 12 is an inverter circuit (or buffer circuit) which includes a power MOS transistor, for example, and is controlled by a driver control circuit 26 of the power transmission control device 20.” *Id.* [0136].

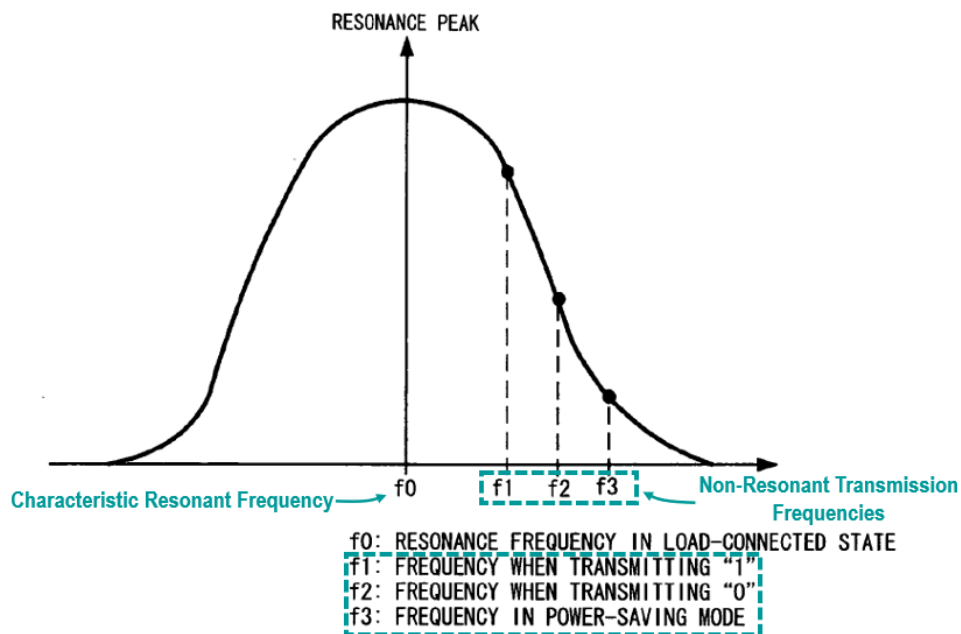


EX1004, FIG. 5 (cropped, annotated).

Element [1.7]: *wherein said driving circuit is configured and operable to produce said oscillating driving voltage at a transmission frequency substantially different from said characteristic resonant frequency of said inductive couple*

67. The Onishi-Flowerdew combination provides Element [1.7]. For example, Onishi discloses that the by power transmission section 12 (component of the claimed **“driving circuit”**) is configured and operable to supply an oscillating driving voltage to primary coil L1 (**primary inductive coil**) that oscillates at a non-resonant transmission frequency (e.g., frequencies f1, f2, or f3) that is substantially different from the characteristic resonant frequency (e.g., frequency f0) of the inductive couple. For example, Onishi’s FIG. 4 demonstrates this:

FIG. 4



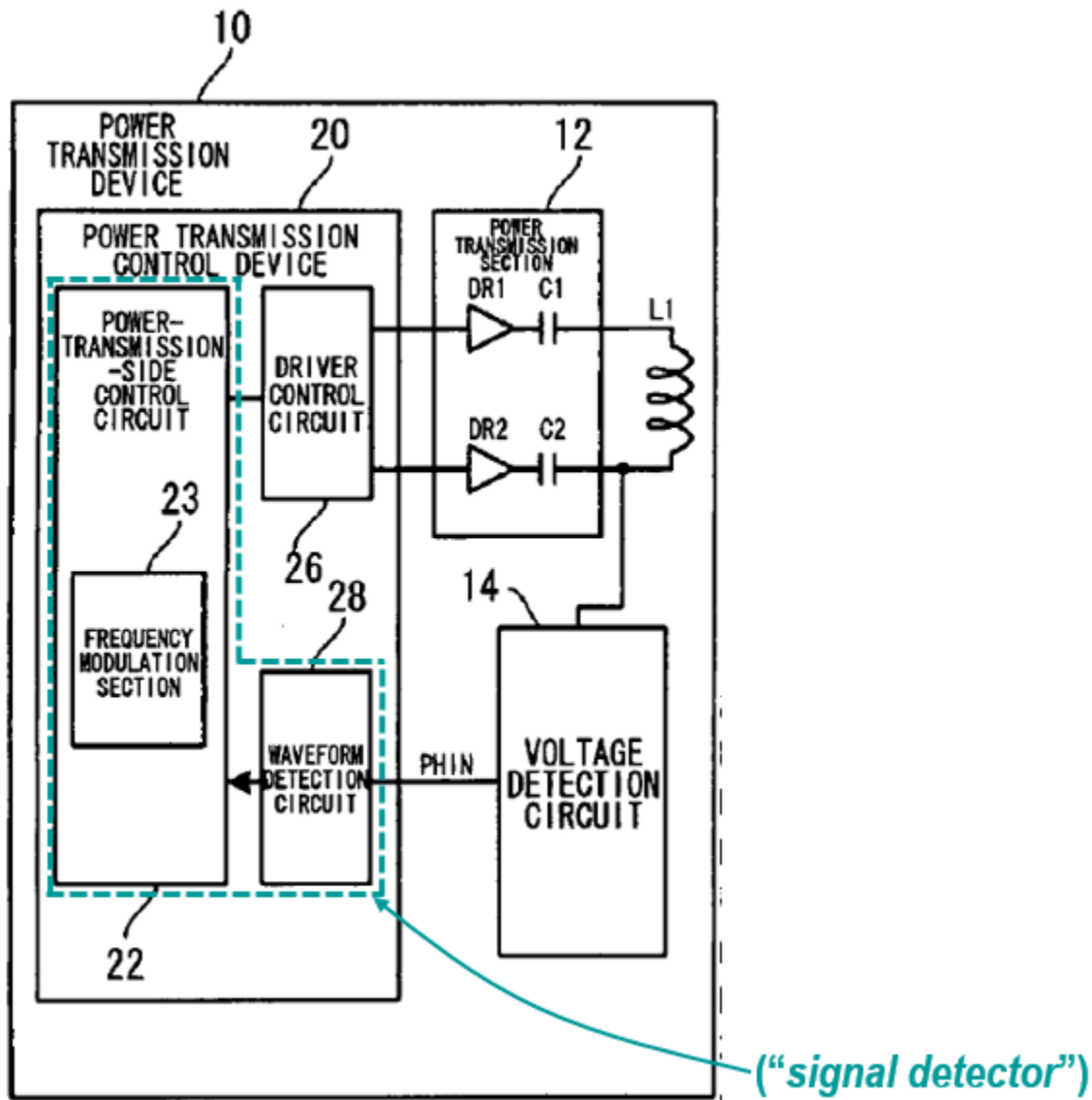
EX1004, FIG. 4 (annotated).

68. According to Onishi, “the frequency f_1 is a frequency used when transmitting ‘1’ during normal power transmission” and “is a basic frequency during power transmission.” EX1004, [0181]. “The frequency f_2 is a frequency used when transmitting ‘0’” and “[a] frequency F_3 is a frequency used in the power-saving mode.” *Id.*; *see also id.*, [0053] (“The transmission frequency during power-saving power transmission is set at a frequency apart from the resonance frequency (resonance peak) as compared with the frequency during normal power transmission, for example.”), [0171], FIG. 3A. Moreover, each of frequencies f_1 , f_2 , and f_3 lie in a near-linear region of the frequency-response curve and thus, as noted during prosecution (*Above*, Section VI.B (citing EX1002, 62)), fall within the scope of being “substantially different” from the characteristic resonant frequency f_0 . EX1001, 21:16-23, 21:56-65, FIG. 6b; EX1002, 62, *above* Section VII. Indeed, the strikingly similar positions of Onishi’s frequencies f_1 , f_2 , and f_3 in the frequency-response curve as the transmission frequency (e.g., f_t in FIG. 6B) identified as “substantially different” in the ’696 specification confirms that Onishi discloses and renders obvious a transmission frequency that is “substantially different” from the characteristic resonant frequency regardless of the outermost scope of this claim term. EX1001, 21:16-23, 21:56-65, FIG. 6b; *above* Section VII.

Claim 2

Element [2.P]: The inductive power outlet of claim 1 said inductive power outlet comprising a signal detector adapted to detect a first signal and a second signal, and said driver is configured to

69. The Onishi-Flowerdew combination provides Element [2.P]. I understand that the term “**said driver**” lacks antecedent basis. However, Onishi nonetheless discloses the claimed “**driver**” in at least the same manner as the “**driving circuit**” recited in claim 1. Onishi also provides the claimed “**signal detector**.” For example, the power transmission device 10 of Onishi’s charger/cradle (**inductive power outlet**) includes a waveform detection circuit 28 that, alone or together with power transmission-side control circuit 22, provides a “**signal detector**” adapted to detect the claimed first and second signals.



EX1004, FIG. 5 (cropped, annotated).

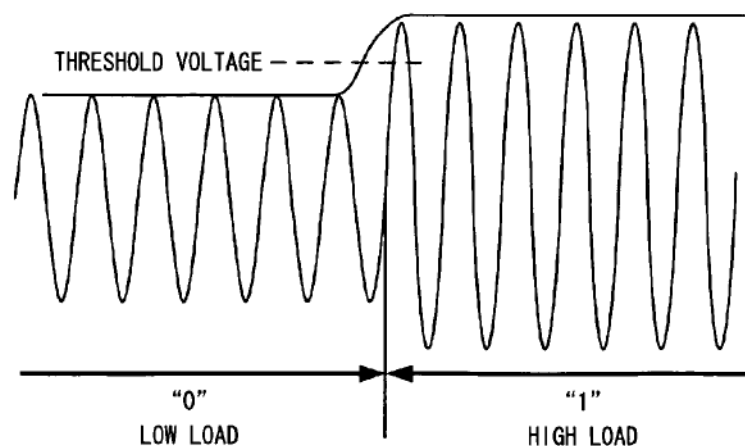
70. This example respectively maps different components from Onishi to the claimed “signal detector” and the claimed “driver.” However, the claimed “signal detector” can also be treated as part of the “driver” in claim 2. In this case, Onishi would still disclose and render obvious this configuration. For example, Onishi’s entire power transmission control device 20, power transmission section

12, and voltage detection circuit 14 cooperate to drive and monitor primary coil L1 and thus provide the claimed “driver,” while waveform detection circuit 28 alone or together with control circuit 22 would still provide the claimed “signal detector.”

71. For context, in Onishi, the power transmission device 10 includes circuitry configured to detect information about the load state and charging status of a battery 94 electrically coupled to the power reception device 40. EX1004, FIGS. 2, 5. While battery 94 is being charged, power transmission device 10 operates in a “normal power transmission” mode that delivers power to the power reception device 40 at a level sufficient to support charging of the battery 94. EX1004, [0053], [0064], [0224]-[0226]. When the battery 94 is fully charged such that it can no longer accept additional charge (i.e., charging is completed), the power transmission device 10 operates in a “power-saving power transmission” mode that delivers less power to the power reception device 40 at a level sufficient to support operation of a charge management function 92—but at a level that would be insufficient to support normal charging of the battery 94. EX1004, [0053], [0226]. Power transmission device 10 determines whether to operate in the “normal power transmission” mode or the “power-saving power transmission” mode based on signals communicated from the power reception device 40 to the power transmission device 10 over the inductive coupling between coils L1 and L2. EX1004, [0223]-[0226].

72. More specifically, Onishi teaches that signals transmitted from power reception device 40 to power transmission device 10 induce different peak voltages in primary coil L1. The peak voltage induced in primary coil L1 can be controlled by modulating a load at the power reception device 40, and Onishi applies this technique to transmit data to the power transmission device 10—including binary values “1” and “0”, which are represented by different ranges of peak voltages induced in primary coil L1. EX1004, [0145]-[0146]. “For example, when a load modulation section 46 of the power reception device 40 modulates load in order to transmit data to the power transmission device 10, the signal waveform of the induced voltage in the primary coil L1 changes as shown in FIG. 3B.” EX1004, [0144]-[0145].

FIG. 3B



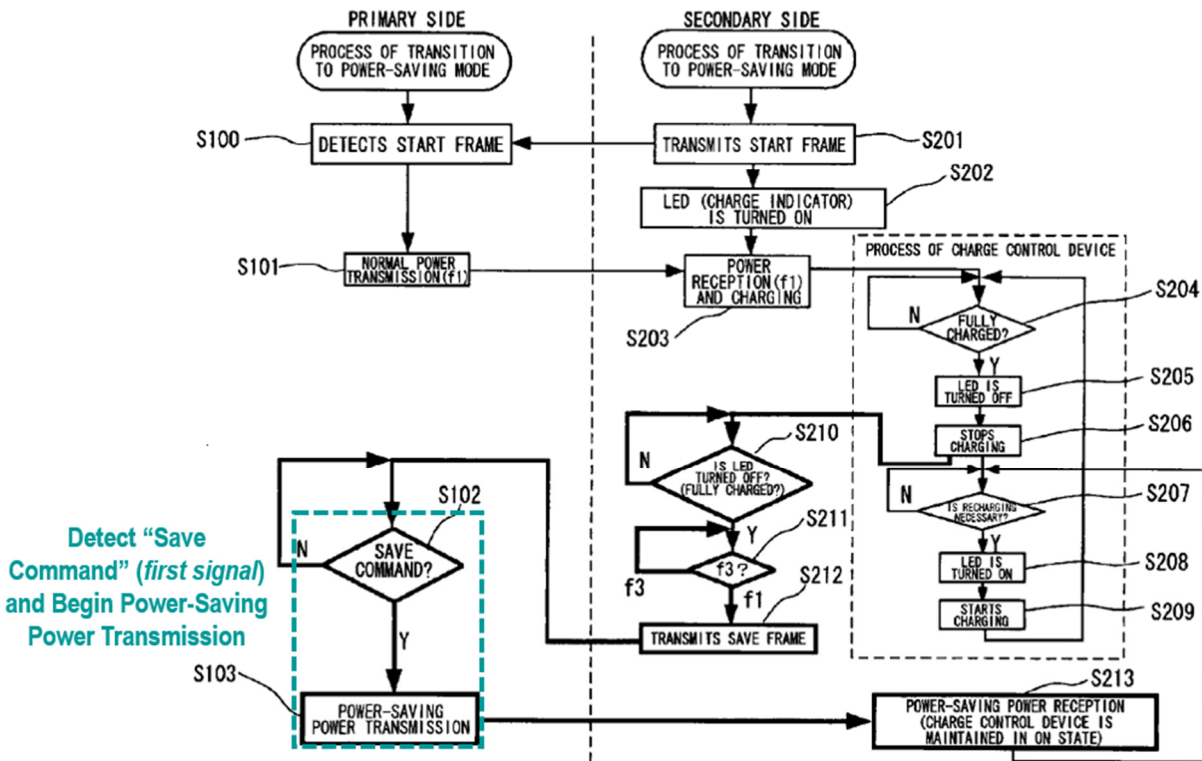
EX1004, 3B.

73. Onishi further explains that a “voltage detection circuit 14” in the power transmission device 10 “detects the voltage induced in the primary coil (L1).” EX1004, [0197]; *see also id.*, [0139], [0199]-[200], FIGS. 2, 5-6. Detection circuit 14 produces a voltage PHIN corresponding to the induced voltage in the primary coil L1, and voltage PHIN is provided as input to a “waveform detection circuit 28.” *Id.*, [0144]. “The waveform detection circuit 28 monitors the waveform of the signal PHIN which corresponds to the induced voltage at one end of the primary coil L1, and performs load detection, foreign object detection, and the like.” EX1004, [0144]. “[T]he waveform detection circuit 28 can determine whether the data from the power reception device 40 is ‘0’ or ‘1’ by determining whether or not the peak voltage has exceeded a threshold voltage as a result of a peak-hold process on the signal waveform of the induced voltage, for example.” *Id.*, [0146]. The output of waveform detection circuit 28 is provided to control circuit 22, which “performs sequence control and a determination process necessary for power transmission, load detection, frequency modulation, foreign object detection, detachment detection, and the like.” *Id.*, [0142]; *see also id.*, [0143], [0159], [0223]-[0225], FIGS. 2, 5.

74. To cause the power transmitting device 10 to switch from normal power transmission mode to the power-saving power transmission mode (e.g., when the battery 94 completes charging), power reception device 40 transmits over the inductive channel a “save command” (**first signal**) that results in corresponding

change(s) in the voltage induced in primary coil L1. EX1004, [0028], [0059]-[0060], [0071], [0076]-[0079], [0099]-[0100], [0144]-[0146], [0151]-[153], [0192], [0215]. “[T]he waveform detection circuit 28 can determine whether the data from the power reception device 40 is ‘0’ or ‘1’ by determining whether or not the peak voltage has exceeded a threshold voltage as a result of a peak-hold process on the signal waveform of the induced voltage, for example.” EX1004, [0146], FIG. 3B. The output of the waveform detection circuit 28 is provided as input to control circuit 22, which “detects the save command transmitted from the secondary-side instrument (step S102), and starts power-saving power transmission (power transmission frequency f3) (step S103).” *Id.*, [0215], FIG. 7.

FIG. 7



EX1004, FIG. 7 (annotated); *see also id.*, FIG. 9 (S120), FIG. 10 (S113, S110).

75. To cause the power transmitting device 10 to switch from power-saving power transmission mode to the normal power transmission mode, power reception device 40 transmits over the inductive channel an indication of a change to a “high-load state” (**second signal**) that results in corresponding change(s) in the voltage induced in primary coil L1. EX1004, [0027], [0063]-[0064], [0101], [0144]-[0146], [0151]-[0153], [0186]-[0187], [0225]. “[W]hen the power reception device has changed from a low-load state (power-saving state) to a high-load state (recharge

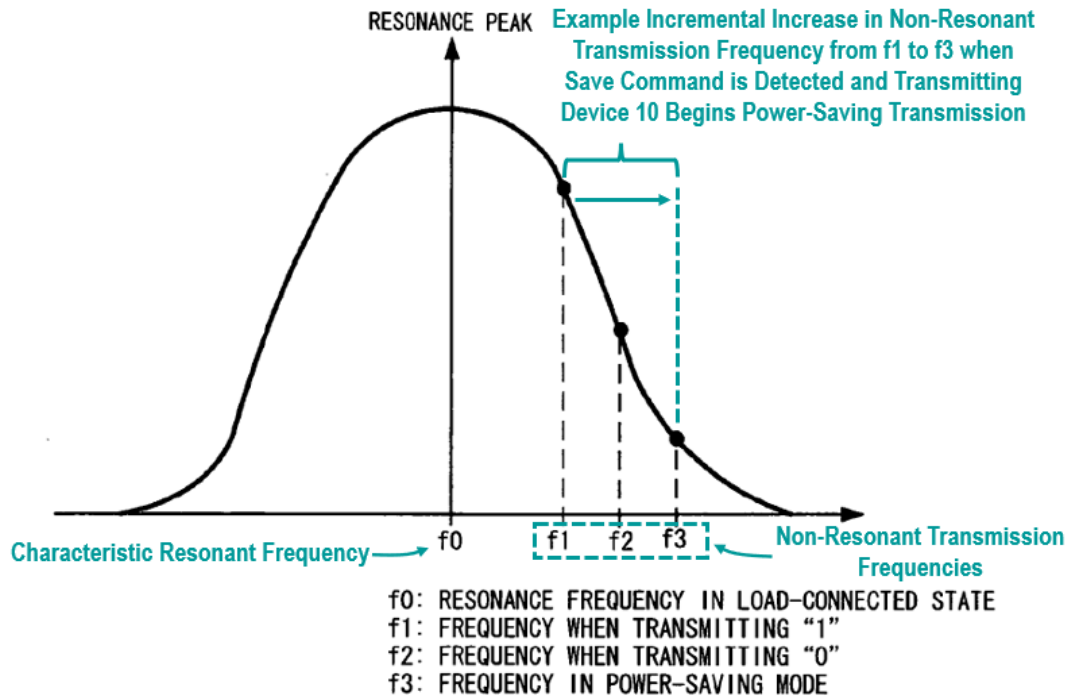
state), the amplitude of the induced voltage in the primary coil increases” and “[t]herefore, the power transmission device can reliably detect a change in load state by determining a change in amplitude using the threshold value, for example.” EX1004, [0064]. In particular, “the power transmission device 10 can detect that the power reception device has changed from a low-load state to a high-load state (i.e., recharging has started in the power-saving mode) by causing the waveform detection circuit 28 ... to determine whether or not the peak voltage has exceeded a threshold voltage as a result of a peak-hold process on the signal waveform of the induced voltage, for example.” *Id.*, [0186]; *see also id.*, [0187] (“cyclically monitors a change in the load of the power reception device 40” or “constantly monitor a change in load”), [0144] (“performs load detection”).

more or less power is required.” EX1001, 22:40-44. These examples show that a signal can, but need not, carry feedback parameters in the ’696 patent. Onishi’s “save command” and Onishi’s indication of a change to a “high-load state” align with the example feedback signals described in the ’696 patent, at least because the “save command” and the indication of a change to a “high-load state” respectively indicate that either less power or more power is required by the power reception device 40 in a manner analogous to the “simple feedback signals” disclosed in the ’696 specification.

Element [2.1]: increase said transmission frequency when said first signal is detected by the detector

77. As described above in the analysis of Element [2.P], Onishi discloses that power transmitting device 10 switches from normal power transmission to power-saving power transmission in response to detecting change(s) in the voltage inducted in primary coil L1 corresponding to a “save command” (**first signal**) transmitted from power reception device 40. EX1004, [0028], [0059]-[0060], [0071], [0076]-[0079], [0099]-[0100], [0144]-[0146], [0151]-[153], [0192], [0215]; *above*, [2.P]. When initiating power-saving power transmission, power transmission section 12 (component of the **driver/driving circuit**) increases the transmission frequency from “f1” or “f2” to “f3,” as shown in FIG. 4:

FIG. 4



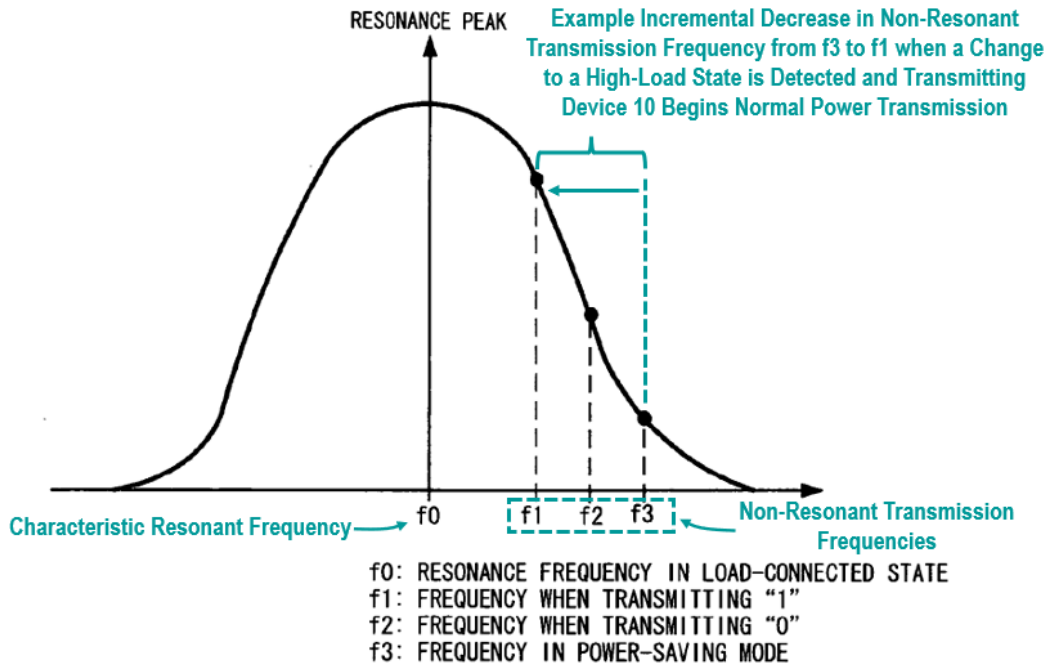
EX1004, FIG. 4 (annotated), [0053] ("The transmission frequency during power-saving power transmission is set at a frequency apart from the resonance frequency (resonance peak) as compared with the frequency during normal power transmission, for example."), [0171] ("The power to be transmitted may be reduced by changing a transmission frequency (i.e., frequency of a drive clock signal of the power transmission section)."), [0181] ("In FIG. 4, the frequency f_1 is a frequency used when transmitting '1' during normal power transmission. The frequency f_1 is a basic frequency during power transmission. The frequency f_2 is a frequency used when transmitting '0' (see FIGS. 3A and 3B). A frequency f_3 is a frequency used

in the power-saving mode.”), [0215] (“starts power-saving power transmission (power transmission frequency f_3)”), [0133]-[0136] (details of power transmission section 12), FIGS. 2, 5-6.

Element [2.2]: decrease said transmission frequency when said second signal is detected by the detector

78. As described above in the analysis of Element [2.P], Onishi discloses that power transmitting device 10 switches from power-saving power transmission to normal power transmission in response to detecting change in the voltage induced in primary coil L1 corresponding to a change to a “high-load state” (**second signal**) transmitted from power reception device 40. EX1004, [0027], [0063]-[0064], [0101], [0144]-[0146], [0151]-[0153], [0186]-[0187], [0225]; *above*, [2.P]. When beginning normal power transmission, power transmission section 12 (component of the **driver/driving circuit**) decreases the transmission frequency from “ f_3 ” to “ f_1 ” or “ f_2 ”, as shown in FIG. 4:

FIG. 4



EX1004, FIG. 4 (annotated), [0225] (“[I]mmediately changes power transmission from power-saving power transmission to normal power transmission (step S122)”), FIG. 9 (S122) (“STOP POWER-SAVING POWER TRANSMISSION ($f_3 \rightarrow f_1$)”), [0171] (“changing a transmission frequency (i.e., frequency of a drive clock signal of the power transmission section).”), [0181] (“In FIG. 4, the frequency f_1 is a frequency used when transmitting ‘1’ during normal power transmission. The frequency f_1 is a basic frequency during power transmission. The frequency f_2 is a frequency used when transmitting ‘0’ (see FIGS. 3A and 3B). A frequency f_3 is a frequency used in the power-saving mode.”), [0133]-[0136] (details of power

transmission section 12), FIGS. 2, 5-6.

Claim 3

Element [3]: The inductive power outlet of claim 1 said driver being configured to adjust said transmission frequency in response to feedback signals

79. As described in detail above with respect to Elements [2.P]-[2.2], Onishi discloses a “**driver**” (e.g., at least power transmission section 12 and optionally additional components of power transmission control device 20) configured to adjust the transmission frequency in response to “**feedback signals**” (e.g., save command, signaled change to a high-load state). *Supra*, Elements [2.P]-[2.2]; EX1004, [0027]-[0028], [0053], [0059]-[0060], [0063]-[0064], [0071], [0076]-[0079], [0099]-[0101], [0133]-[0136], [0143]-[0146], [0151]-[153], [0171], [0181], [0186]-[0187], [0192], [0197], [0215], [0225], FIGS. 4, 7, 9-10.

Claim 4

Element [4]: The inductive power outlet of claim 3 wherein said feedback signals carry data pertaining to the operational parameters of said electric load

80. The Onishi-Flowerdew combination provides Element [4]. For example, Onishi discloses that the feedback signals (e.g., save command signaled change to a high-load state) from power reception device 40 pertain to operational parameters of electric load 90 (including battery 94). For example, the “save

command” provides “information relating to the full-charge state of the battery” and “requests power-saving power transmission.” EX1004, [0060]; *see also id.*, [0025], [0072], [0076]-[0079] The battery’s full-charge state is an operational parameter of the battery that indicates charging is complete and that the battery will accept no more charge. The “save command” pertains to at least this operational parameter of the battery 94 in load 90. Likewise, Onishi’s feedback signals that indicate a change from a low-load state to a high-load state carry data pertaining to the operational parameters of the electric load, including data that indicates the battery 94’s charge has decreased and that charging will resume. EX1004, [0053], [0064], [0173]-[0177]; *see also id.*, [0027], [0064], [0101], [0144]-[0146], [0151]-[0153], [0186]-[0187], [0225].

81. The additional language in claim 4 recites only that the feedback signals “carry data **pertaining to** the operational parameters of said electric load.” (Emphasis added.) Claim 4 does not require that the feedback signals explicitly carry the operational parameters themselves.

Claim 5

***Element [5]: The inductive power outlet of claim 4
wherein said operational parameters are
selected from the group consisting of:
required operating voltage for said electric
load; required operating current for said
electric load; required operating
temperature for said electric load; required
operating power for said electric load;
measured operating voltage for said
electric load; measured operating current
for said electric load; measured operating
temperature for said electric load;
measured operating power for said electric
load; power delivered to said primary
inductive coil; power received by said
secondary inductive coil, and a user
identification code***

82. The Onishi-Flowerdew combination provides Element [5]. For example, Onishi discloses that the feedback signals (e.g., save commands, signaled change to a high-load state) pertain to the operational parameters of the electric load 90 (including battery 94). *Above*, Elements [2.P]-[2.2], [3]-[4]. Among others, the feedback signals pertain to the measured operating voltage, required operating current, and required operating power of the load. For example, the “save command” is issued when the charging of battery 94 is completed, thereby indicating that the required operating current and required operating power of load 90 (and battery 94) can be decreased and that the measured operating voltage corresponds to a full-charge state. EX1004, [0053], [0064], [0168], [0173]-[0177]; *see also id.*,

[0025], [0027], [0060], [0064], [0072], [0101], [0144]-[0146], [0151]-[0153], [0186]-[0187], [0225]. Likewise, the second signal corresponding to a change from a low-load state to a high-load state indicates that the electric load 90 requires more power and more current, e.g., because the measured operating voltage and charge of the battery 94 has dropped, thereby and indicating a need for battery recharging to resume. *Id.*

Claim 6

***Element [6]: The inductive power outlet of claim 2
 wherein said detector is selected from the
 list comprising optical detectors, radio
 receivers, audio detectors and voltage peak
 detectors***

83. The Onishi-Flowerdew combination provides Element [6]. For example, Onishi discloses that waveform detector 28—which alone or together with control circuit 22 provides the recited “**signal detector**”—includes voltage peak detectors. EX1004, [0200] (“form a peak detection circuit”), FIGS. 2, 4-6; *see also id.*, [0134], [0144]-[0146], [0201]. For example, waveform detector 28 implements a voltage peak detector configured to detect a data “0” from the voltage induced in primary coil L1 and a voltage peak detector configured to detect a data “1” for the voltage induced in primary coil L1. *Id.* Onishi also discloses a respective voltage peak detector at each of nodes NA4 and NA5. EX1004, [0200] (“[T]he peak voltage of the detection signal PHIN from the voltage detection circuit 14 is held by a node

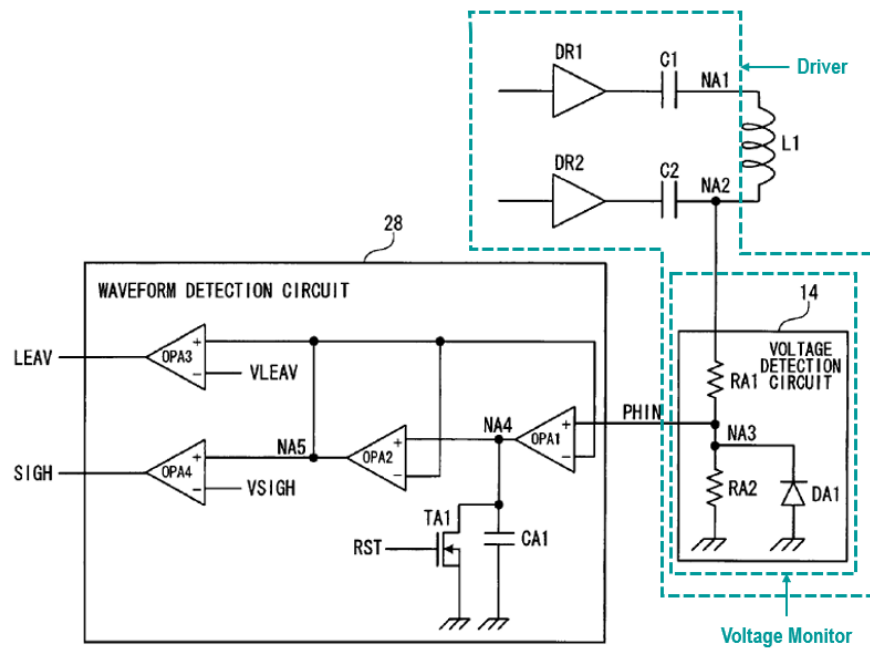
NA4, and the peak voltage signal held by the node NA4 is subjected to impedance conversion ... and is output to a node NA5.”).

Claim 7

*Element [7]: The inductive power outlet of claim 1
 wherein said driver further comprises a
 voltage monitor for monitoring the
 amplitude of a primary voltage across said
 primary coil*

84. The Onishi-Flowerdew combination provides Element [7]. For example, Onishi discloses that voltage detection circuit 14—i.e., a component of the claimed “**driving circuit**” or “**driver**” (the term “**said driver**” in claim 7 lacks antecedent basis) (*see supra*, [1.1], [2.P])—comprises a voltage monitor for monitoring the amplitude of a primary voltage across primary coil L1. EX1004, [0197] (“The power transmission section 12 generates an alternating-current voltage and drives the primary coil (L1). The voltage detection circuit 14 detects the voltage induced in the primary coil (L1).”), [0139], [0199]-[0200], [0224], FIGS. 2, 5-6; *above*, Element [1.1].

FIG. 6



EX1004, FIG. 6 (annotated).

Claim 9

Element [9]: The inductive power outlet of claim 1 comprising a power converter selected from the group comprising: a transformer, a DC-to-DC converter, an AC-to-DC converter, an AC-to-AC converter, a flyback transformer, a flyback converter, a full-bridge converter, a half-bridge converter and a forward converter.

85. The Onishi-Flowerdew combination provides Element [9]. For example, Onishi discloses that the charger/cradle (**inductive power outlet**) includes the primary side of a transformer. EX1004, [0137] (“primary coil L1 ... is electromagnetically coupled with the secondary coil L2 ... to form a power

transmission transformer”).

86. The teachings of Onishi in view of Flowerdew further render obvious an AC-to-DC converter and a rectifier in the charger/cradle (**inductive power outlet**). For example, Onishi discloses that “[p]ower is supplied to the charger 500 through an AC adaptor 502.” EX1004, [0126], FIG. 1A. A POSITA would have understood and found obvious that an AC adaptor like that disclosed in Onishi is an AC-to-DC converter that, e.g., converts AC wall power to a DC power signal. While Onishi’s AC adaptor is implemented external to the charger/cradle device, AC adaptors were also commonly implemented before the Critical Date as an integrated component of the device to which the AC adaptor supplies its DC power signal. Indeed, Flowerdew discloses this predictable option: “[c]harger 302 is designed to draw power from a power source 306 such as a standard electrical wall outlet.” EX1005, 5:5-6, FIG. 2. Because the power source 306 can be a standard wall outlet supplying AC power, Flowerdew acknowledges that the charger’s controller can include a “rectifier” that would rectify the AC power signal and produce a DC power signal. *Id.*, 5:18. It would have been obvious based on Flowerdew to implement an AC-to-DC converter in Onishi’s charger/cradle to condition the power provided to the power transmission section and eliminate the need for an external AC adaptor. Eliminating the external AC adaptor would have been beneficial to reduce the number of components required for the user to operate the charger and would have

increased user convenience in using the charger by enabling it to directly plug into a wall outlet. A POSITA would have reasonably expected success integrating the AC adaptor (e.g., a rectifier) in Onishi's charger/cradle since integrated AC adaptors were well known by the relatively late Critical Date of the '696 patent.

Claim 10

*Element [10]: The inductive power outlet of claim 1
incorporated into at least one application
selected from a group consisting of:
inductive chargers, inductive power
adaptors, power tools, kitchen appliances,
bathroom appliances, computers, media
players, office equipment, implanted
devices, pace makers, trackers and RFID
tags*

87. The Onishi-Flowerdew combination provides Element [10]. For example, Onishi discloses that the inductive power outlet analyzed in claim 1 (above) is a charger/cradle used to inductively recharge a battery of a portable telephone or other electronic instrument and thus is incorporated into an application of an **inductive charger**. EX1004, [0123]-[0127], [0137], FIGS. 1A-2. Onishi also describes “[t]he electronic instrument to which this embodiment is applied is not limited to the portable telephone ... this embodiment may be applied to various electronic instruments such as a wristwatch, a cordless telephone, a shaver, an electric toothbrush, a wrist computer, a handy terminal, a portable information terminal, and a power-assisted bicycle.” *Id.* [0127].

Claim 13

***Element [13]: The inductive power outlet of claim 1
wherein said alignment mechanism
comprises a visual indication***

88. The Onishi-Flowerdew combination provides Element [13]. As described above (Section VIII.C), Flowerdew plainly suggests using an alignment mechanism including “one or more markers” (or a “directional logo”) as a **visual indication** to indicate “a preferred alignment and/or orientation.” EX1005, 7:52-61, 11:25-44 (“directional logo” to indicate “a preferred orientation”). The predictable combination would have implemented Onishi’s system in a manner that included a conventional implementation. *Above*, Section VIII.C.

Claim 14

***Element [14]: The inductive power outlet of claim 1
wherein said alignment mechanism
comprises a tactile indication.***

89. The Onishi-Flowerdew combination provides Element [14]. As described above (Section VIII.C), Flowerdew plainly suggests using an alignment mechanism including “dished recesses” or other shaped surface features that provides physical structures noticeable to a user’s touch (**tactile indication**) for guiding the user’s placement of items “optimized for the alignment.” EX1005, 7:52-61; 11:25-44 (“geometrically advantageous”), FIGS. 5 and 10. The predictable combination would have implemented Onishi’s system in a manner that included a

conventional implementation. *Above*, Section VIII.C.

**IX. ANALYSIS – OBVIOUSNESS BASED ON ONISHI, FLOWERDEW,
AND PARTOVI (GROUND 1B)**

A. Partovi (EX1007)

90. Partovi describes an inductive power transfer system. EX1007, [0060]. Partovi demonstrates that it was known before the Critical Date of the '696 patent for inductive power transfer systems to include alignment mechanisms to align the coils in a charger and a receiver device “for optimum power transfer.” EX1007, [0082]-[0087], [0090]-[0091], [0096], [0135] (describing “[a]n important aspect of power transfer efficiency relates to the alignment of coils with respect to each other”). Partovi explains that “[t]he power drops off to 25% of the maximum value when the two coils are offset by a coil radius.” EX1007 [0135]. Partovi teaches that such alignment mechanisms can include the conventional options of: “magnet” elements, “mechanical means (dimples, protrusions, etc.),” “lights,” “LEDs,” “displays,” or “audio signals or messages” to help guide the user to place the mobile device on a primary coil for maximum reception. EX1007, [0082], [0096], [0135].

B. Predictable Combination of Onishi, Flowerdew and Partovi

91. Based upon my knowledge and experience in the field of the '696 patent and my review of Onishi, Flowerdew, and Partovi, it is clear that a POSITA would have been motivated to further modify the charger system from the Onishi-Flowerdew combination of Ground 1A to implement specific alignment mechanisms

like those described in Partovi (e.g., magnetic alignment mechanisms, mechanical/surface alignment mechanisms, and/or alignment mechanisms that use audible indication or visual indications) to achieve known benefits. As discussed above (Section IX.A), Partovi suggests using a variety of such conventional alignment mechanisms—including magnetic alignment mechanisms, mechanical/surface alignment mechanisms, and alignment mechanisms that use audible indication or visual indications. EX1007, [0082]-[0087], [0090]-[0091], [0096], [0135]. A POSITA would have understood the benefits of alignment mechanisms described in Partovi with the power transmission device taught by the Onishi-Flowerdew combination. Notably, Partovi specifically teaches that “[a]n important aspect of power transfer efficiency relates to the alignment of coils with respect to each other.” EX1007, [0135].

92. There are several rationales that would have prompted the POSITA to pursue a combination based on Onishi in view of Flowerdew and Partovi in which Onishi’s charger would include an alignment mechanism like those suggested by Partovi (e.g., magnetic alignment mechanisms, mechanical/surface alignment mechanisms, and/or alignment mechanisms that use audible indication or visual indications). I provide an exemplary discussion of various reasons below, each of which independently supports the predictability and known advantages of the combination.

93. First, a POSITA would have been motivated to implement the Onishi-Flowerdew combination to include an additional/confirmatory alignment mechanism using magnets, protrusions, audible, and/or visual indications (as suggested by Partovi) to advantageously provide built-in confirmation/feedback to the user that the receiver was properly positioned on the charger. EX1007, [0096] (“to help guide the user to place the mobile device on a primary coil for maximum reception”).

94. Second, a POSITA would have been motivated to do so because, beyond Flowerdew’s suggested shaped surface features as I described above, Partovi’s further suggestion for a combination of magnetic alignment elements (for biasing or “snapping” the receiver device to the desired orientation), mechanical protrusions, audible alignment indications, and/or visual alignment indications would have been recognized as particularly useful for elderly users or users with hearing or visual impairments who would benefit from a variety of alignment verification options.

95. Based on the similarities and overlap among these references, a POSITA would have been sufficiently skilled to implement the Onishi-Flowerdew-Partovi combination given the predictable techniques disclosed in each reference and the relatively advanced state of the art at the time. For these reasons, a POSITA would have had a reasonable expectation of success in achieving the Onishi-

Flowerdew-Partovi combination as described herein.

C. Application of the Predictable Onishi-Flowerdew-Partovi Combination

Claim 11

Claim [11]: The inductive power outlet of claim 1 wherein said alignment mechanism comprises a first magnetic element configured to engage a second magnetic element associated with the power receiver.

96. For each of the reasons that I described above (Section IX.C), the Onishi-Flowerdew-Partovi combination provides Claim [11]. Again, Partovi suggests an alignment mechanism including “a magnet” (**a first magnetic element**) contained in the charger that “attracts and pulls” a magnet contained within a receiver (**a second magnetic element associated with the power receiver**). EX1007, [0042], [0082], [0087], [0096], [0135], [0139].

Claim 12

Claim [12]: The inductive power outlet of claim 1 wherein said alignment mechanism comprises an audible indication.

97. For each of the reasons that I described above (Section IX.C), the Onishi-Flowerdew-Partovi combination provides claim 12. Again, Partovi suggests an alignment mechanism including an **audible indication** to alert the user of alignment. EX1007, [0082], [0090], [0096] (“that audio signals or messages can be used for alignment”).

Claim 13

***Claim [13]: The inductive power outlet of claim 1
wherein said alignment mechanism
comprises a visual indication.***

98. For each of the reasons that I described above (Section IX.C), the Onishi-Flowerdew-Partovi combination provides claim [13]. Again, Partovi suggests an alignment mechanism including a **visual indication** can be used of alignment. EX1007, [0082], [0096] (visible “protrusions” or “lights, LEDs, displays ... to help guide the user to place the mobile device”).

X. ANALYSIS – OBVIOUSNESS BASED ON BAARMAN392 AND PARTOVI (GROUND 2A)

A. Baarman392 (EX1008)

99. Baarman392 describes “an inductive charging system for recharging a battery.” EX1008, *Abstract*; *see also* [0011],[0032]. Baarman392’s system includes a charger circuit 6 and a secondary circuit 8. EX1008, [0032], [0047] *see also Abstract*, [0004], [0007], [0008], [0023], [0031], FIGS. 2, 4A-4B. FIG. 2 shows a charger circuit 6. EX1008, [0032]. Charger circuit 6 includes a primary coil 15 and a frequency controller 80 that electrical power to the primary coil 15 at a desired frequency. *Id.*, [0032].

100. Secondary circuit 8 includes a secondary coil 30 electromagnetically coupled to the primary coil 15. EX1008, [0035]. The oscillating field produced by primary coil 15 induces an AC current in secondary coil 30, which is rectified and

used to charge a battery 34. *Id.* Baarman392's secondary circuit 8 further includes components configured to generate a surge of current through secondary coil 30 when either an over-voltage or an over-current is detected. EX1008, [0035]-[0037]. The current surge through the secondary coil 30 produces a corresponding surge through primary coil 15, which is detected by peak detector 22 and controller 23 in the charger circuit 6.

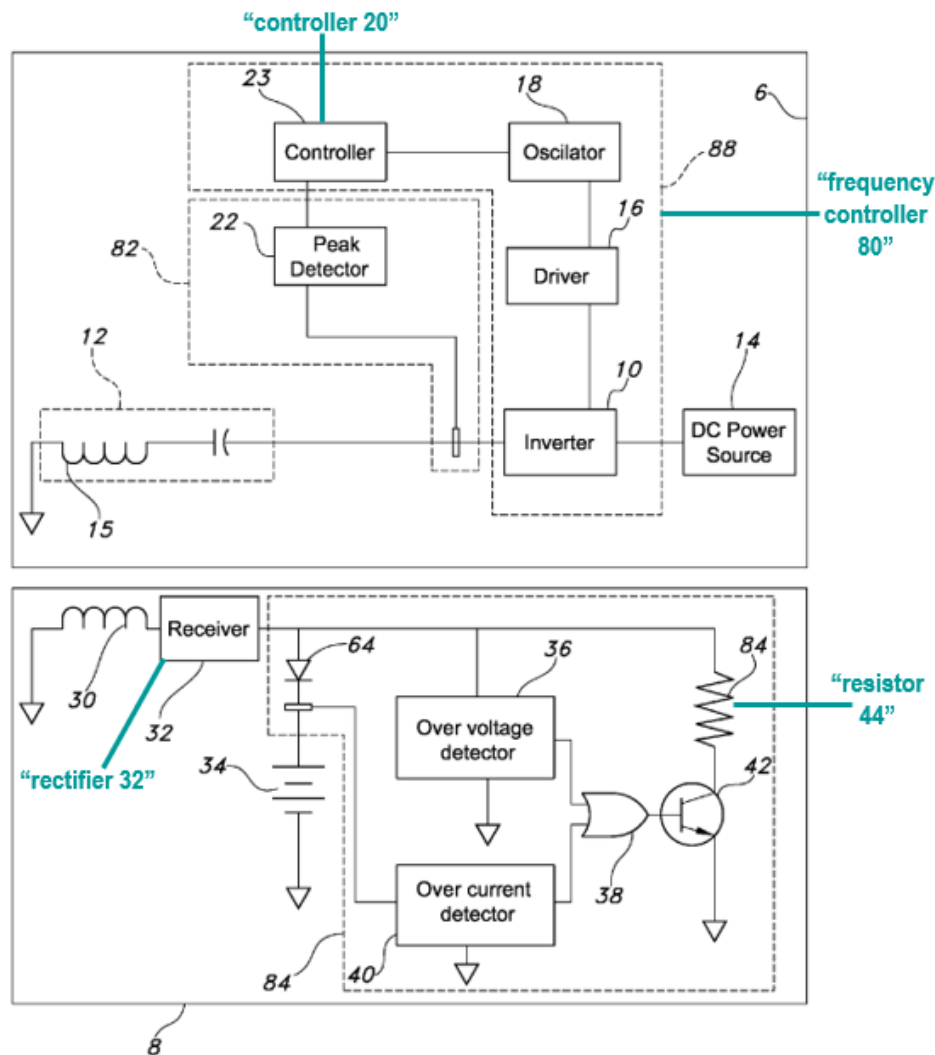


FIG. 2

EX1008, FIG. 2 (annotated). Several components depicted in FIG. 2 of Baarman392

have numeric identifiers that do not match the numerals given in the textual description of FIG. 2. For example, FIG. 2 as published labels the frequency controller as numeral “88” rather than “80” as described in the text, labels the controller as numeral “23” rather than “20” as described in the text, labels the resistor as numeral “84” rather than “44” as described in the text, and labels component 32 as a “receiver” rather than a “rectifier” as described in the text. *Compare* EX1008, FIG. 2, *with id.*, [0032]-[0037]. These minor typographical errors do not meaningfully impact Baarman392’s applicability to the Challenged Claims. For clarity, each of the reproductions of FIG. 2 in this declaration have been annotated to depict the same reference numerals and labels as those used in the text of paragraphs [0032]-[0037]. Those annotations pertain to the reference numerals of controller “20,” frequency controller “80,” and resistor “44,” and the “rectifier” label of component 32.

101. Baarman392 illustrates a power transfer curve for an electromagnetic couple between primary coil 15 and secondary coil 30. EX1008, [0038] (describing when “the primary coil 15 and the secondary coil 30 are loosely coupled ... the slope of the power transfer curve about the resonant frequency is not as steep as if the coils 15, 30 were tightly coupled.”), FIG. 3. In operation, inverter 10 supplies an oscillating drive voltage between between frequency A and frequency B in FIG. 3.

EX1008, [0038], FIG. 3. “Between frequency A and frequency B, the power transfer curve can be piece-wise linearized by a software lookup table located in the controller.” EX1008, [0038].

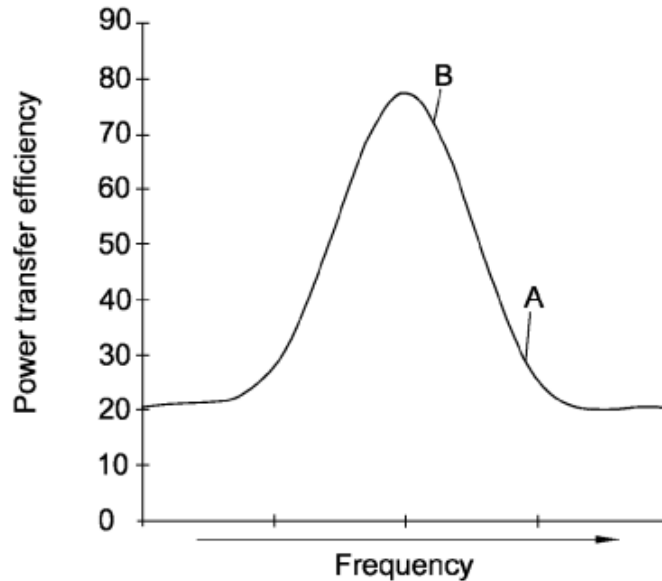


FIG. 3

102. Baarman392 further describes a method for operating the charger that includes steps of “applying power to a primary coil at a frequency, evaluating feedback from the secondary circuit through the primary coil and secondary coil inductive coupling and adjusting the frequency of the power applied to the primary coil as a function of the feedback from the secondary circuit.” EX1008, [0016], *see also* [0048]-[0064], FIG. 7. When the reflected impedance is detected, the operating frequency is set to a start value (e.g., “FREQ_START” at 110 in FIG. 7) and the frequency is then decreased incrementally (e.g., by ΔFREQ) to increase the power

transferred to the secondary circuit. EX1008, [0052]-[0055], FIG. 7. When no over-voltage or over-current condition is detected, the frequency applied to the primary coil 15 gradually decreases by incremental amounts over time thereby increasing the power transferred to the secondary circuit. EX1008, [0055]-[0058], FIG. 7. When an over-voltage or over-current condition is detected (e.g., when a current surge is detected at the primary circuit), the frequency applied to the primary coil 15 is increased by an incremental amount (e.g., by $2 \cdot \Delta \text{FREQ}$) to decrease the power transferred to the secondary circuit. EX1008, [0059]-[0061], FIG. 7.

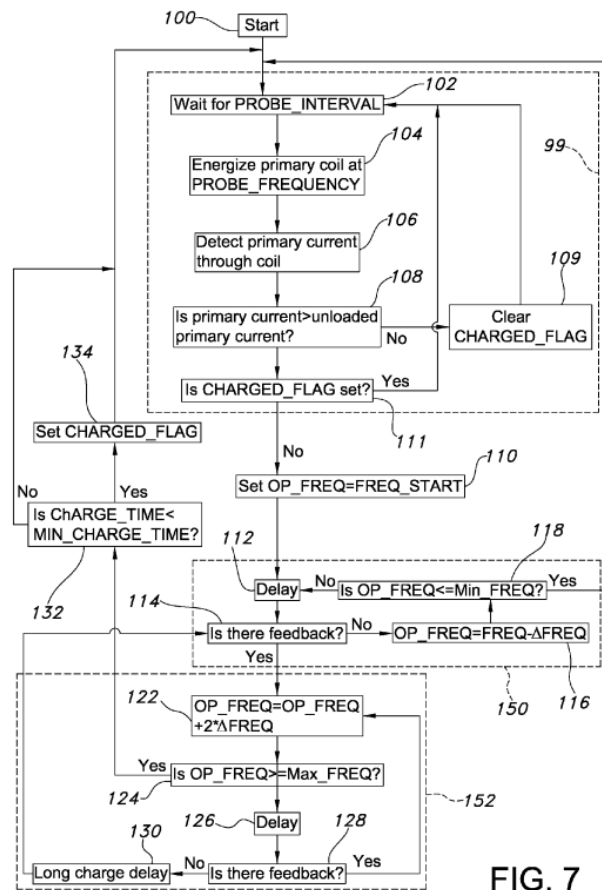


FIG. 7

B. Partovi (EX1007)

103. An overview of Partovi's teachings are described above in Section IX.A.

C. Predictable Combination of Baarman392 and Partovi

104. Baarman392 discloses an inductive charging system that includes a charger circuit 6 with a primary coil 15 configured to transfer power to a secondary coil 30 of a secondary circuit 8. EX1008, *Abstract*, [0011], [0032]-[0035]. When coupled, the primary coil 15 and secondary coil 30 exhibit a characteristic resonant frequency. EX1008, [0038]. The charger circuit 6 includes a frequency controller 80 that drives the primary coil 15 at a frequency that is substantially different from the characteristic resonant frequency. EX1008, [0038], FIG. 3.

105. Baarman392 does not expressly describe an "alignment mechanism," but such features were conventionally used in similar wireless charger systems to achieve known benefits, as suggested by Partovi. There are several rationales that would have prompted the POSITA to pursue a combination based on Baarman392 in view of Partovi so that Baarman392's charger would include an alignment mechanism an alignment mechanism as suggested by Partovi for purposes of achieving known benefits. I provide an exemplary discussion of various reasons below, each of which independently supports the predictability and known advantages of the combination.

106. First, a POSITA would have been motivated to implement an alignment mechanism (suggested by Partovi) in Baarman392's system to advantageously facilitate alignment of the primary and secondary coils "for optimum power transfer." EX1007, [0082] ("magnet" elements, "mechanical means (dimples, protrusions, etc.)"), [0096] ("lights," "LEDs," "displays," or "audio signals or messages"), [0135]. Indeed, the efficiency of the inductive couple between Baarman392's primary and secondary coils would have been enhanced and repeatably consistent by using such conventional options.

107. Second, a POSITA also would have been motivated to implement the Baarman392-Partovi combination to allow a user to more conveniently and rapidly place the rechargeable device on the charging platform in an optimized or otherwise stable position for charging without requiring tedious repositioning of the receiver device for achieving coil alignment. For example, a POSITA also would have understood that implementing a magnetic alignment mechanism (as suggested by Partovi) would have advantageously biased the receiver device into an optimal charging position (e.g., by using a magnetic field to "snap" the device toward the aligned position).

108. Third, a POSITA also would have been motivated to implement the Baarman392-Partovi combination because, in addition or alternative to Partovi's magnetic alignment mechanism (described above), Partovi's suggestion for

providing further confirmation in the form of surface dimples/protrusions, audible alignment indications, and/or visual alignment indications would have been particularly beneficial for elderly users or users with hearing or visual impairments.

109. Based upon my knowledge and experience in this field and my review of the relatively straightforward and predictable structures in Baarman392 and Partovi, it is clear that a POSITA would have possessed the level of skill necessary to implement this combination and would have had a reasonable expectation of success implementing the combination, especially given the overlapping technologies of Baarman392 and Partovi. Indeed, both Baarman392 and Partovi are directed to similar wireless charger technologies. *Supra*, Sections IX.A, X.A.

D. Application of the Predictable Baarman392-Partovi Combination

Claim 1

Element [1.P]: An inductive power outlet operable to transfer power to an inductive power receiver, said inductive power outlet comprising

110. The Baarman392-Partovi combination provides Element [1.P]. For example, Baarman392 discloses an inductive charging system 4 that transfers power from an inductive battery charger (**inductive power outlet**) incorporating a charger circuit 6 to a portable electronic device (**inductive power receiver**) incorporating a secondary circuit 8. EX1008, [0032], [0047] *see also* Abstract, [0004], [0007], [0008], [0023], [0031], FIGS. 2, 4A-4B.

Element [1.1]: a platform for supporting said inductive power receiver

111. The Baarman392-Partovi combination provides Element [1.1]. For example, Baarman392 discloses “the secondary circuit may be incorporated into the portable electronic device so that the device can be placed in close proximity to the charger circuit for charging, thereby eliminating the need to plug the device into a charger.” EX1008, [0023], *see also* [0047] (“the user may place the device in the charger before the battery is full discharged”), *supra* Element [1.P]. A POSITA would have understood the teachings of Baarman392 to mean that the inductive charging device includes a platform where the user “place[s]” the device “in close proximity to the charging circuit.” At the very least, it would have been obvious to implement Baarman392’s charger to include a platform for supporting the portable electronic device (**inductive power receiver**) to ensure the portable device could be properly placed on the charger in close proximity to the charging circuit in furtherance of Baarman’s goal, thereby improving alignment between the primary and secondary coils and improving power transfer efficiency. Indeed, Partovi confirms that inductive charging devices like those disclosed in Baarman392 conventionally included such platforms long before the Critical Date of the ’696 patent. EX1007, [0052] (stating “[i]n its simplest format, the mobile device charger or power supply preferably has a substantially flat configuration, such as the

configuration of a pad 100, and comprises multiple coils or sets of wires 104.”), [0013], [0015], [0039], [0051], [0097], [0135], FIGS., 1, 3-5, 8, 15-16; *see also* EX1001, 9:9-25, FIG. 1A.

***Element [1.2]: at least one primary inductive coil
embedded in said platform***

112. The Baarman392-Partovi combination provides Element [1.2]. For example, Baarman392 discloses that charger circuit 6 includes “a primary coil 15.” EX1008, [0032]-[0033], [0039] FIG. 2; *supra* Element [1.1]. A POSITA would have understood the teachings of Baarman392 to mean that the primary coil is embedded in a platform of the charger. For example, the POSITA would have recognized that the charging circuit, including the primary coil 15, is embedded in the inductive battery charger. At a minimum, a POSITA would have found it obvious for the primary coil 15 in the Baarman392-Partovi combination to be embedded in a platform that incorporates the charger circuit 6 for each of the reasons addressed above in the analysis of Element [1.1]. *Supra*, Element [1.1]; EX1007, [0052] (stating “[i]n its simplest format, the mobile device charger or power supply preferably has a substantially flat configuration, such as the configuration of a pad 100, and comprises multiple coils or sets of wires 104.”), [0013], [0015], [0039], [0051], [0097], [0135], FIGS., 1, 3-5, 8, 15-16; *cf.* EX1001, 9:9-25, FIG. 1A. Additionally, a POSITA would have embedded the primary coil 15 in a platform as

suggested by Partovi to protect the primary coil and other electronics of the charger circuit 6 from the environment while providing a surface to support the inductive power receiver including secondary circuit 8.

Element [1.3]: an alignment mechanism configured to facilitate alignment between said primary inductive outlet and said inductive power receiver

113. The Baarman392-Partovi combination provides Element [1.3]. For example, as discussed above, even if Baarman392 does not expressly discuss the use of a conventional “alignment mechanism,” such a feature was commonly implemented in similar wireless charging systems before the Critical to achieve several known benefits, as demonstrated by Partovi. *Above*, Section X.C. Partovi shows in Fig. 12 that, even if the coils are separated only by a thin gap vertically, a lateral misalignment can significantly decrease power transmission. A POSITA would have been motivated to implement an alignment mechanism as suggested by Partovi (e.g., a magnetic alignment mechanism, an audible alignment mechanism, a visual alignment mechanism, mechanical means (dimples, protrusions, etc.), or a combination thereof) in the Baarman392’s charger so that the Baarman392’s charger circuit 6 having the primary coil and Baarman392’s secondary circuit 86 having a secondary coil would be aligned for “optimum” power transfer and to achieve the further advantages articulated above. EX1007, [0082]-[0087], [0090]-[0091],

[0096], [0135]; *supra*, Section X.C.

***Element [1.4]: such that an inductive couple is formed
 between said primary inductive coil and a
 secondary inductive coil of said inductive
 power receiver, said inductive couple
 having a characteristic resonant frequency***

114. The Baarman392-Partovi combination provides Element [1.4]. For example, Baarman392 discloses that secondary circuit 8 includes a secondary coil 30 (**secondary inductive coil**) that forms an inductive couple with the primary coil 15 in the charger circuit 6. EX1008, FIG. 2, [0038]. In particular, “the primary coil 15 and the secondary coil 30 are loosely coupled” to provide a power transfer curve like that shown in FIG. 3 (reproduced below). EX1008, [0038], FIG. 3. As FIG. 3 shows, the inductive coupling of the primary and secondary coils in Baarman392’s system yields a characteristic resonant frequency where the power transfer efficiency is greatest. EX1008, [0038] (“the power transfer is highest when the inverter 10 is operating at resonance”).

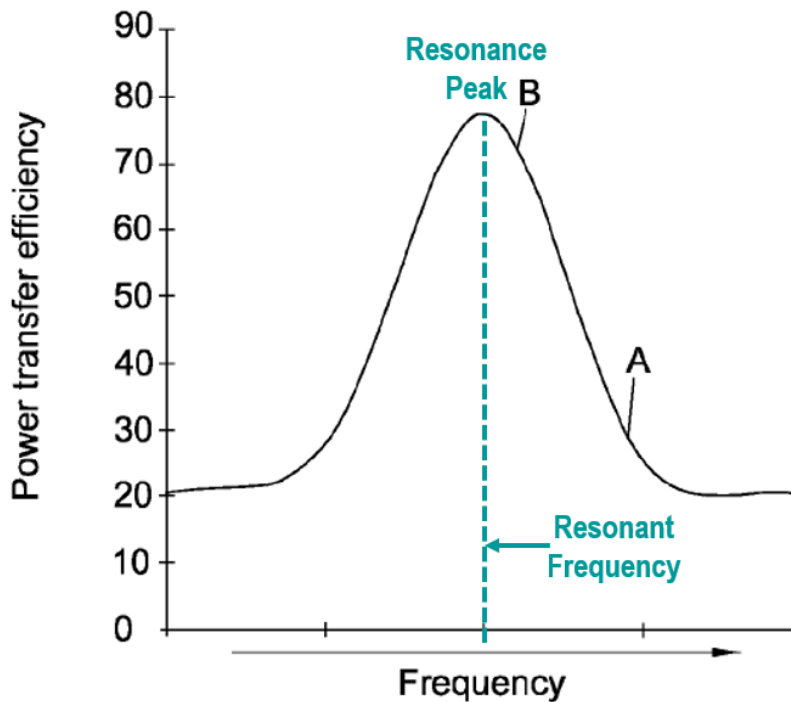


FIG. 3

EX1008, FIG. 3 (annotated).

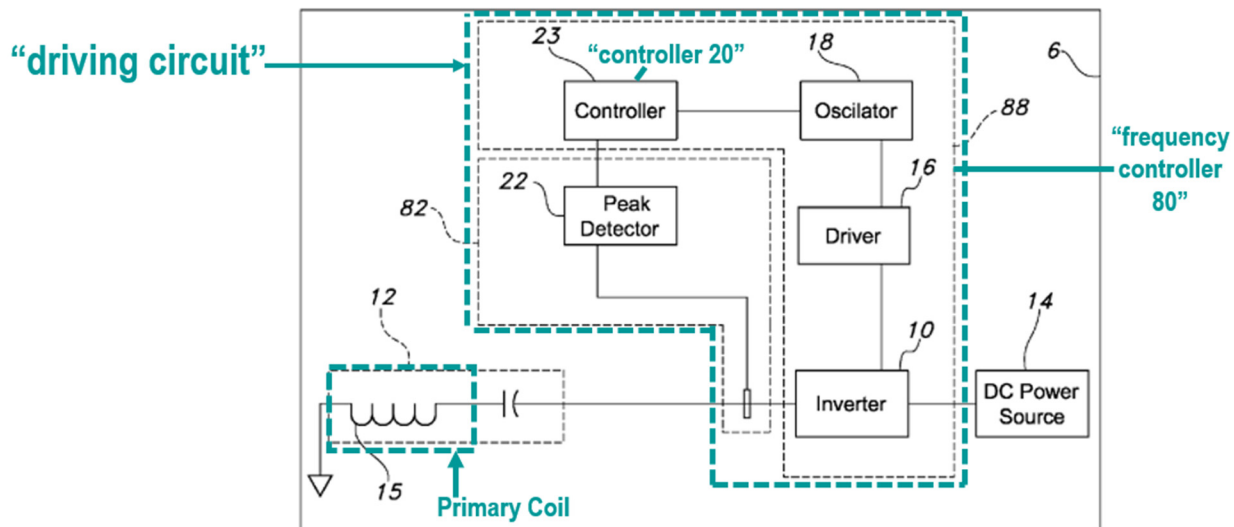
Element [1.5]: a driving circuit wired to said primary inductive coil

115. The Baarman392-Partovi combination provides Element [1.5]. For example, Baarman392 discloses a frequency controller 80 (including inverter 10, driver 16, oscillator 18, and controller 20)—which together with peak detector 22 provides the recited “**driving circuit**”—that is wired to the primary inductive coil 15 via the inverter 10. EX1008, [0032]-[0039], [0048]-[0058], FIG. 2; *see also id.*, FIGS. 4A-4B.

116. Dependent claim 7 clarifies that the scope of the claimed “driving

circuit” is not restricted solely to the circuit component that directly supplies a drive voltage to the primary inductive coil; rather, it also includes, for example, a “voltage monitor” for monitoring a voltage of the primary coil. EX1001, Cl. 7. In this context, Baarman392 addresses the claimed “driving circuit” as including the peak detector 22 in connection with the components of the frequency controller 80 including inverter 10, the driver 16, oscillator 18, and controller 20.

117. The inverter 10 (component of the “**driving circuit**”) “provides AC (alternating current power to the tank circuit 12 from a source of DC (direct current) power 14.” EX1008, [0033]. “The tank circuit 12 may be either a series resonant tank circuit or a parallel resonant tank circuit.” *Id.* “[T]he driver 16 provides the signals necessary to operate the switches within the inverter 10,” and “[t]he driver 16 in turn operates at a frequency set by the oscillator 18.” *Id.*; *see also id.*, [0038], [0049], [0061], FIGS. 2, 4A-4B. Baarman392 thus discloses how components of frequency controller 80 including inverter 10 in connection with driver 16 provide a driving voltage across the primary inductive coil 15, whether in series resonant or parallel resonant tank circuit configuration.



EX1008, FIG. 2 (cropped, annotated); EX1008, [0033].

Element [1.6]: *said driving circuit comprising a switching unit configured and operable to provide an oscillating driving voltage across said primary inductive coil such that a secondary voltage is induced in the secondary inductive coil*

118. The Baarman392-Partovi combination provides Element [1.6]. For example, Baarman392 discloses “an inverter 10” (**switching unit**) that, as part of the frequency controller 80 (a component of the claimed **driving circuit**), is configured and operable to “drive a tank circuit 12” including primary coil 15. EX1008, [0033]; *above*, Element [1.5]. “The tank circuit 12 may be either a series resonant tank circuit or a parallel resonant tank circuit.” EX1008, [0033]. “[T]he driver 16 provides the signals necessary to operate the switches within the inverter 10,” and “[t]he driver 16 in turn operates at a frequency set by the oscillator 18.” *Id.*; *see also*

id., [0038], [0049], [0061], FIGS. 2, 4A-4B. Baarman392 thus discloses how the inverter 10 provides an oscillating driving voltage across the primary inductive coil 15, whether in series resonant or parallel resonant tank circuit configuration, such that a secondary voltage is induced in the secondary inductive coil 30. EX1008,[0032], [0033], [0035], [0038], [0049], [0061].

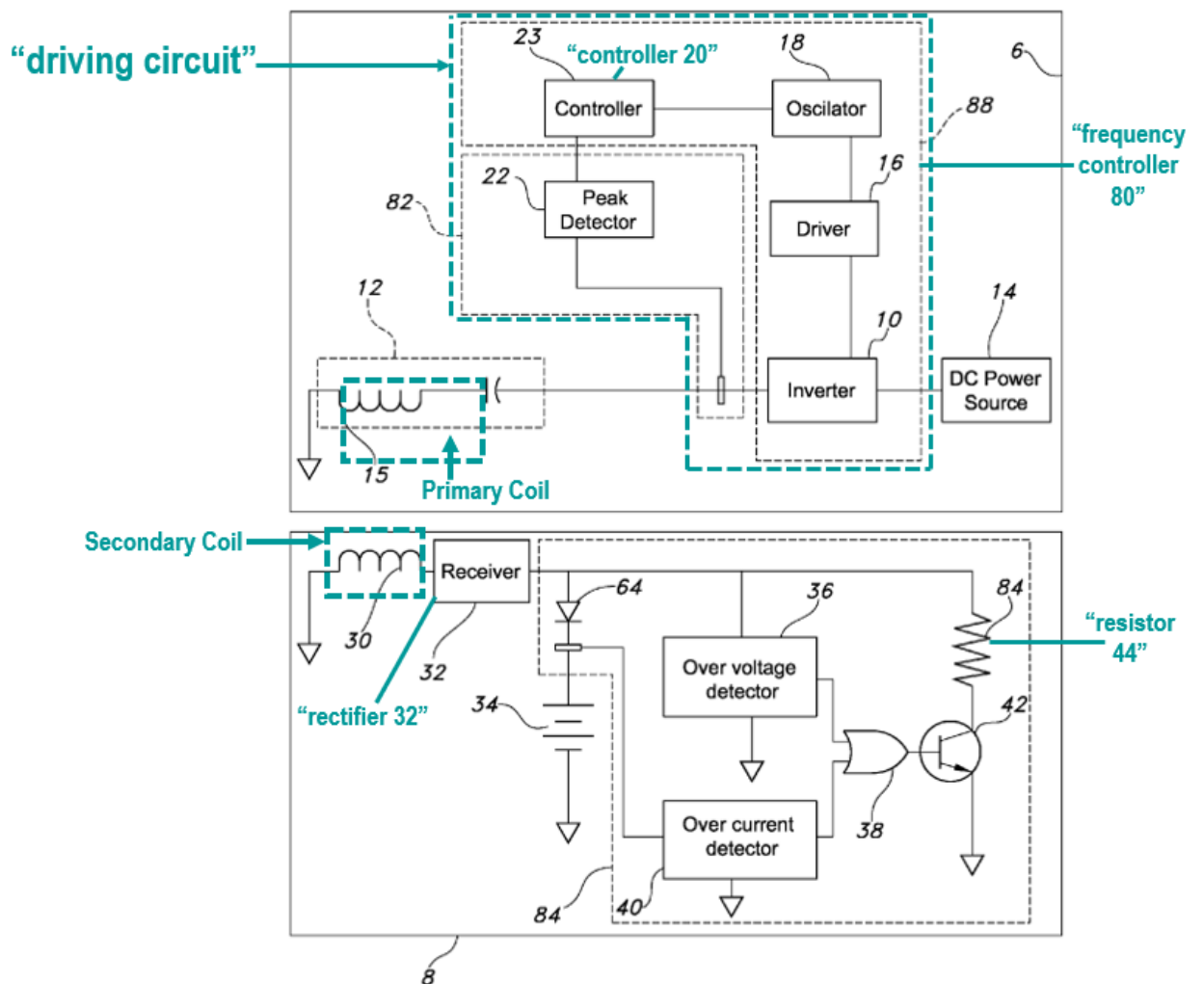


FIG. 2

EX1008, FIG. 2 (annotated).

Element [1.7]: wherein said driving circuit is configured and operable to produce said oscillating driving voltage at a transmission frequency substantially different from said characteristic resonant frequency of said inductive couple

119. The Baarman392-Partovi combination provides Element [1.7]. For example, Baarman392 discloses that “even if the inverter 10 is not operating at resonance, significant power transfer can occur when the inverter is operating off-resonance.” EX1006, [0038]. With reference to FIG. 3, Baarman392 explains that “[g]enerally, the inverter 10 is operated between frequency A and frequency B.” *Id.*

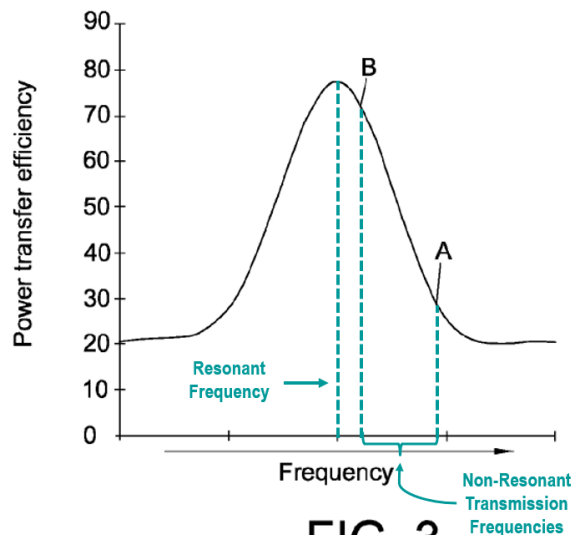


FIG. 3

EX1006, FIG. 3 (annotated).

120. Baarman392 further teaches that “[b]etween frequency A and frequency B, the power transfer curve can be piece-wise linearized by a software lookup table located in the controller 20” such that “a decrease in the operating

frequency of the inverter 10 will result in a generally predictable increase in the power transferred from the primary coil 15 to the secondary coil 30.” EX1006, [0038]; *see also id.*, [0015]-[0019], [0055]-[0057], FIG. 7. As shown here, Baarman392’s inverter 10 (in connection with driver 16) —i.e., components of the claimed **driving circuit**—produces a driving voltage at a non-resonant transmission frequency within a near-linear region of the power transfer curve. Consistent with the specification and file history of the ’696 patent, Baarman392’s operating frequencies (e.g., between frequencies A and B) fall within the scope of being “substantially different” from the characteristic resonant frequency of the inductive couple. *Above*, Section VII. Indeed, the strikingly similar positions of Baarman392’s transmission frequencies between A and B in the frequency-response curve as the transmission frequency (e.g., f_t in FIG. 6B) identified as “substantially different” in the ’696 specification confirms that Baarman392 discloses and renders obvious a transmission frequency that is “substantially different” from the characteristic resonant frequency regardless of the outermost scope of this claim term. EX1001, 21:16-23, 21:56-65, FIG. 6b.

Claim 3

Element [3]: The inductive power outlet of claim 1 said driver being configured to adjust said transmission frequency in response to feedback signals

121. The Baarman392-Partovi combination provides Element [3]. For example, Baarman392 discloses that controller 20 frequency controller 80 (i.e., a component of the claimed driver)—which together with peak detector 22 (another of the driver)—periodically increases or decreases the non-resonant transmission frequency by an incremental value depending on whether feedback is received indicating an abnormal charging condition associated with battery 34. EX1008, [0033], [0034] (“the controller 20 uses signals from the peak detector 22 to assist in determining the frequency of operation”), [0037] (“The controller 20 then changes the frequency of the oscillator 18.”), [0038], [0055]-[0059], FIGS. 3, 7.

Claim 4

*Element [4]: The inductive power outlet of claim 3
 wherein said feedback signals carry data
 pertaining to the operational parameters of
 said electric load*

122. The Baarman392-Partovi combination provides Element [4]. For example, Baarman392 describes how secondary circuit 8 communicates feedback signals to the charger circuit 6 in response to an over-voltage or over-current situation detected in connection with battery 34 (**electric load**). EX1006, [0013]-[0014], [0035]-[0036], [0046], FIGS. 2, 5, 7; *supra*, Claim 3. These feedback signals carry data pertaining to a measured operating voltage and measured operating current (**operational parameters**) of battery 34 (**electric load**). EX1006, [0041]

(“the over-voltage detector 36 or the over-current detector 40 determines that too much voltage or too much current is applied to the battery 34[] ...”), [0039]-[0046], [0013], [0023]-[0025], FIGS. 2, 4. Voltage and current are also components of electric power and Baarman392’s detected voltages and currents therefore also provide a measured operating power for the battery 34.

Claim 5

Element [5]: The inductive power outlet of claim 4 wherein said operational parameters are selected from the group consisting of: required operating voltage for said electric load; required operating current for said electric load; required operating temperature for said electric load; required operating power for said electric load; measured operating voltage for said electric load; measured operating current for said electric load; measured operating temperature for said electric load; measured operating power for said electric load; power delivered to said primary inductive coil; power received by said secondary inductive coil, and a user identification code

123. The Baarman392-Partovi combination provides Element [5] for each of the reasons addressed above with respect to Element [4].

Claim 7

***Element [7]: The inductive power outlet of claim 1
wherein said driver further comprises a
voltage monitor for monitoring the
amplitude of a primary voltage across said
primary coil.***

124. The Baarman392-Partovi combination provides Element [7]. As I have explained below (Ground 2B, Claim 6) the current through Baarman392's primary coil (Fig. 4B, inductor 15) is converted to a voltage and smoothed by circuit elements 52, 54, and R9.

125. Baarman392 discloses that peak detector 22 (a component of the claimed **driver** and/or **driving circuit** (*see above*, Ground 2A, Element [1.5]) implements voltage amplitude detection and voltage peak detection for reasons described in further detail below and in the analysis of claim 6 in Ground 2B. *Infra*, Ground 2B, Claim 6.

126. To elaborate on Baarman392, information from the secondary circuit 8 to be measured by controller 20 takes two paths: (1) a path that generates a digital pulse when the secondary circuit 8 flags a fault condition, and (2) a path that provides an analog signal related to power transfer from the primary circuit 6 to the secondary circuit 8. (Figs 2, 4A, 4B). Each path provides a voltage monitor for monitoring the amplitude of a primary voltage across the primary coil, as recited in claim 7.

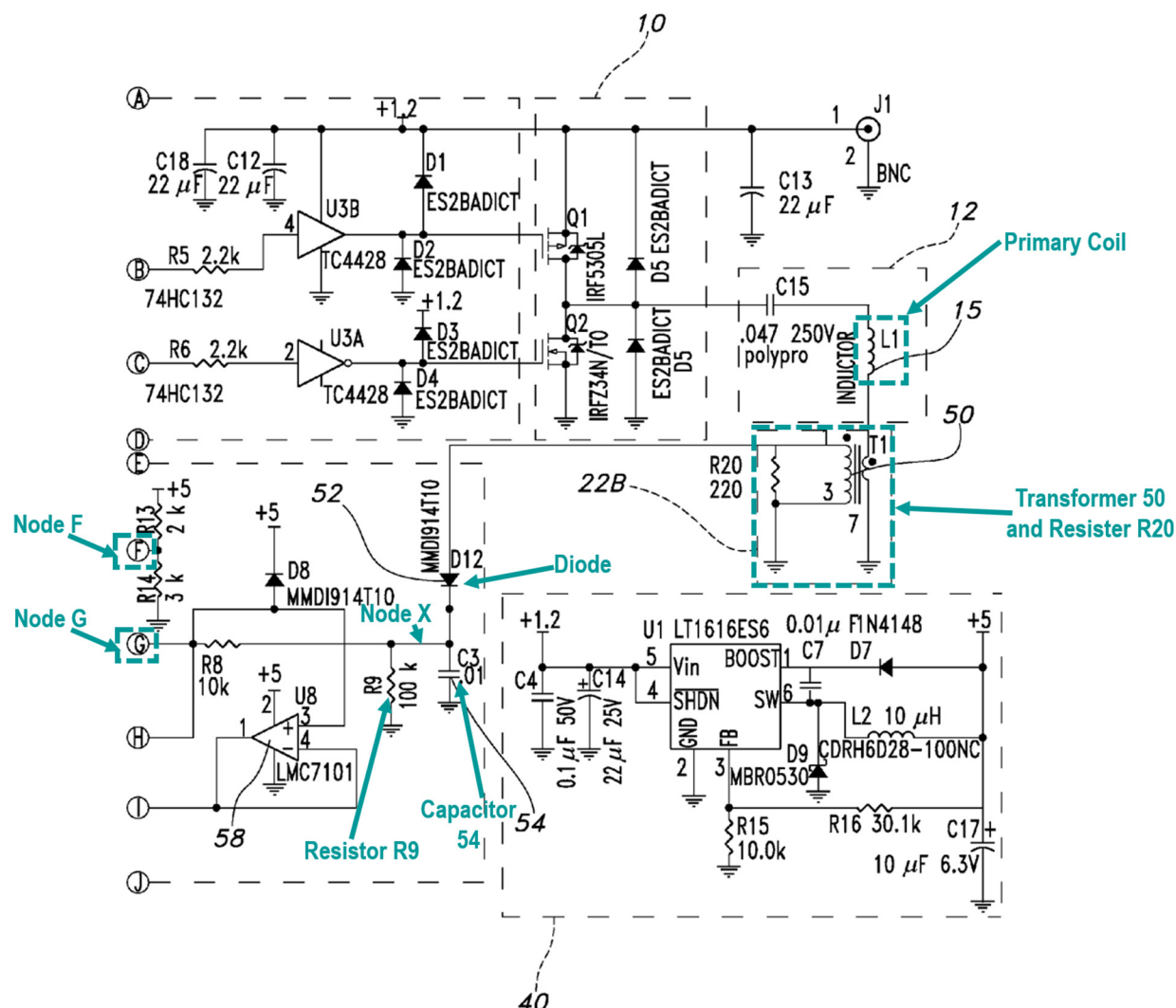
127. In path (2), normal operation includes power transfer from inductor 15

on the primary side to inductor 30 on the secondary side. This power transfer causes loading of the primary inductor 15 to occur which can be sensed by the circuits on the primary side. EX1006, [0038] (“However, even if the inverter 10 is not operating at resonance, significant power transfer can occur when the inverter is operating off-resonance. Generally, the inverter 10 is operated between frequency A and frequency B. Frequency B is somewhat less than the resonant frequency. Between frequency A and frequency B, the power transfer curve can be piece-wise linearized by a software lookup table located in the controller 20.”)

128. This loading will manifest as a change in effective impedance of the inductor compared to the case when no loading occurs, and the loading can be sensed as a change in the amplitude or phase of the voltage or current in inductor 15. As a POSITA would know, the amplitude and phase of a circuit such as a loaded inductor can be found by dividing the voltage amplitude and phase across the loaded inductor by the impedance of the loaded inductor. Likewise, if one knows the current amplitude and phase one can obtain the voltage amplitude and phase by multiplying the current amplitude and phase by the impedance of the loaded inductor. The current and voltage waveforms under these normal operating conditions are not independent, but are simply related through the impedance.

129. A change in voltage or current in inductor 15 is sensed by the combination of transformer 50 and resistor R20, which together behave as a low-

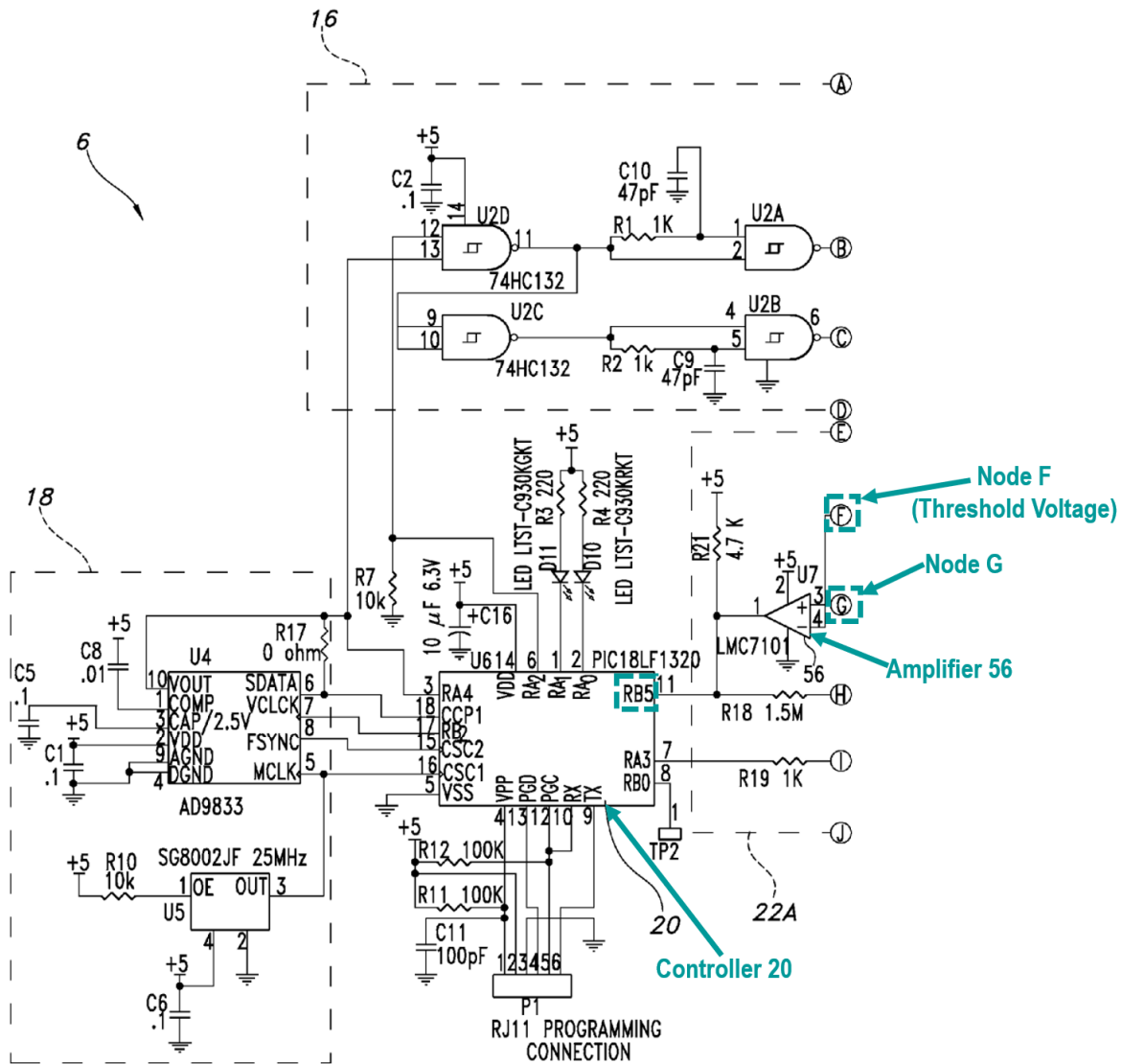
value resistor in series with inductor 15. By Ohm's law, the oscillating current in inductor 15 thus generates an oscillating voltage in the primary (right-hand side in Fig. 4B) of transformer 50 that is directly proportional to the oscillating current in inductor 15. The oscillating voltage in the primary of transformer 50 induces an oscillating voltage in the secondary of transformer 50. This voltage in the secondary of transformer 50 is thus proportional to the current in inductor 15. Diode 52 then rectifies the oscillating voltage in the secondary of transformer 50 in order to generate a pulsing and positive voltage signal at the node connected to capacitor 54 and resistor R9 (which I have labeled as node X in annotated Fig. 4B).



EX1006, FIG. 4B (annotated).

130. As would be well-understood by a POSITA, capacitor 54 and resistor R9 together form a low-pass filter, smoothing the high-frequency pulses on a time scale that is longer than the period of oscillation of the signal generated by driver 16 (Fig. 2, 4A). In the embodiment shown in Baarman392, this time scale is on the order of a millisecond (based on the values of R9 and capacitor 54 in Fig. 4B). Thus the voltage at node X is a smoothed version of the amplitude of the oscillating voltage

in the secondary of transformer 50. The voltage at node X is effectively equal to the voltage at node G (the 10k resistor between them serving as a current-limiting function to protect the amplifiers downstream.). Thus, the voltage at node G is effectively proportional to the amplitude of the current and voltage in inductor 15. In path (2), the voltage at node G is buffered by unity-gain amplifier 48 and then recorded by port RA3 on controller 20. Thus, controller 20 can continuously monitor the voltage across inductor 15.



EX1006, FIG. 4A (annotated). Baarman392 also contemplates the disclosed peak detector 22 as monitoring “other characteristics of the power in the charger circuit 6 may be evaluated to provide charge information regarding the battery.” EX1008, [0034]. In view of this disclosure, the use of a voltage monitor for monitoring a voltage across primary coil 15 would have been obvious to a POSITA—especially since each would be effective to detect feedback when current is surged through

secondary coil 30 to indicate a battery over-current or over-voltage situation. Moreover, voltage and current monitors were commonly implemented before the Critical Date and different types of monitoring circuits were commonly substituted and achieved predictable results while meeting the needs/constraints of a given design. A POSITA would have sought to use a different voltage monitoring circuit with less expensive components than Baarman392's current peak detector 22 in several designs.

Claim 9

Element [9]: The inductive power outlet of claim 1 comprising a power converter selected from the group comprising: a transformer, a DC-to-DC converter, an AC-to-DC converter, an AC-to-AC converter, a flyback transformer, a flyback converter, a full-bridge converter, a half-bridge converter and a forward converter

131. The Baarman392-Partovi combination provides Element [9]. For example, Baarman392 discloses that the peak detector 22 of charger circuit 6 includes a power converter including a “transformer 50.” EX1008, [0039], FIGS. 4A-4B. Every transformer necessarily conveys power from the primary to the secondary (or vice-versa) even if the transformer's function is to transfer a signal. Transformer 50 converts power from the primary coil 15 to a level suitable for use by other components of the peak detector 22 and the controller 20. EX1008, [0039]

(“The peak detector 22 (comprised of 22A and 22B) is connected in series with the primary coil 15 and provides a signal by way of the transformer 50 that is proportional to the current through the primary coil 15.”).

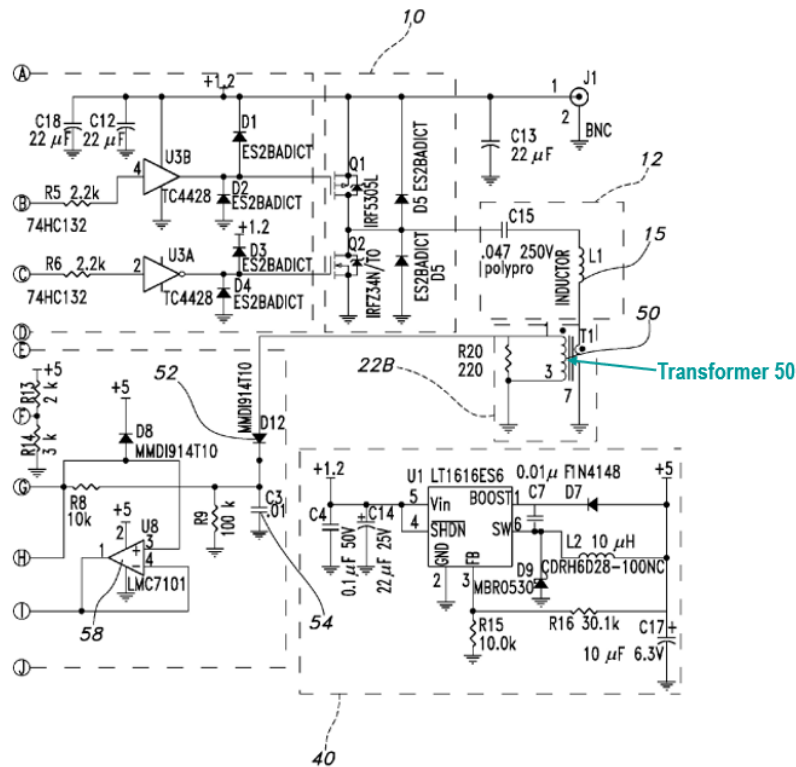


FIG. 4B

EX. 1008, FIG. 4B (annotated).

132. Barman392 also discloses a DC power source in Fig. 2 as Element 14. EX1008, [0033], FIG. 2. A POSITA would have known and it would have been obvious that this DC power source would include an AC-to-DC converter when connected to a wall power outlet that provides AC power. Indeed, it would have been obvious to include such an AC-to-DC converter in the DC power source 14 to

achieve Baarman392's objective of supplying DC power to the charger circuit 6 even when the DC power source 14 is itself powered by an AC source. Likewise, a POSITA would have known and it would have been obvious that this DC power source would include a DC-to-DC converter when connected to a supply of DC power.

Claim 10

*Element [10]: The inductive power outlet of claim 1
incorporated into at least one application
selected from a group consisting of:
inductive chargers, inductive power
adaptors, power tools, kitchen appliances,
bathroom appliances, computers, media
players, office equipment, implanted
devices, pace makers, trackers and RFID
tags*

133. The Baarman392-Partovi combination provides Element [10]. For example, Baarman392 discloses that the inductive power outlet analyzed in claim 1 (above) is a charger used to inductively recharge “portable electronic devices,” and thus is incorporated into an **inductive charger**. EX1007, [0010]-[0011] (“An inductive system for recharging a battery”), [0023]. Baarman392 describes the system as being “well-suited for use in charging portable electronic devices, such as cell phones, personal digital assistants, handheld gaming devices, personal media players and other similar devices.” EX1007, [0023], [0047], Cl. 18-20.

Claim 11

*Element [11]: The inductive power outlet of claim 1
 wherein said alignment mechanism
 comprises a first magnetic element
 configured to engage a second magnetic
 element associated with the power receiver*

134. The Baarman392-Partovi combination provides Element [11]. For example, Partovi teaches and the combination provides a magnetic alignment mechanism in which “the center of the primary in the charger contains a magnet” (**a first magnetic element**) that “attracts and pulls” a magnet contained within a receiver (**a second magnetic element associated with the power receiver**). EX1007, [0042], [0082], [0087], [0096], [0135], [0139]; *above*, Section X.C.

Claim 12

*Element [12]: The inductive power outlet of claim 1
 wherein said alignment mechanism
 comprises an audible indication*

135. The Baarman392-Partovi combination provides Element [12]. For example, Partovi teaches and the combination provides an alignment mechanism that includes an **audible indication**. EX1007, [0082], [0090], [0096] (“audio signals or messages to help guide the user”); *above*, Section X.C.

Claim 13

*Element [13]: The inductive power outlet of claim 1
 wherein said alignment mechanism
 comprises a visual indication*

136. The Baarman392-Partovi combination provides Element [13]. For

example, Partovi teaches and the combination provides an alignment mechanism that includes a **visual indication**. EX1007, [0079] (“LEDs to show ...”), [0082] (“visual signs”), [0090] (“LEDs[] ... that indicate”), [0096] (“lights, LEDs, displays ... to help guide the user”); above, Section X.C.

Claim 14

*Element [14]: The inductive power outlet of claim 1
 wherein said alignment mechanism
 comprises a tactile indication*

137. The Baarman392-Partovi combination provides Element [14]. For example, Partovi teaches and the combination provides an alignment mechanism that includes “mechanical means (dimples, protrusions, etc.)” exposed/touchable along the surface (**tactile indication**) to be “used for alignment,” which would have been particularly useful, for example, for users with visual impairments. EX1007, [0082]; *above* Section X.C.

XI. ANALYSIS – OBVIOUSNESS BASED ON BAARMAN392, PARTOVI, AND TOCCI (GROUND 2B)

A. Tocci (EX1009)

138. Tocci is a textbook that covered basic principles of digital systems before the earliest possible priority date of the ’696 patent. *See* EX1009. Based on my experience, the topics covered in Tocci correspond to topics that would commonly be covered in an undergraduate course in digital systems design or analysis. Among other things, Tocci introduces the conventional concept of Boolean

variables and their beneficial uses in digital logic circuits. EX1009, 57; *generally id.*, 208-219.

B. Predictable Combination of Baarman392, Partovi, and Tocci

139. The Baarman392-Partovi combination provides a charger circuit 6 that, consistent with the teachings of Baarman392, adjust its transmission frequency depending on whether it detects feedback from the secondary circuit 8 indicating the occurrence of an abnormal charging condition (e.g., a battery over-voltage or over-current condition). EX1008, [0019], [0055]-[0061], FIG. 7; *above*, Section X.C. For example, when the charger circuit 6 detects feedback indicating an abnormal charging condition, it decreases the power transmitted to the secondary circuit 8 by moving the transmission frequency further from resonance. EX1008, [0019], [0055]-[0061]. When the charger circuit 6 has not detected the particular type of feedback indicating an abnormal charging condition, it incrementally increases the power transmitted to the secondary circuit 8 by adjusting the transmission frequency closer to resonance. *Id.*

140. Although Baarman392's description frames its charger circuit 6 as either receiving feedback indicating an abnormal charging condition or not receiving such feedback, Baarman392 does not expressly describe the underlying logic/form of such feedback. A POSITA, however, would have immediately recognized

conventional techniques for expressing binary conditions like binary feedback options disclosed in Baarman392 (whether the battery charging status is normal or abnormal). For example, Tocci teaches the then-popular and well-established concept of expressing binary conditions as Boolean variables. EX1009, 57. Much like Baarman392's teaching for binary options for the charging condition feedback, Tocci explains that a Boolean variable has two "states" or "logic levels," as illustrated by Table 3-1:

Logic 0	Logic 1
False	True
Off	On
Low	High
No	Yes
Open switch	Closed switch

EX1009, 57.

141. Based on my review, there are multiple reasons that would have motivated a POSITA to implement Baarman392-Partovi's charging condition feedback using conventional Boolean variables as suggested by Tocci. In the resulting Baarman392-Partovi-Tocci combination, the secondary circuit 8 would predictably provide feedback regarding the battery 34's charging status—i.e., whether charging is normal (no over-voltage or over-current condition detected) or abnormal (over-voltage or over-current condition detected)—according to the logic

levels defined by a conventional Boolean variable. *Id.* In one predictable example, a LOW logic level feedback signal would represent a normal charging condition while a HIGH logic level feedback signal would represent an abnormal charging condition. *Id.*

142. This example is supported by the fact that Tocci further explains that the logic levels of a Boolean variable can correspond to different electrical variables (e.g., different voltage levels). EX1009, 57. Considering these teachings, in the context of Baarman392, it would have been obvious, for example, for a LOW logic level feedback to be communicated to the charger circuit 6 by inducing or maintaining a current in the primary coil at a first level (or range), and for the HIGH logic level feedback to be communicated to the charger circuit 6 by inducing a current in the primary coil at a second level (or range). Predictable current or voltage ranges for Baarman392's system would have been ordinarily selected to correspond to the LOW and HIGH logic levels, although no changes would necessarily be required to the configuration of the circuits disclosed in Baarman392 because the LOW logic level would predictably correspond to the primary coil currents when no over-current or over-voltage condition is detected at the battery and the HIGH logic level would predictably correspond to the primary coil currents when these currents are detected.

143. First, a POSITA would have been motivated to implement

Baarman392-Partovi's charging condition feedback using a conventional Boolean variable because Tocci expressly suggests that it would advantageously enable "relatively easy" Boolean algebra to be performed with the detected logic levels (e.g., at Baarman392's feedback detector 82). EX1009, 57.

144. Second, a POSITA would have been motivated to implement Baarman392-Partovi's charging condition feedback using a conventional Boolean variable (as suggested by Tocci) so as to advantageously align Baarman392-Partovi's system with traditional digital logic circuits ordinarily used to construct such charger devices. Boolean variables had been used in digital logic circuits for decades before the '696 patent.

145. Third, a POSITA would have been motivated to implement Baarman392-Partovi's charging condition feedback using a conventional Boolean variable (as suggested by Tocci) because assigning disparate ranges of primary coil currents to the respective logic levels of Baarman392-Partovi's charging condition feedback would have reduced noise and ensured that different charging conditions could be readily discerned by the charger circuit 6 based on the different ranges of primary coil currents.

146. Moreover, considering the traditional conventional "textbook" nature of Boolean variables suggested by Tocci's textbook and Baarman392-Partovi's original solution for detecting the binary charging feedback conditions provided in

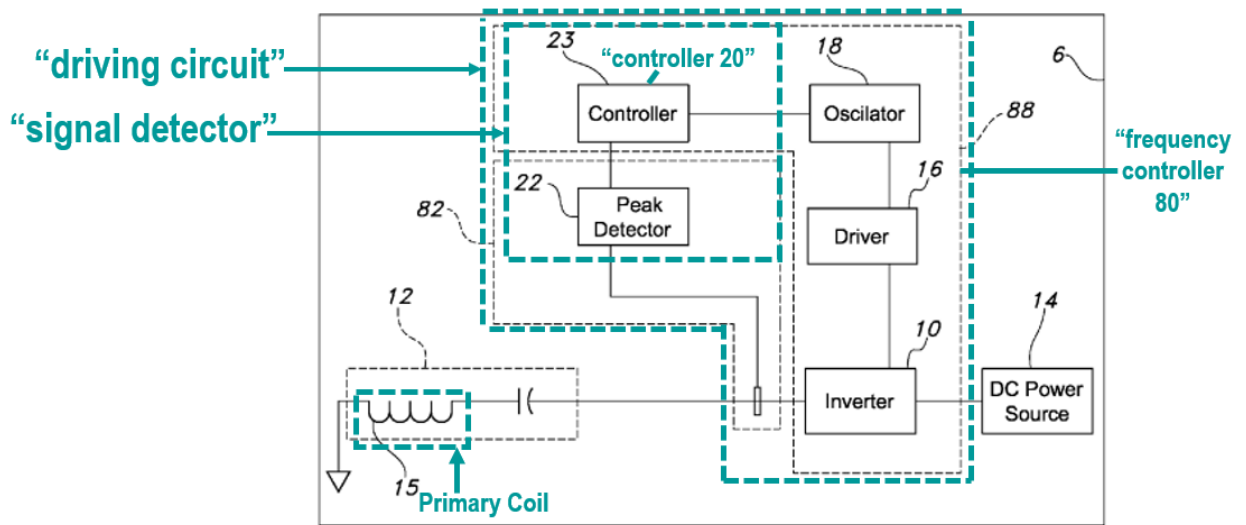
Baarman392-Partovi's original solution, the level of predictably at the time was high. A POSITA would have had a reasonable expectation of success implementing the Baarman392-Partovi's-Tocci combination as described.

C. Application of the Predictable Baarman392-Partovi-Tocci Combination

Claim 2

Element [2.P]: The inductive power outlet of claim 1 said inductive power outlet comprising a signal detector adapted to detect a first signal and a second signal, and said driver is configured to

147. The Baarman392-Partovi-Tocci combination provides Element [2.1]. For example, Baarman392 discloses that its peak detector 22 and a controller 20 of the charger circuit 6 (**inductive power outlet**) collectively operate to provide a "**signal detector**" adapted to detect feedback from the secondary circuit 8 indicative of an abnormal charging condition (e.g., a battery over-voltage or over-current state). EX1008, [0034]-[0037], [0039], [0045]-[0046], FIGS. 2, 4A-4B, 5.



EX1008, FIG. 2 (annotated).

148. When “the output of the over-voltage detector 36 or the output of the over-current detector 40 indicate an over-voltage or an over-current situation” associated with the battery 34, a switch 34 is turned on at the secondary circuit 8 that causes a surge of current through secondary coil 30 and a corresponding surge through the primary coil 15 (due to inductive coupling). EX1008, [0036]-[0037]. “The current surge [through the primary coil 15] is detected by the peak detector 22,” and the “controller 20 uses signals from the peak detector 22 to assist in determining the frequency of operation for the oscillator 18, and thereby the frequency of the inverter 10.” EX1008, [0037], [0034], FIG. 6; *see also id.*, [0045] (describing how “[t]he controller 20 continuously samples the output of the peak detector 22” and uses flags and latches to detect and record feedback indicated by the peak detector), [0057] (“checks for the occurrence of a feedback signal”), FIG.

7 (S114).

149. To the extent Baarman392 does not *expressly* disclose that its signal detector (e.g., peak detector 22 in connection with controller 20) is adapted to detect first and second signals as claimed, these features were nonetheless predictable and would have been obvious based on the Baarman392-Partovi-Tocci combination. *Above*, Section XI.B. For the multiple reasons articulated above, a POSITA would have been motivated to implement Baarman392's charging condition feedback as a conventional Boolean variable (as suggested by Tocci) to achieve known benefits. EX1009, 57. Therefore, in the predictable combination, an abnormal charging condition indicative of a battery over-current or over-voltage situation would have been represented by a first Boolean logic signal (**first signal**) such as HIGH, while a normal charging condition would have been represented by a second Boolean logic signal (**second signal**) such as LOW. *Above*, Section XI.B; EX1009, 57.

150. Consistent with the teachings of Baarman392, the second Boolean logic signal (**second signal**) would have been provided to the charger circuit 8 by maintaining switch 42 closed and not surging current through secondary coil 30 or primary coil 15. *Above*, Section XI.B. In contrast, the first Boolean logic signal (**first signal**) would have been communicated to the charger circuit 8 by activating switch 42 and inducing a current surge in coils 15 and 30. *Id.* Thus, consistent with Baarman392's ordinary operation for detecting the feedback information,

Baarman392's peak detector 22 and controller 20 (collectively, the **signal detector**) would have detected the second Boolean logic signal corresponding to a normal charging condition when the peak current through the primary coil 15 does not exceed a certain level; likewise Baarman392's peak detector 22 and controller 20 (collectively, the **signal detector**) would have detected the first Boolean logic signal corresponding to an abnormal charging condition when the peak current through the primary coil 15 exceeds a certain level. *Id.*; EX1008, [0020].

151. Based on my review, it would have been clear to a POSITA that the first and second Boolean logic signals provided to the charger circuit 8 in the Baarman392-Partovi-Tocci combination each constitutes a "signal" as that term is used in the '696 patent. The specification of the '696 patent does not expressly define a "signal," but it does describe examples that demonstrate the breadth of this term in the '696 patent. For example, at col. 22:40-44, the specification explains that "a microcontroller in the driver 6230 may use [] feedback parameters to calculate the required transmission frequency and to adjust the driver accordingly" or "[a]lternatively, simple feedback signals may be provided indicating whether more or less power is required." EX1001, 22:40-44. These examples show that a signal can, but need not, carry feedback parameters in the '696 patent. The Baarman392-Partovi-Tocci combination's Boolean logic signals align with the example feedback signals described in the '696 patent, at least because these signals

“indicate whether more or less power is required” by the power reception device 40 in a manner analogous to the “simple feedback signals” disclosed in the ’696 specification.

Element [2.1]: increase said transmission frequency when said first signal is detected by the detector

152. The Baarman392-Partovi-Tocci combination renders obvious Element [2.1]. For example, Baarman392 discloses that the frequency controller 80 (a component of the claimed **driver/driving circuit**) is configured to provide less power by increasing the non-resonant transmission frequency by an incremental amount when a feedback signal is detected that indicates an abnormal charging condition (e.g., an over-current or over-voltage situation). EX1008, [0015] (“the operating frequency of the inverter is increased in order to move the frequency of the power applied to the primary coil away from the resonant frequency”), [0019] (“after a feedback signal is received, incrementally moving the frequency of the power applied to primary close farther from resonance until a feedback signal is no longer received”), [0059] (“If a feedback signal is detected, then the power transfer to the battery 34 should be reduced. The frequency is therefore increased by an amount equal to twice the value of $\Delta FREQ$ ”), [0056] (“ $\Delta FREQ$ could be a constant, or it could be determined by obtaining the value from a lookup table”), [0033], [0038], FIGS. 3, 7.

153. Furthermore, as described above in Element [2.P], the predictable Baarman392-Partovi-Tocci combination would have been implemented so that an abnormal charging condition would be represented by a first Boolean logic signal (**first signal**) such as HIGH. *Above*, Section XI.B; Element [2.P]; EX1007, 57. In this context, Baarman392-Partovi-Tocci's driver would have predictably provided less power by increasing the non-resonant transmission frequency by twice the value of $\Delta FREQ$ when the first Boolean logic signal is detected by the peak detector 22 and controller 20 (collectively, the claimed **signal detector**).

*Element [2.2]: decrease said transmission frequency when
said second signal is detected by the
detector*

154. The Baarman392-Partovi-Tocci combination renders obvious Element [2.2]. For example, Baarman392 discloses that the frequency controller 80 (a component of the claimed **driver/driving circuit**) of the charger circuit 6 is configured to provide more power by decreasing the non-resonant transmission frequency by an incremental value when there is no indication of an abnormal charging condition (e.g., an over-current or over-voltage situation). EX1008, [0015] ("the operating frequency of the inverter is reduced to move the frequency of the power applied to the primary coil closer to the resonant frequency"), [0019] ("the charging step generally includes the steps of incrementally moving the frequency of the power applied to the primary coil closer to resonance until a feedback signal is

received”), [0055] (“The controller 20 then determines whether a feedback signal, discussed previously, has been received. If not, then the frequency is decreased by Δ FREQ. Step 116.”), [0056] (“ Δ FREQ could be a constant, or it could be determined by obtaining the value from a lookup table”), [0033], [0038], FIGS. 3, 7.

155. Further, as described above in Element [2.P], the predictable Baarman392-Tocci combination would have been implemented so that a normal charging condition would be represented by a second Boolean logic signal (**second signal**) such as LOW. *Above*, Section XI.B; Element [2.P]-[2.1]; EX1009, 57. In this context, Baarman392-Partovi-Tocci’s driver would have predictably provided more power by decreasing the non-resonant transmission frequency by Δ FREQ when the second Boolean logic signal is detected by the peak detector 22 and controller 20 (collectively, the claimed **signal detector**).

Claim 6

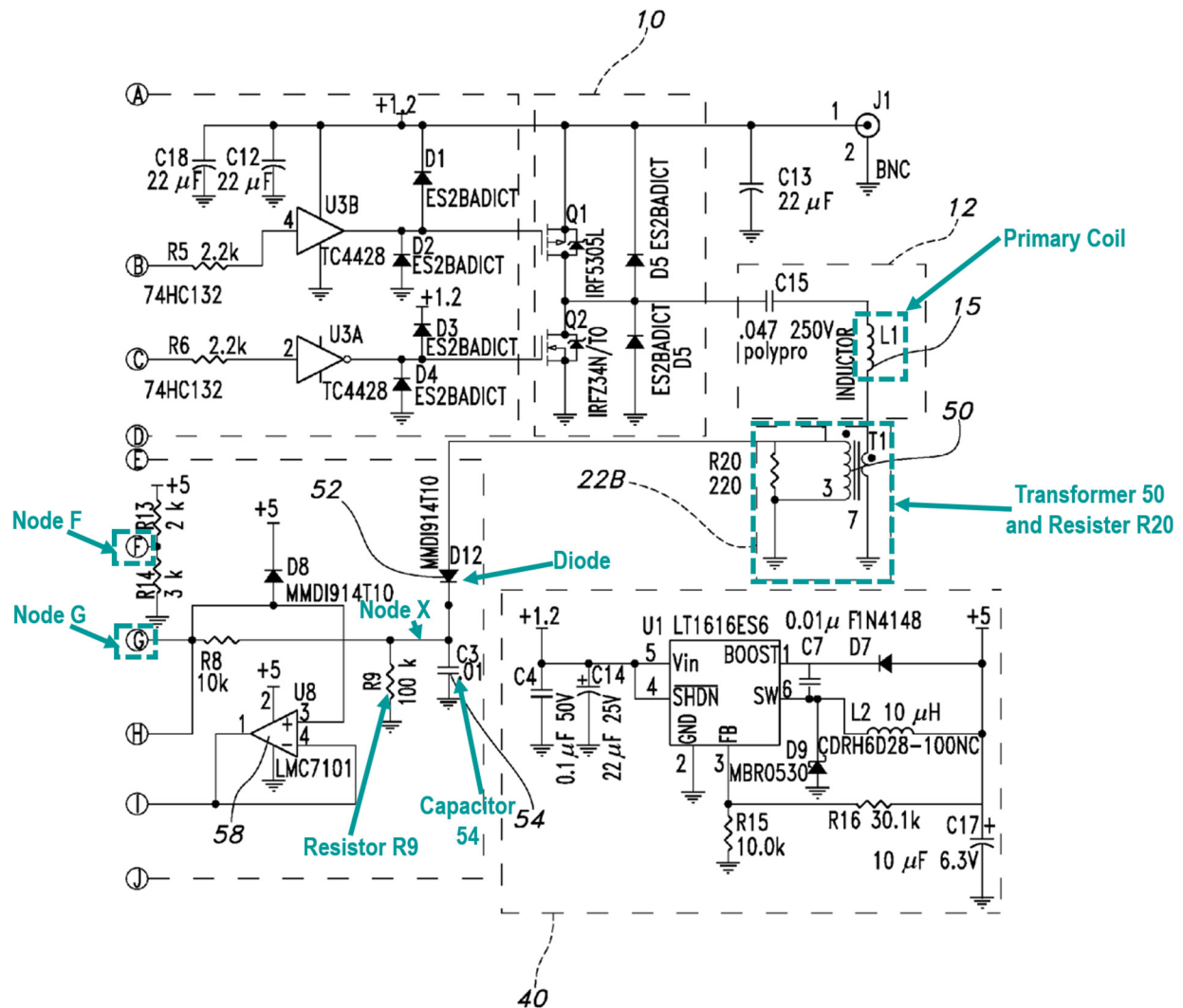
*Element [6]: The inductive power outlet of claim 2
 wherein said detector is selected from the
 list comprising optical detectors, radio
 receivers, audio detectors and voltage peak
 detectors*

156. The Baarman392-Partovi-Tocci combination provides Element [6]. For example, Baarman392 discloses that peak detector 22 (a component of the claimed **signal detector**) “provides a signal by way of the transformer 50 that is proportional to the current through the primary coil 15.” EX1008, [0039], FIGS. 2,

4A-4B. “The signal is rectified by a diode 52 and then used to charge capacitor 54” and “operational amplifiers 56, 58 are used to smooth the signal for sampling by the controller 20.” *Id.*

157. To elaborate on Baarman392, the path for information from the secondary circuit 8 to be measured by controller 20 takes two paths: (1) a path that generates a digital pulse when the secondary circuit 8 flags a fault condition, and (2) a path that provides an analog signal related to power transfer from the primary circuit 6 to the secondary circuit 8. (Figs 2, 4A, 4B). Claim 6 concerns path (1).

158. In path (1), the battery protection circuits will short out the secondary coil 30 via closing transistor switch 42 if a fault condition (over-current or over-voltage to the battery) occurs. EX1006, [0041]-[0042], FIG. 5. Shorting the secondary coil causes a current spike in the secondary coil 30 (Fig 5), and hence also in the primary coil 15 (Fig. 4B).



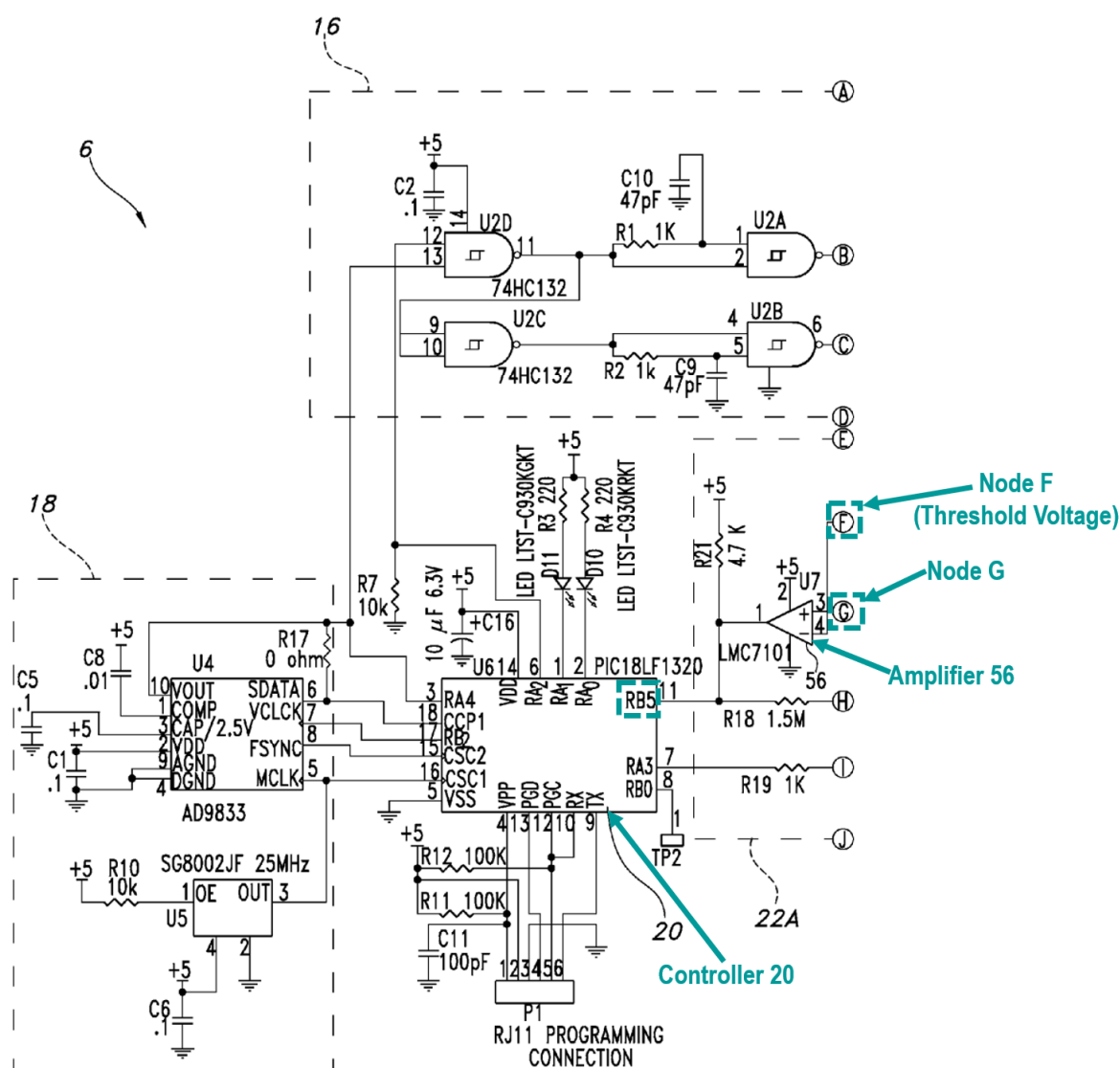
EX1006, FIG. 4B (annotated).

159. The current spike is then sensed by the combination of transformer 50 and resistor R20, which together behave as a low-value resistor in series with inductor 15. By Ohm's law, the oscillating current in inductor 15 thus generates an oscillating voltage in the primary (right-hand side in Fig. 4B) of transformer 50 that is directly proportional to the oscillating current in inductor 15. The oscillating voltage in the primary of transformer 50 induces an oscillating voltage in the

secondary of transformer 50. This voltage in the secondary of transformer 50 is thus proportional to the current in inductor 15. Diode 52 then rectifies the oscillating voltage in the secondary of transformer 50 in order to generate a pulsing and positive voltage signal at the node connected to capacitor 54 and resistor R9 (which I have labeled as node X in annotated Fig. 4B).

160. As would be well-known to any POSITA, capacitor 54 and resistor R9 together form a low-pass filter, smoothing the high-frequency pulses on a time scale that is longer than the period of oscillation of the signal generated by driver 16 (Fig. 2, 4A). In the embodiment shown in Baarman392, this time scale is on the order of a millisecond (based on the values of R9 and capacitor 54 in Fig. 4B). Thus the voltage at node X is a smoothed version of the amplitude of the oscillating voltage in the secondary of transformer 50. The voltage at node X is effectively equal to the voltage at node G (the 10k resistor between them serving as a current-limiting function to protect the amplifiers downstream.). Thus, the voltage at node G is effectively proportional to the amplitude of the current in inductor 15 and reflects any current spikes generated in the secondary circuit 8.

161. From node G, path (1) travels to amplifier 56 (Fig. 4A), where its voltage value is compared with a threshold value generated at node F (Fig. 4B).



EX1006, FIG. 4A (annotated). If the peak value of the voltage spike at node G is less than the threshold voltage, then amplifier 56 does not output a pulse. However, if the peak value of the voltage spike at node G does exceed the threshold voltage, the amplifier 56 generates a digital pulse that can be read by controller 20 at port RB5 (Fig. 4A).

162. Thus, path (1) comprises a voltage peak detector. “This increase in

current is detected by the peak detector 22. The output of the peak detector caused by the increased current through the primary coil is shown in FIG.6. The output of the peak detector in the illustrated embodiment increases by about 1.55V for about 10ms.” Baarman392 [0045]

163. Baarman392 elides some of the detailed elaboration above. It was unnecessary to include this level of detail because a POSITA at the time (and indeed, probably since the 1970s) would have understood that circuit elements 22A and 22B (with their sub-components) together comprise a voltage peak detector.

164. The amplifiers 56 and 58 serve to compare the voltage at node G to a fixed threshold value on node F (which is about 3 Volts in Fig 4B) and generate a digital output indicating whether the peak current in inductor 15 is above a threshold value. This digital output is recorded by controller 10.

XII. OVERVIEW OF CONCLUSIONS FORMED

165. This declaration explains the conclusions that I have formed based on my independent analysis. To summarize those conclusions:

- Based upon my knowledge and experience, and my review of the materials listed above, Claims 1-7, 9-10, and 13-14 of the '696 patent are rendered obvious by Onishi (EX1004) in view of Flowerdew (EX1005). *See above*, Ground 1A—Section VIII.
- Based upon my knowledge and experience, and my review of the

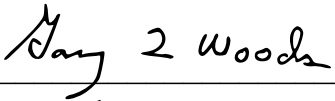
materials listed above, Claims 11-13 of the '696 patent are rendered obvious by Onishi (EX1004) in view of Flowerdew (EX1005) and Partovi (EX1007). *See above*, Ground 1B—Section IX.

- Based upon my knowledge and experience, and my review of the materials listed above, Claims 1, 3-5, 7, and 9-14 of the '696 patent are rendered obvious by Baarman392 (EX1008) in view of Partovi (EX1007). *See above*, Ground 2A—Section X.
- Based upon my knowledge and experience, and my review of the materials listed above, Claims 2 and 6 of the '696 patent are rendered obvious by Baarman392 (EX1008) in view of Partovi (EX1007) and Tocci (EX1009). *See above*, Ground 2B—Section XI.

XIII. CONCLUSION

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

Executed this 31st day of May, 2024.



Dr. Gary L. Woods

APPENDIX A

Gary L. Woods *Curriculum Vitae*

Updated Jan. 2024

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Houston TX 77005
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Education

Stanford University: Ph.D. Applied Physics, 1997 (M.S. 1991)

Advisor: Prof. Martin M. Fejer

National Science Foundation Graduate Fellowship

Dissertation title: *Nonlinear Optical Waveguide Devices Utilizing Intersubband Transitions in III-V Semiconductor Quantum Wells*

Rice University: BSEE & BA Physics, *cum laude*, 1988

Fulfilled requirements for BS in Physics. Phi Beta Kappa, Eta Kappa Nu, Tau Beta Pi, more; George R. Brown Forensics Society, debate team captain; National Merit Scholar; Sid Richardson College Fellow & Athenian Award.

Employment

2008-present: *Professor in the Practice in Computer Technology*, Dept. of Electrical & Computer Engineering, Rice University, Houston, TX. (*Distinguished Professor in the Practice* since 2020).

2006-present: *Consultant*, specializing in debug of integrated circuits and design of optical and electronic systems; Sunnyvale, CA and Houston, TX.

2003-2006: *Senior Scientist*, Credence Systems Corp., Diagnostics and Characterization Group, Sunnyvale, CA (originally Optonics Inc., acquired by Credence in 2003).

2000-2002: *Chief Technical Officer & co-founder*, Spectralane, Inc., Santa Clara, CA

1998-2000: *Senior Researcher*, Intel Corp., Santa Clara, CA

1996-1998: *Postdoctoral Fellow*, University of California, ECE Dept. & Quest Center, Santa Barbara, CA

1988-1989 *Member of Technical Staff*, Texas Instruments Corp. Dallas, TX (summers)

1987 *Undergraduate research asst.*, Rice University ECE dept. Houston, TX (summer)

1985-1986 *Computer programmer*, US Dept. of Energy, Bartlesville, OK (summers)

1984 *Computer operator*, Phillips Petroleum Company, Bartlesville, OK (summer)

Summary of consulting in court cases

- Shenzhen Xinxsing E-Commerce Co., Ltd., v. Shenzhen Cariku Technology Co., Ltd. PTAB IPR Case # PTAB-IPR2024-00222, US Patent 9,643,506. Wrote declaration supporting petitioners' position.
- Netlist, Inc. vs. Micron Technology, Inc. *et al.*, Federal District Court, Eastern District of Texas. Case # 2:22-cv-203-JRG-RSP, filed June 10, 2022.
 - Patent case, pending.
 - Wrote reports supporting Defendants' position.

- Deposed in Jan 2024.
- Helanea Smith vs. William Q. Williams *et al.*, Case No. 2021-36623, 281st Judicial District, Harris County, Texas.
 - Tort case, pending
 - Performed analyses of wireless communication for plaintiff.
- Ten related PTAB IPR cases involving Scramoge Technology, Ltd, vs. Samsung and Google, among others. 2021-2022. Cases settled. I wrote declarations supporting IPRs. I likely would have been a testifying expert.
 - Google LLC et al v. Scramoge Technology Limited PTAB-IPR2022-00683, US Patent No. 7,825,537
 - Google LLC f/k/a Google Inc. et al v. Scramoge Technology Limited PTAB-IPR2022-00643, US Patent No. 10,193,392
 - Samsung Electronics Co., Ltd. et al v. Scramoge Technology Limited PTAB-IPR2022-00653, US Patent No. 10,199,876,
 - Samsung Electronics Co., Ltd. et al v. Scramoge Technology Limited PTAB-IPR2022-00636, US Patent No. 9,490,652
 - Google LLC v. Scramoge Technology Limited PTAB-IPR2022-00603, US Patent No. 10,804,740
 - Samsung Electronics Co., Ltd. et al v. Scramoge Technology Ltd. PTAB-IPR2022-00478, U.S. Patent No. 10,367,370
 - Samsung Electronics Co., Ltd. et al v. Scramoge Technology Limited PTAB-IPR2022-00385, U.S. Patent No. 9,843,21
 - Samsung Electronics Co., Ltd. et al v. Scramoge Technology Limited PTAB-IPR2022-00284, U.S. Patent No. 9,997,962
 - Samsung Electronics Co., Ltd. et al v. Scramoge Technology Limited PTAB-IPR2022-00241, U.S. Patent No. 9,825,482
 - Samsung Electronics Co., Ltd. et al v. Scramoge Technology Limited PTAB-IPR2022-00185, U.S. Patent No. 10,424,941
- Hamamatsu vs. Semicaps, Federal District Court, Northern District of California, case #17-cv-03440-DMR, Filed June 14, 2017.
 - Patent case, settled.
 - Worked for plaintiff Semicaps. Wrote reports on infringement and invalidity.
 - If case had gone to trial, I likely would have been a testifying expert.
- Hamamatsu vs. Semicaps; PTAB IPR2017-02110 & IPR2017-02112; both filed 09/15/2017
 - PTAB IPR cases; both decided in favor of Semicaps.
 - I worked for the respondents in 2018-2019 and wrote declarations concerning prior art and opposing the petitioners' expert's opinions to support patent validity. I did not testify.
- Nokia vs. Apple; International Trade Commission. Case # 337-TA-1039; Filed 01/27/2017(?). The case ended up settling.
 - Patent case
 - I worked for the defendants in 2017. If the case had continued to a hearing at the ITC I likely would have been a testifying expert.
- NFC Technology, LLC. Vs. Samsung Electronics Co.; Ltd. et al., Federal District Court, Eastern District of Texas; Case # 2:15-cv-283; Filed 2/26/2015. Case ended up settling.
 - Patent case
 - I worked for the defendants in 2015 & 2016. I provided advice on prior art, claim construction, infringement analysis, etc. I likely would have been a non-testifying expert had the case made it to trial.
- X6D Limited vs. Volfoni, Inc. Federal District Court, Central District of California; Case # CV10-09583 MMM, Filed 9/23/2011. I do not know the outcome of this case.
 - Patent case.
 - I worked for the plaintiffs in 2011 and 2012 and prepared an expert report. I would have been the testifying expert if the case had made it to trial.

- X6D Limited; X6D USA Inc.; and XpanD, Inc. vs. Li-Tek Corporation Company et al., Defendants; Federal District Court, Central District of California; Case #10-cv-02327-GHK-PJW. Filed 3/30/2010. I do not know the outcome of this case.
 - Trade secret and patent case.
 - I worked for the plaintiffs in 2011-2012 and prepared expert reports. I would have been the testifying expert if the case had made it to trial

Educational programs & university courses taught

1. “Senior Design Lab” (Elec 494), ECE Dept., Rice University. AY2009-present. Yearlong 2-3 credit “capstone” course for all graduating seniors. Mentored approx. 10 senior teams each year. Co-created interdisciplinary “collaborative capstone” course across ECE, BioEngineering and Mechanical Engineering. Many senior teams won state, national, and international awards in areas ranging from electrical engineering to global health. Every project in my course, every year, has had a working prototype by spring. My teams have won numerous national and international awards.
2. “Introduction to Physical Electronics” (Elec 305), ECE Dept., Rice University. F’08, F’09, F’10; S’11-S’19. A 3-credit junior-level lecture course on semiconductor devices (FETs, ICs, BJTs, etc.), transmission lines, and antennas. The course was consistently ranked among the best ECE courses by Rice ECE undergrads.
3. “Fundamentals of Electrical Engineering II Lab” (Elec 244), ECE Dept., Rice University, S’15, S’20. New laboratory course for sophomores covering basics of circuits (RLC, discrete transistors, opamps, PWM, class D amplifiers, control with digital hardware in the loop.). After lockdown, distributed parts kits & scope dongles to enable circuit construction by students at home.
4. “Electronic Measurement Systems” (Elec 243), ECE Dept., Rice University, S’20, S’22, S’23. Co-taught. A circuits course for non-majors, a core course for sophomores in the Dept. of BioEngineering at Rice. Developed and administrated new lab assignments.
5. “Photonics Measurements” (Elec 364), ECE Dept., Rice University, S’22, S’23. Developed and taught a laboratory-based course covering lasers, optics, spectroscopy, electro-optics, and microscopy. Course based on graduate level text *Building Electro-Optical Systems* by Hobbs.
6. “Basic Electronics” (F’19), a 3-hour workshop on introductory electronics taught to about 100 engineering freshmen. Developed from scratch and funded with an internal grant. Equipment purchased includes ADALM2k USB dongle which now supports general activities in the Oshman Engineering Design Kitchen (OEDK).
7. “Fundamentals of Electrical Engineering I Laboratory” (Elec 240), ECE Dept., Rice University, F’18, F’20-F’23. A one credit course companion to the core Elec 241 Fundamentals of EE course. Adapted from the MOOC which I helped to develop (see below.)
8. “Survey of Engineering Disciplines” (Engi 150), ECE Dept., Rice University, F’16. A one-credit seminar for freshmen to expose them to types of careers open to engineers.
9. “Introduction to Embedded Programming” (Elec 497), ECE Dept., Rice University, S’13, S’14, F’14, F’15, F’16. F’17. Zero/one-credit course on microcontroller programming in C and PCB design for senior design teams without an ECE student. Developed “Escape Platform” embedded programming PCB and software base for teaching purposes.
10. “Fundamentals of Electrical Engineering Laboratory”, Massive Open Online Course (MOOC) offered through Coursera, Spring ’14. Assisted with development of laboratory assignments and parts kit. This was one of the first MOOCs ever to offer a laboratory component through a parts kit purchased separately by enrollees.
11. “Fundamentals of Electrical Engineering II Lab” (Elec 242), ECE Dept., Rice University, S’14. Developed a stand-alone set of laboratory exercises for the 4-credit course. Spun out as a separate course (Elec 244) in Spring ’15.

12. “Analog Circuits Lab” (Elec 342), ECE Dept., Rice University, S’09, S’10, F’11. Developed a new 4-credit lab course on intermediate analog circuits (amplifiers, FETS & BJTs, small signal models, feedback, audio power amplifiers, PCB design.) Course culminated in design and construction of audio power and amplifier on a PCB.
13. “Project Management and Professional Issues” (Elec 394), ECE Dept., Rice University, S’10, S’11, S’12. 2-credit course on project management, career choices, professional interactions, and intellectual property.
14. “Semiconductor device physics in 4 hours,” an original half-day lecture course covering device physics from p-n junctions through FETs. Presented at Credence Systems Corp., Feb. 2007.
15. “Design Debug,” an original 3-day lecture + laboratory course on techniques for debug of IC designs, offered through Semitracks, Inc. Presented at U.S. Dept. of Defense, June 2007. See <http://www.semitracks.com/courses/design/design-debug.php>

Honors

- *George R. Brown Award for Superior Teaching*, April 2016 & April 2019. Awarded annually to the top 10 instructors out of about 600 at Rice University, based on input from recent students.
- *George R. Brown Award for Superior Teaching*, April 2018 & April 2021. Finalist (one of top 25 but not one of top 10).
- *Hudspeth Award*, April 2019. Awarded by Rice Office of Student Activities to the top advisors of student clubs.

Rice academic service and responsibilities

- *Member of ECE undergraduate committee* 2008-present, Chair AY20-21. Inputs on curricular changes and ABET readiness. Developed new senior design (capstone) course structure. Developed new curricular structure to support Vertically Integrated Projects (VIP).
- *Member, Faculty Committee Engineering Design Minor*, 2016 – present. Oversight of policies supporting the new Engineering Design Minor.
- *Faculty Sponsor, Rice Electric Vehicle Club*, 2016-present. Starting in AY ’18-’19 I made the REV part of my Vertically Integrated Projects (VIP) team. They successfully completed the Shell Eco Marathon course for the first time in about 5 years.
- *Academic advisor, Engineering Design Minor*, 2016-present. Advised students pursuing or considering the Engineering Design Minor.
- *School of Engineering Curriculum Review Committee*, F’18-present. (Chair AY 2018, ’19, ’20-23). Reviewed proposed courses within SoE for credit-worthiness. As Chair, tried to convince 7 tenured/tenure-track faculty members to perform a 30-minute task using only constant hectoring and guilt as motivators.
- *Coordinator of Vertically Integrated Projects in ECE Dept.*, 2014-present. Developed course content for VIP projects. VIP projects involved about 10-12 undergrads along with grad students, postdocs and PIs. Program is currently being expanded to 5 departments in two schools.
- *ECE Undergraduate academic advising*, 2008-present. Responsibility for curricular and career advice for about 1/3 of Rice ECE majors.
- *Oversight of ECE undergraduate teaching lab*, 2014-present. Developed and drove implementation of plan to update and modernize equipment in the lab where core circuits courses are taught for all ECE majors and non-majors.
- *Chair of ECE undergraduate awards committee*, 2013-2014 -- responsibility for nominating students for Rice awards.

- *Divisional Advisor* for Sid Richardson (residential) College, 2010-2019; for Duncan (residential) College, 2019-2020, McMurtry (residential) College, 2021-present. Responsibility for advising Freshmen and Sophomores majoring in any Engineering discipline.
- *First-Year Mentor and Faculty Associate*, Sid Richardson (residential) College, 2009-2019; for Duncan (residential) College, F'19-present. Social interactions with students, informal advising of individuals, occasional meetings with freshman groups, frequent lunches, etc.
- *Mentoring of Freshman design teams*, AY 2010-11 -present. Mentored 1-2 freshman design teams in Engi 120 (Intro to Engineering Design) course in all but one semester.
- *OEDK "office hours"* – 2014-'2019 For 2-3 weeks before the Engineering Design Showcase in April each year, I made myself available from 10PM- 12AM nearly every evening to provide assistance with electronic design & troubleshooting for any team. Since COVID much of this advising has been remote.

Grants and awards

1. G. Woods, F. Li, D. Subramanian, L. Duenas-Osorio, "Scalable and Robust Prototype of Sensor Network for Real-Time Street-Level Flood Measurement", Houston Solutions Lab grant, \$73K, AY 2018-19.
2. G. Woods, R. Ramos, L.Yu, , "Creating a Curricular Scaffolding Structure to Evaluate and Enhance Performance of Vertically Integrated Projects," Rice University Quality Enhancement Program on the Scaffolding Experiential Inquiry and Research in the Curriculum, \$30K, AY 2018-19.
3. G. Woods, R. Simar, "Enhancing Experiential Learning in Design of Electronics", Rice University Quality Enhancement Program on the Scaffolding Experiential Inquiry and Research in the Curriculum, \$30K, AY 2017-18.
4. G. Woods, "Freshman Seminar -- Survey of Engineering Disciplines," Rice University Excellence in Engineering Education grant, \$7K, AY 2016-17.
5. G. Woods, "Integrated Electronics Ecosystem for the OEDK", Rice University Brown Foundation Teaching Grant, \$5K, 2016.
6. B. Aazhang, J. Cavallaro, G.L. Woods, on sub-award via Georgia Tech from Helmsley Foundation for establishing Vertically Integrated Projects among members of the international VIP Consortium. Jan 2014-present. Amount due to Rice is about \$130,000 over 3 years.
7. J. Cavallaro, G.L. Woods, National Space Grant Foundation Award # Xhab 2014-03, "SpaceRing: A Versatile, Scalable Power-Generation and Cooling System For Deep-Space Habitats", (co-PI). \$20,000.
8. J. Kono, G. Woods, R. Vaitai, (co-PI) "RAMSES: Repetitive advanced magnet for student experiments and science international senior design project," Rice Faculty Initiatives Fund, 2013, \$20,000.
9. G.L. Woods, M.K. O'Malley, Z.M. Oden, (PI) "Course Module on Embedded Electronics Systems for Multidisciplinary Senior Design Projects", Rice University Brown Foundation Teaching Grant, 2012, \$5000
10. G.L. Woods, K. Kelly, "Vivid Demonstrations of Concepts in Physical Electronics," Rice University Brown Foundation Teaching Grant, 2011, \$4000.
11. F. Koushanfar, S. Reda, G.L. Woods, "Algorithmic Techniques for Post-Silicon Characterization Using Infrared Emissions" (co-PI). NSF #1116858, \$260,000, 2011-2014

Other activities

Member of Technical Advisory Board and co-founder, 2009-present: InView Technology Corp., Austin TX. Advisor to startup company seeking to commercialize compressive-sensing technology developed at Rice for the application of non-visible camera systems. Developed an analog optoelectronic front end with 100x performance improvement over commercial systems.

Consultant, 2006-present.

- Advising semiconductor companies on optical probing related to debugging integrated circuits. Several successful “debug wins,” helping to accelerate product-launch dates.
- Expert legal consultant in several federal patent cases (district court, PTAB, and ITC) in fields such as RF, circuits, PCB design, and optoelectronics

Publications & Patents

Journal Articles

1. G. Timothy Noe, G. Timothy Noe, Ikufumi Katayama, Fumiya Katsutani, James J. Allred, Jeffrey A. Horowitz, David M. Sullivan, Qi Zhang, Fumiya Sekiguchi, Gary L. Woods, Matthias C. Hoffmann, Hiroyuki Nojiri, Jun Takeda, and Junichiro Kono, “Single-shot terahertz time-domain spectroscopy in pulsed high magnetic fields,” *Optics Express*, vol. 24 (26), p. 30328 (2016).
2. G. Timothy Noe, Qi Zhang, Joseph Lee, Eiji Kato, Gary L. Woods, Hiroyuki Nojiri, and Junichiro Kono, “Rapid scanning terahertz time-domain magnetospectroscopy with a table-top repetitive pulsed magnet,” *Applied Optics* vol. 53 (26), p. 5850 (2014).
3. G.T. Noe II, H. Nojiri, J. Lee, G.L. Woods, J. Léotin, J. Kono, “A table-top, repetitive pulsed magnet for nonlinear and ultrafast spectroscopy in high magnetic fields up to 30T”, *Review of Scientific Instruments* vol. 84 (12) p. 123906, 2013.
4. D.T. Morris, C.L. Pint, R. S. Arvidson, A. Lüttge, R.H. Hauge, A.A. Belyanin, G.L. Woods, J. Kono, “Midinfrared third-harmonic generation from macroscopically aligned ultralong single-wall carbon nanotubes,” *Phys. Rev. B* vol. 87 (16), p.161405, 2013.
5. Z. M. Oden, M. K. O'Malley, G. Woods, T. Kraft, B. Burke, “Outcomes of Recent Efforts at Rice University to Incorporate Entrepreneurship Concepts into Interdisciplinary Capstone Design,” *International Journal of Engineering Education*, vol. 28, no 2., pp.1-5, 2012.
6. U. Kindereit, G. Woods, J. Tian, U. Kerst, R. Leihkauf, and C. Boit, "Quantitative Investigation of Laser Beam Modulation in Electrically Active Devices as Used in Laser Voltage Probing," *IEEE Transactions on Device and Materials Reliability*, vol. 7, pp. 19-30, 2007.
7. J. Y. Liao, G. L. Woods, and H. L. Marks, "Rapid diagnostics of ASIC circuit marginalities using dynamic laser stimulation," *IEEE Transactions on Device and Materials Reliability*, vol. 6, pp. 9-16, 2006.
8. G. L. Woods, P. Papaparaskeva, M. Shtaif, I. Brener, and D. A. Pitt, "Reduction of Cross-Phase Modulation-Induced Impairments in Long-Haul WDM Telecommunication Systems Via Spectral Inversion," *IEEE Photonics Technology Letters*, vol. 16, pp. 677-9, 2004.
9. A. Imamoglu, H. Schmidt, G. Woods, and M. Deutsch, "Strongly interacting photons in a nonlinear cavity," *Physical Review Letters*, vol. 79, pp. 1467-70, 1997.
10. H. C. Chui, G. L. Woods, M. M. Fejer, E. L. Martinet, and J. S. Harris, Jr. "Tunable mid-infrared generation by difference frequency mixing of diode laser wavelengths in Intersubband InGaAs/AlAs quantum wells," *Applied Physics Letters*, vol. 66, pp. 265-7, 1995.
11. E. L. Martinet, H. C. Chui, G. L. Woods, M. M. Fejer, J. S. Harris, Jr., C. A. Rella, B. A. Richman, and H. A. Schwettman, "Short wavelength (5.36-1.85 μ m) nonlinear spectroscopy of coupled InGaAs/AlAs Intersubband quantum wells," *Applied Physics Letters*, vol. 65, pp. 2630-2, 1994.
12. H. C. Chui, E. L. Martinet, G. L. Woods, M. M. Fejer, J. S. Harris, Jr., C. A. Rella, B. I. Richman, and H. A. Schwettman, "Doubly resonant second harmonic generation of 2.0 μ m light in coupled InGaAs/AlAs quantum wells," *Applied Physics Letters*, vol. 64, pp. 3365-7, 1994.
13. H. C. Chui, E. L. Martinet, G. L. Woods, M. M. Fejer, J. S. Harris, Jr., C. A. Rella, B. I. Richman, and H. A. Schwettman, "Doubly resonant second harmonic generation of 2.0 μ m light in coupled InGaAs/ AlGaAs quantum wells," *Applied Physics Letters*, vol. 64, 1994.

14. L. Gordon, G. L. Woods, R. C. Eckardt, R. R. Route, R. S. Feigelson, M. M. Fejer, and R. Byer, "Diffusion-bonded stacked GaAs for quasiphase-matched second-harmonic generation of a carbon dioxide laser," *Electronics Letters*, vol. 29, pp. 1942-4, 1993.

Conference papers and presentations

1. Z.M. Oden, E. Richardson, G. Woods, A. Dick, M. O'Malley, "A model for a successful collaborative capstone design course," paper P-Th-670, *Biomedical Engineering Society Annual Meeting*, 2014.
2. G.T. Noe II, Q. Zhang, J. Lee, E. Kato, H. Nojiri, G. Woods, J. Kono, "Terahertz Time-Domain Magnetospectroscopy using a Table-Top Repetitive Pulsed Magnet", *CLEO:QELS_Fundamental Science*, 2014.
3. A.M. Andalcio, P. Breen, L.A. Hendricks, T.J. Sarkar, G.T. Noe, G.L. Woods, J. Kono, and J. Leotin, "Compact single-shot terahertz time-domain spectroscopy system for magneto-optics with a mini-coil pulsed magnet," *International Conference on Infrared, Millimeter and Terahertz Waves (IRMMW-THz) Conference*, 2013.
4. K. Dev, G. Woods, S. Reda, "High-throughput TSV testing and characterization for 3D integration using thermal mapping," in *Design Automation Conference*, 2013.
5. G.T. Noe II, H. Nojiri, J. Leotin, G. Woods, A. Belyanin, and J. Kono, "Superfluorescence from a Dense Electron-Hole Plasma in Pulsed High Magnetic Fields" in *CLEO:QELS_Fundamental Science*, 2013.
6. S. Su, J. Kerwin, S. Crowe, J. Cavallaro, G.L. Woods, "Teaching embedded programming to electrical engineers, BioEngineers, and mechanical engineers via the escape platform," in *Interdisciplinary Engineering Design Education Conference (IEDEC)*, 2013.
7. D.T. Morris, G.L. Woods, J. Kono, C.L. Pint, R.H. Hauge, "Second Harmonic Generation in Highly Aligned Carbon Nanotubes on GaAs," American Physical Society Meeting Abstracts, p.28015, 2011.
8. T. Sun, G. Woods, K.F. Kelly, "Compressive imaging applied to infrared-based semiconductor failure analysis," *International Conference on Infrared, Millimeter and Terahertz Waves (IRMMW-THz) Conference*, 2011.
9. Z.M. Oden, M.K. O'Malley, G.L. Woods, T.M. Volz, "Work in progress- Implementing and evaluating efforts to engage interdisciplinary teams to solve real-world design challenges," in *Frontiers in Education (FIE)*, 2011.
10. A. N. Nowroz, G. Woods, and S. Reda, "Improved Post-Silicon Power Modeling Using AC Lock-In Techniques," in *Design Automation Conference 2011*.
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Graduate-student supervision

1. Technical advice and service on MS thesis committee of Adam Samaniego, a student in the group of Prof. Ashok Veeraraghavan at Rice University, 2013-14.
2. Darius Morris, a student in the group of Prof. Jun Kono in ECE Dept. at Rice University. 2011-2012.
3. Hands-on supervision of experimental research of Ulrike Kindereit, a doctoral student in the group of Professor Christian Boit at TU-Berlin, 2005-2006. (See publication list).

Summary of capstone teams

- Primary faculty advisor or technical mentor for >100 capstone teams (~75% with grading + technical responsibility, ~25% with significant technical mentorship) in the yearlong collaborative capstone (senior design) course. Of all the teams, ~40% were interdisciplinary (not counting double majors).
- Sponsors/ Customers (approx.) more than: Research 26, Students 13, Industry 23, External collaborators 27, Other 23
- Results: ~8 teams with conference/ journal publications or patents; ~8 with clinical trials or deployments; ~6 commercializations; ~10 Vertically Integrated Projects; numerous awards at university, national, and international levels.
- More than 20 projects involving rechargeable batteries, recharging circuits, or wireless power transmission.