

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Yossi Azancot et al.
U.S. Patent No.: 9,083,204 Attorney Docket No.: 46570-0022IP1
Issue Date: July 14, 2015
Appl. Serial No.: 14/152,368
Filing Date: January 10, 2014
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. 9,083,204 (“the ’204 patent”) (EX1001).

2. I have been asked to provide my independent analysis of the ’204 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 ’204 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 ’204 Patent (January 10, 2014) and as of the earliest alleged priority date of the ’204 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 ’204 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 ’204 patent.

II. QUALIFICATIONS

4. In formulating my independent analysis of the '204 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 '204 patent was made, I do know that the '204 patent's earliest claimed priority date is March 17, 2008. For purposes of my obviousness analysis in Grounds 1A- 2 (Sections VIII-X), 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 '204 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 '204 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 '204 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 '204 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. Pub. No. 2007/0236169 (“Purdy”)
EX1006	U.S. Pub. No. 2008/0079392 (“Baarman392”)
EX1007	PCT Pub. WO 2006/031133A1 (“Malpas”)
EX1008	U.S. Pub. 2009/0212736 (“Baarman736”)
EX1009	Excerpts from Ronald J. Tocci et al., Digital Systems: Principles and Applications, Pearson Education International, 10th Edition (2007) (“Tocci”)

EX1016	U.S. Patent No. 9,048,696 to Azancot (“the ’696 patent”)
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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 ’204 PATENT

A. Overview of the ’204 Patent

25. The ’204 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 :

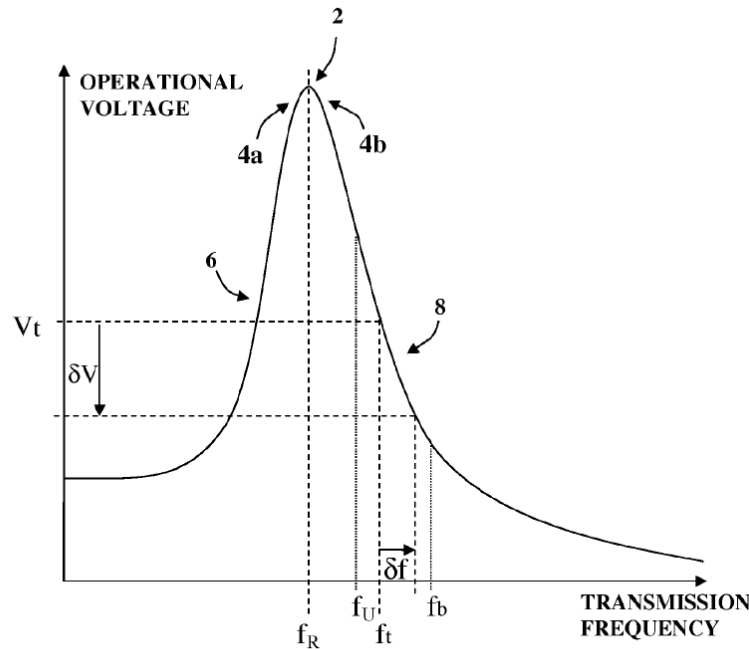


Fig. 6b

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 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.

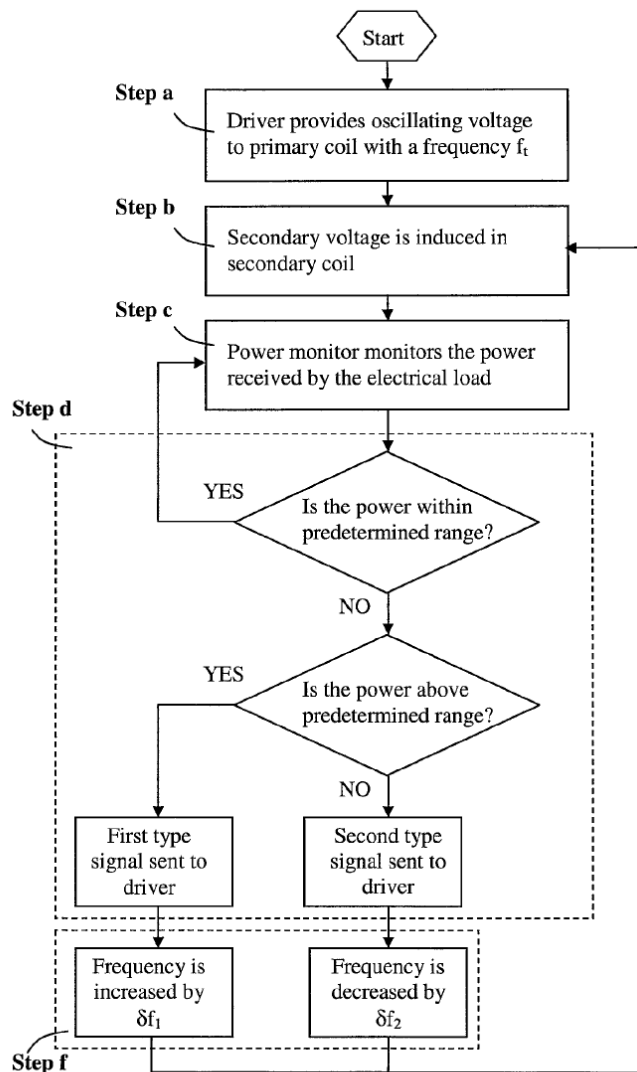


Fig. 6d

EX1001, FIG. 6d.

B. The Prosecution History of the '204 Patent

29. The '204 patent was filed January 10, 2014, and claims priority to several earlier-filed applications, the earliest filed March 17, 2008. EX1001, 1.

30. 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 '204 patent. In a first Office action dated September 30, 2014, the Examiner rejected the originally submitted claims as obvious over Malpas (EX1007), and further indicated that the terms “significantly” and “substantially” as recited in the independent claims were indefinite. EX1002, 117-127. The applicant responded by amending the claims to require a “non-resonant transmission frequency higher than said characteristic resonant frequency of said inductive couple.” EX1002, 96-100. 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 does not “deliberately select[]” a “transmission frequency ... higher than the characteristic resonant frequency.” *Id.*, 102-105.

31. 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, 74-86. The Examiner then conducted an interview with the applicant’s representative on February 26, 2015, where agreement was reached that amending the claims to recite a “substantially different” transmission frequency “per Figure 6b and the specification [0160+] would overcome the art of record.” *Id.*, 69. Consistent with the record of the interview, the applicant replied to the final action by amending the claims to recite a “non-resonant transmission frequency **substantially different** from said characteristic

resonant frequency of said inductive couple.” EX1002, 55-64. 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.

32. The Examiner issued a notice of allowance on July 16, 2015. EX1002, 35-39. The Examiner stated no reasons for allowance in the notice.

C. The Issued Claims of the '204 Patent

33. Counsel has asked me to consider the validity of claims 1-6, 8, and 10-13 (the “Challenged Claims”) of the '204 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 transfer system comprising
[1.1]	at least one inductive power outlet comprising at least one primary inductive coil wired to a power supply via a driver;
[1.2]	said primary inductive coil for forming an inductive couple having a characteristic resonant frequency with at least one secondary inductive coil wired to an electric load,
[1.3]	said secondary inductive coil associated with an inductive power receiver
[1.4]	wherein said driver is configured to provide a driving voltage across said primary inductive coil,
[1.5]	said driving voltage oscillating at a non-resonant transmission frequency substantially different from said characteristic resonant frequency of said inductive couple,

Claim Element	Language
[1.6]	wherein said inductive power outlet further comprises a signal detector adapted to detect a first signal and a second signal, and
[1.7]	said driver is configured to: provide less power by increasing said non-resonant transmission frequency by an incremental value when said first signal is detected by the detector, and
[1.8]	provide more power by decreasing said non-resonant transmission frequency by an incremental value when said second signal is detected by the detector.
[2]	The system of claim 1 said signal detector being configured to adjust said transmission frequency in response to feedback signals.
[3]	The system of claim 2 wherein said feedback signals carry data pertaining to the operational parameters of said electric load.
[4]	The system of claim 3 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;

Claim Element	Language
	power received by said secondary inductive coil; and a user identification code.
[5]	The system of claim 1 wherein said signal detector is selected from the list comprising optical detectors, radio receivers, audio detectors and voltage peak detectors.
[6]	The system of claim 1 wherein said driver further comprises a voltage monitor for monitoring the amplitude of a primary voltage across said primary coil.
[8]	The system 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.
[10.P]	A method for regulating inductive power transmission from a primary inductive coil, wired to a power supply via a driver, to a secondary inductive coil, wired to an electric load, said method comprising the following steps:
[10.1]	providing an oscillating voltage to said primary inductive coil at an initial transmission frequency f_t substantially different from a characteristic resonant frequency f_R of the system;
[10.2]	inducing a secondary voltage in said secondary inductive coil;
[10.3]	monitoring power received by said electric load;
[10.4]	sending a feedback signal when the monitored power deviates from a predetermined range;
[10.5]	said driver receiving said feedback signal; and
[10.6]	said driver adjusting said non-resonant transmission

Claim Element	Language
	frequency.
[11]	The method of claim 10 wherein the step of sending a feedback signal further comprises: sending a feedback signal of a first type Sa to said driver, whenever said power drops below a predetermined lower threshold, and sending a feedback signal of a second type Sb to said driver, whenever said power exceeds a predetermined upper threshold.
[12]	The method of claim 10 wherein said initial non-resonant transmission frequency f_t is higher than the characteristic resonant frequency f_R .
[13]	The method of claim 10 wherein the step of said driver adjusting said non-resonant transmission frequency further comprises: said driver reducing said non-resonant transmission frequency by an incremental value df_1 when the received feedback signal is of the first type Sa, and said driver increasing said non-resonant transmission frequency by an incremental value $+df_2$ when the received feedback signal is of the second type Sb.

D. The '204 Patent's Priority Date

34. The '204 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 '204 patent. At counsel's instruction, I have nonetheless treated each of the references cited in Grounds 1A-2 (i.e., Onishi, Purdy, Baarman³⁹², and Tocci) as prior art for purposes of my analysis in this declaration.

VII. CLAIM CONSTRUCTION

35. 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.

36. Here, the phrase "substantially different" in independent claims 1 and 10 (Elements [1.5] and [10.1]) was expressly addressed during prosecution of the '204 patent. For that reason, I have addressed what is encompassed by this claim phrase in further detail below.

37. Independent claim 1 recites "a non-resonant transmission frequency **substantially different** from [a] characteristic resonant frequency of [an] inductive couple." EX1001, 28:33-36. Independent claim 10 recites "an initial transmission

frequency f_t **substantially different** from a characteristic resonant frequency f_R .”

Id., 10:21-24. Based on my review, the specification and file history of the '204 patent inform what must fall within the scope of these claim elements.

38. 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 :

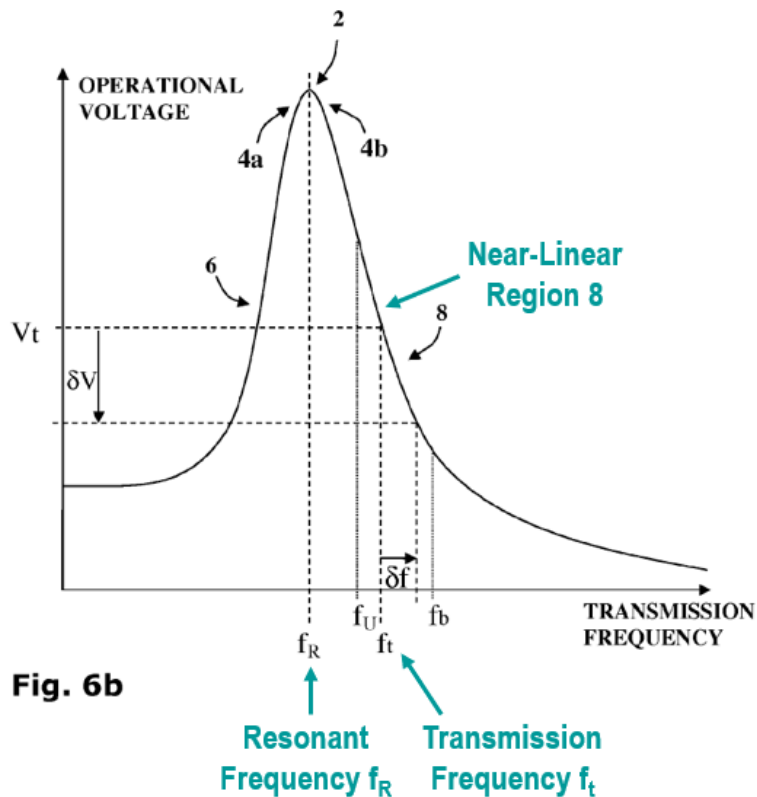


Fig. 6b

EX1001, FIG. 6b (annotated).

39. 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, 62.

40. Based on my review, the specification and file history confirm that a transmission frequency “substantially different” from a characteristic resonant frequency as claimed 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 ’204 patent are non-resonant transmission frequencies “substantially different” from the characteristic reference frequency.

41. Each of Grounds 1A-2 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. Based on my review, Grounds 1A-2 below respectively anticipate or render obvious the Challenged Claims under any construction that is consistent with the specification of the ’204 patent.

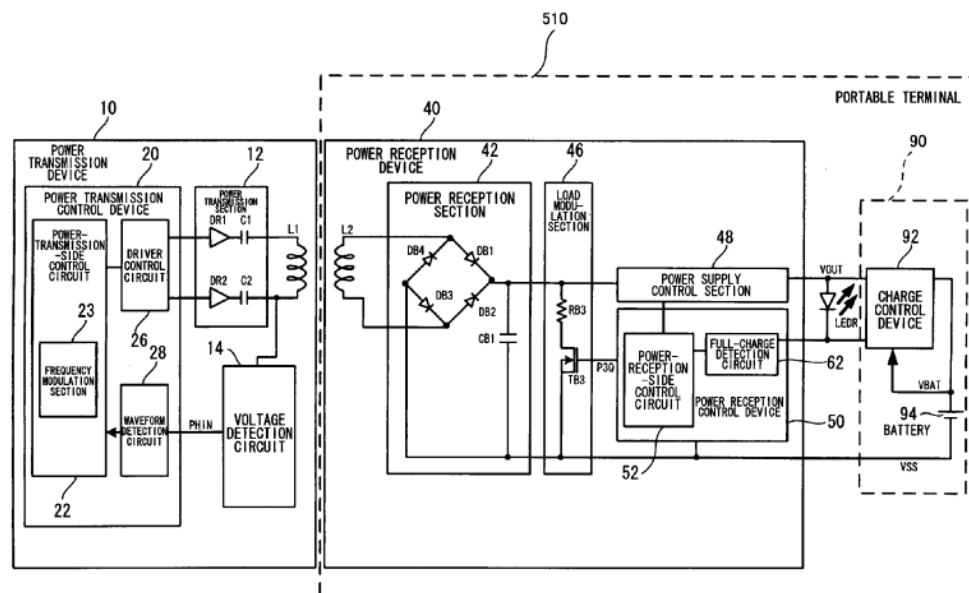
VIII. ANALYSIS – ANTICIPATION BASED ON ONISHI (GROUND 1A)

A. Onishi (EX1004)

42. 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.

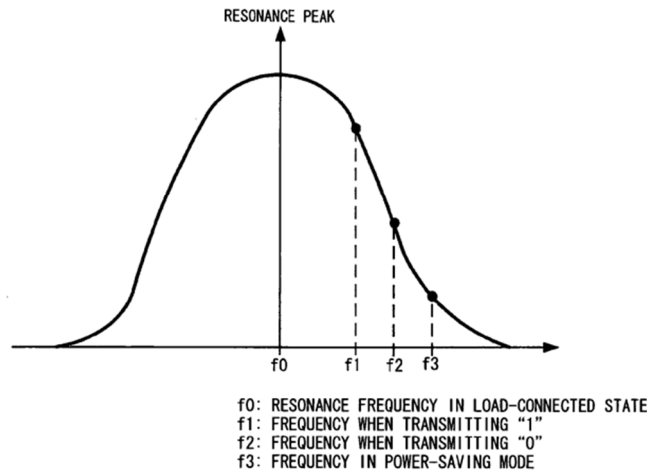
FIG. 5



EX1004, FIG. 5.

43. 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.

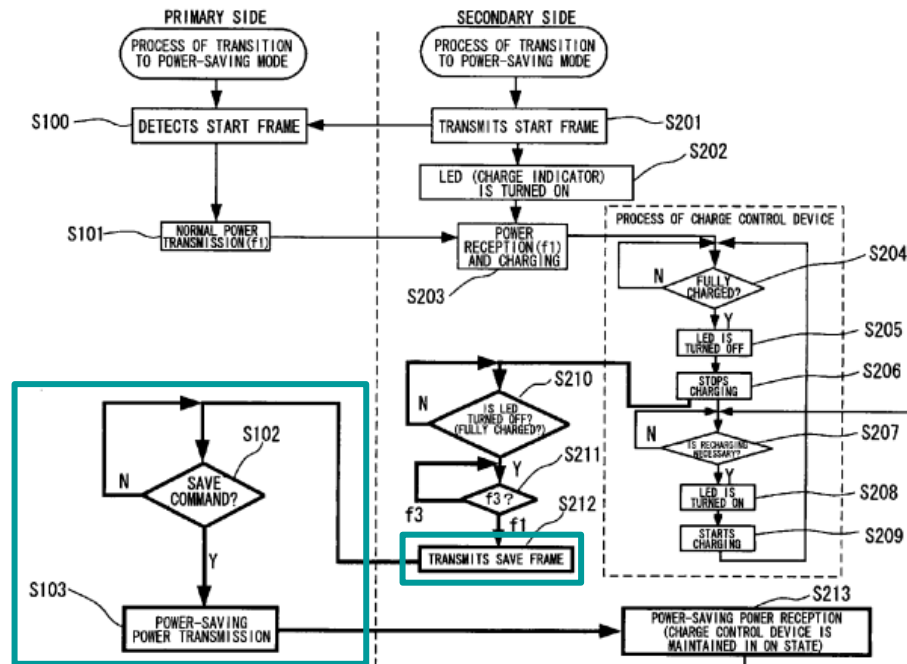
FIG. 4



EX1004, FIG. 4.

44. 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] [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.

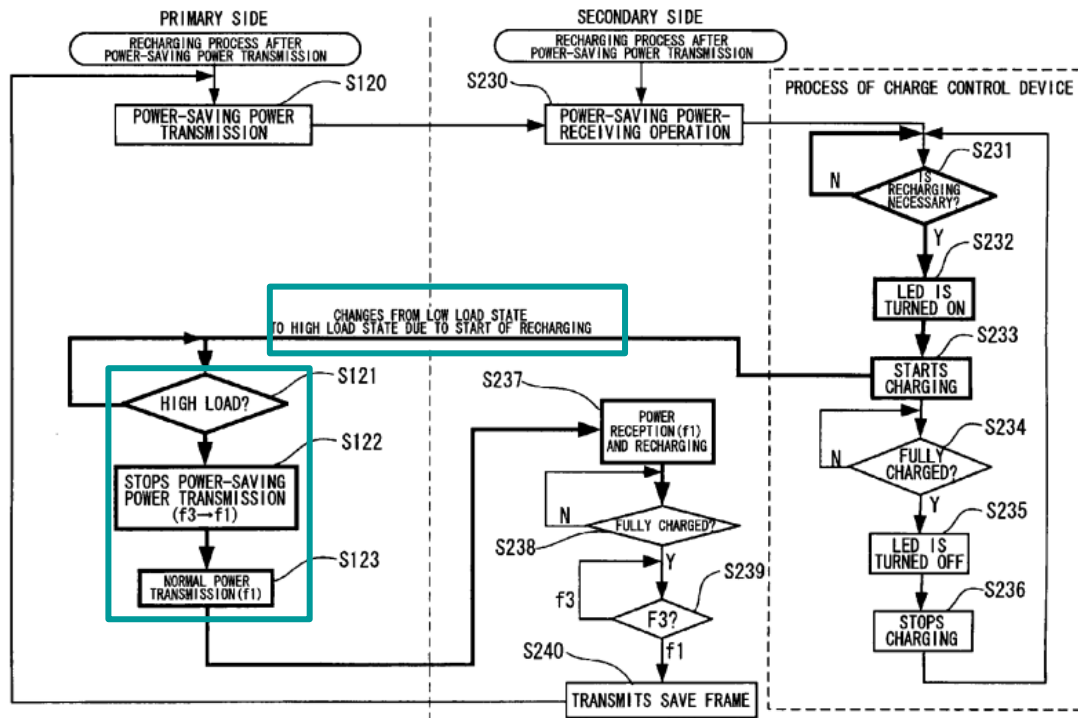
FIG. 7



EX1004, FIG. 7 (annotated).

45. 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. Application of Onishi

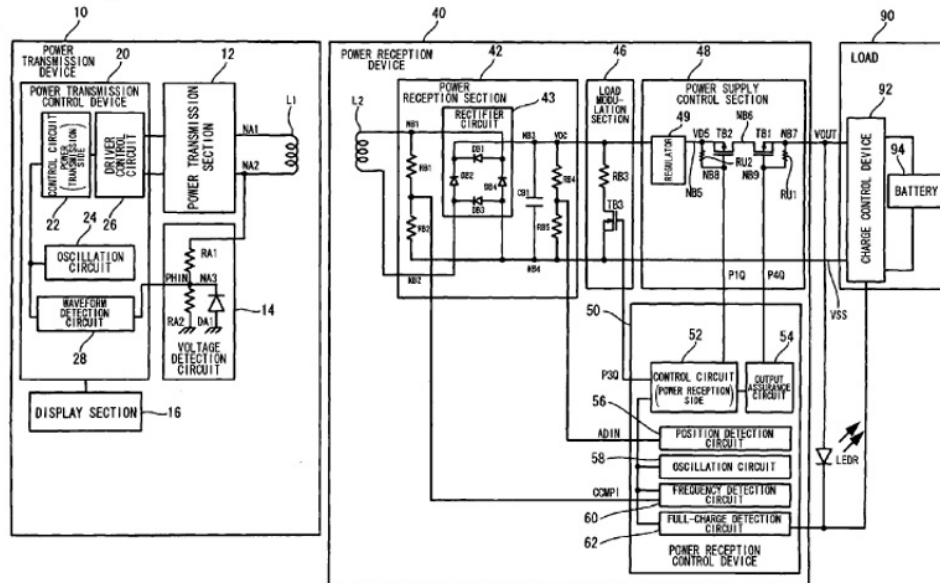
Claim 1

Element [1.P]: An inductive power transfer system comprising

46. Onishi anticipates Element [1.P] and discloses the recited “**inductive power transfer system**.” Onishi’s inductive power transfer system includes a “power transmission device 10” and a “power reception device 40.” EX1004, [0124]-[0131], FIGS. 1A, 2, 5.

Onishi's Inductive Power
 Transfer System

FIG. 2



EX1004, FIG. 2 (annotated).

47. Onishi discloses that the power transmission device 10 can be disposed in a charger 500 and “[t]he 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.” EX1004, [0125]. Onishi explains that “non-contact power transmission (contactless power transmission) ... utilizes electromagnetic induction to enable power transmission without metal-to-metal contact.” *Id.*, [0003]; *see also id.*, [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] (“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”).

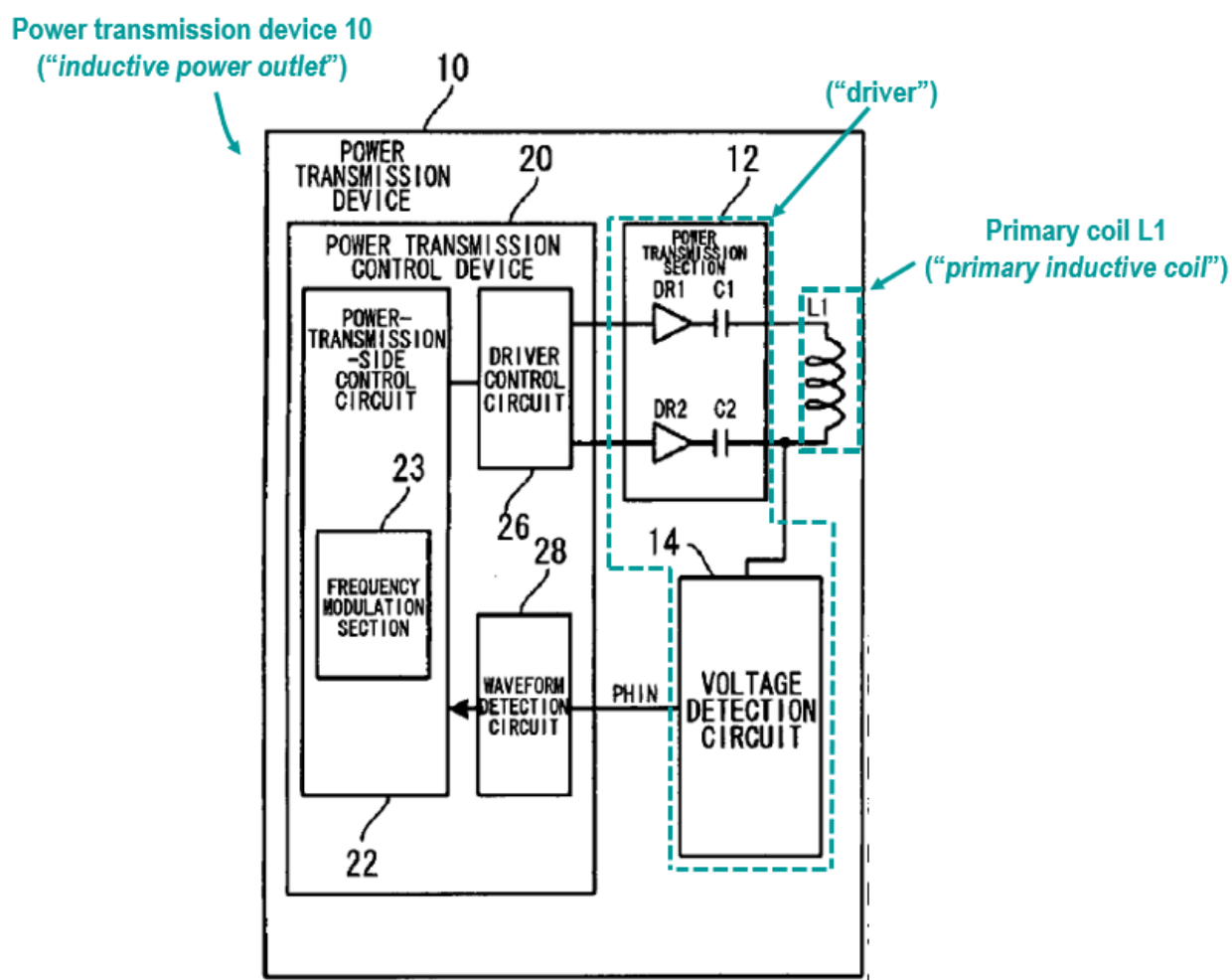
Element [1.1]: at least one inductive power outlet comprising at least one primary inductive coil wired to a power supply via a driver;

48. Onishi anticipates Element [1.1]. For example, Onishi discloses that its inductive power transmission system includes a power transmission device 10 (**inductive power outlet**). EX1004, [0131]; *generally id.*, [0125]-[0168], FIGS. 2, 5. The power transmission device 10 includes a primary coil L1 (**primary inductive coil**) wired to a power adapter 502 (**power supply**) via a power transmission section 12 (component of the **driver**). EX1004, [0125]-[0168], FIGS. 1A, 2, 5.

49. Dependent claim 6 clarifies that the scope of the claimed “driver” is not restricted solely to the circuit component that directly drives the primary inductive coil; rather, it also includes, for example, a “voltage monitor” for monitoring a voltage of the primary coil EX1001, Claim 6. 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 “driver.” *Below*, Claim [6]; EX1004, [0139], [0197]-[0200], [0224], FIGS. 2, 5-6.

50. Onishi discloses that “[p]ower is supplied to the charger 500 through an AC adaptor 502,” and that power from the adaptor 502 is supplied to the primary coil L1 of the power transmission device 10 to thereby provide “non-contact power transmission” to the reception device 40. EX1004, [0126], FIG. 1A. This power supply path is confirmed by Onishi’s teaching that the power transmission section 12 “generates an alternating-current voltage” and “supplies the generated alternating-current voltage to the primary coil L1.” *Id.*, [0133]; *see also id.*, FIGS. 2, 5. “The 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.” *Id.*, [0135]; *see also id.*, [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).”). Considering that AC adaptor 502 supplies power to the charger and that the power transmission section 12 in the charger supplies AC power to the primary coil L1, it is clear that power

from AC adaptor 502 is provided downstream to power the primary coil L1 via the power transmission section 12 (which is a component of the claimed driver). Even if Onishi does not expressly show primary coil L1 *directly* wired to AC adaptor 502, such direct wiring is not required by claim 1, which explicitly contemplates that the primary inductive coil and the power supply are indirectly wired via a driver.



EX1004, FIG. 5 (cropped, annotated).

51. As another example, Onishi’s charger/cradle (e.g., charger 500), which includes power transmission device 10, provides the claimed “at least one inductive

power outlet.” Onishi anticipates claim 1 regardless of whether the entire charger/cradle or just the power transmission device 10 is mapped to the claimed inductive power outlet.

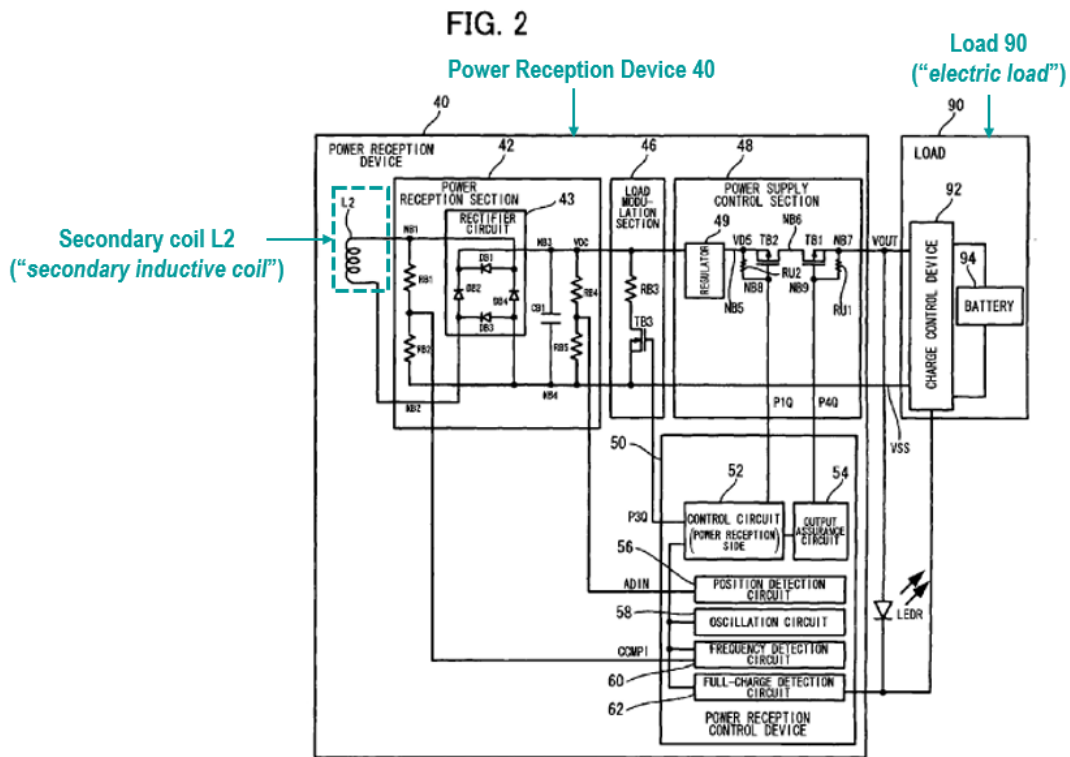
Element [1.2]: said primary inductive coil for forming an inductive couple having a characteristic resonant frequency with at least one secondary inductive coil wired to an electric load,

52. Onishi anticipates Element [1.2]. 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]; *see also id.*, [0003], [0125], [0128], FIGS. 2, 5.

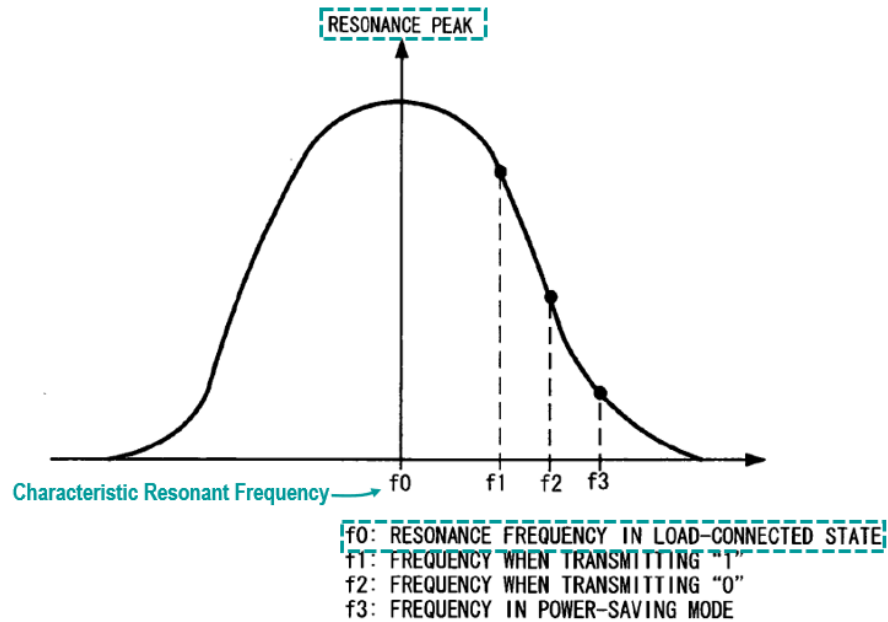
53. Onishi’s secondary coil L2 (**secondary inductive coil**) is wired to a load 90 (**electric load**), as illustrated in FIG. 2:



EX1004, FIG. 2 (cropped, annotated); *see also id.*, [0128], [0131], [0137]-[0138], [0165]-[0168], FIG. 5

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

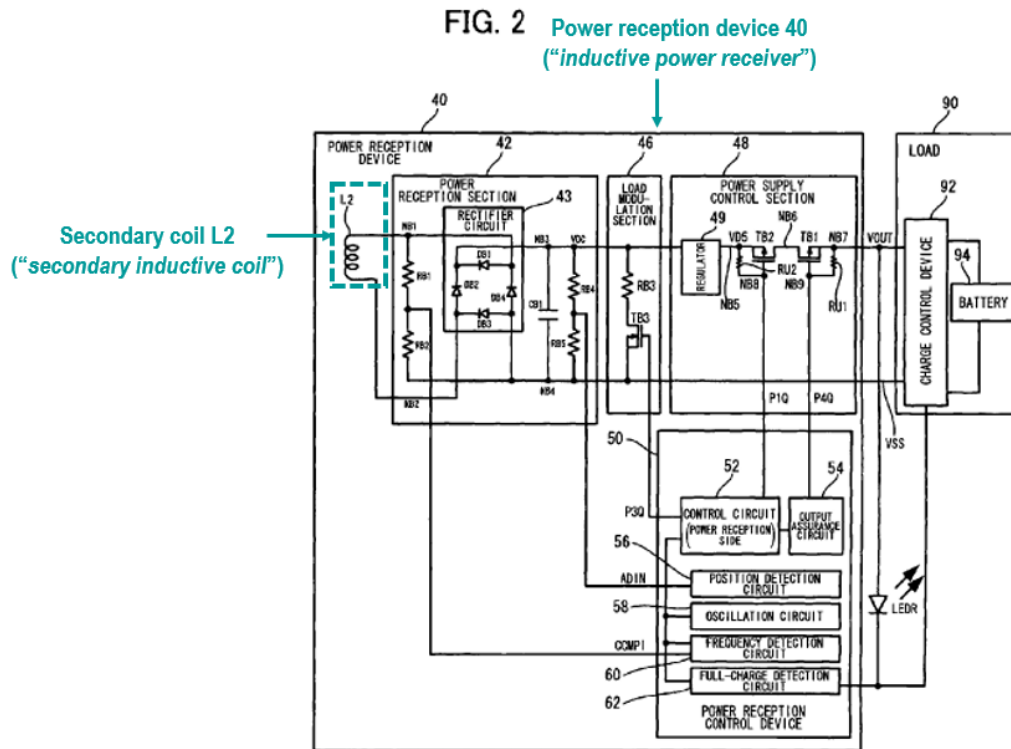
FIG. 4



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 [1.3]: said secondary inductive coil associated with an inductive power receiver

55. Onishi anticipates Element [1.3]. For example, Onishi discloses that secondary coil L2 (**secondary inductive coil**) is associated with the power reception device 40 (**inductive power receiver**). EX1004, [0147] (“The power reception device 40 (power reception module or secondary module) may include the secondary coil L2”), [0137]-[0138], [0180], FIGS. 2, 5.



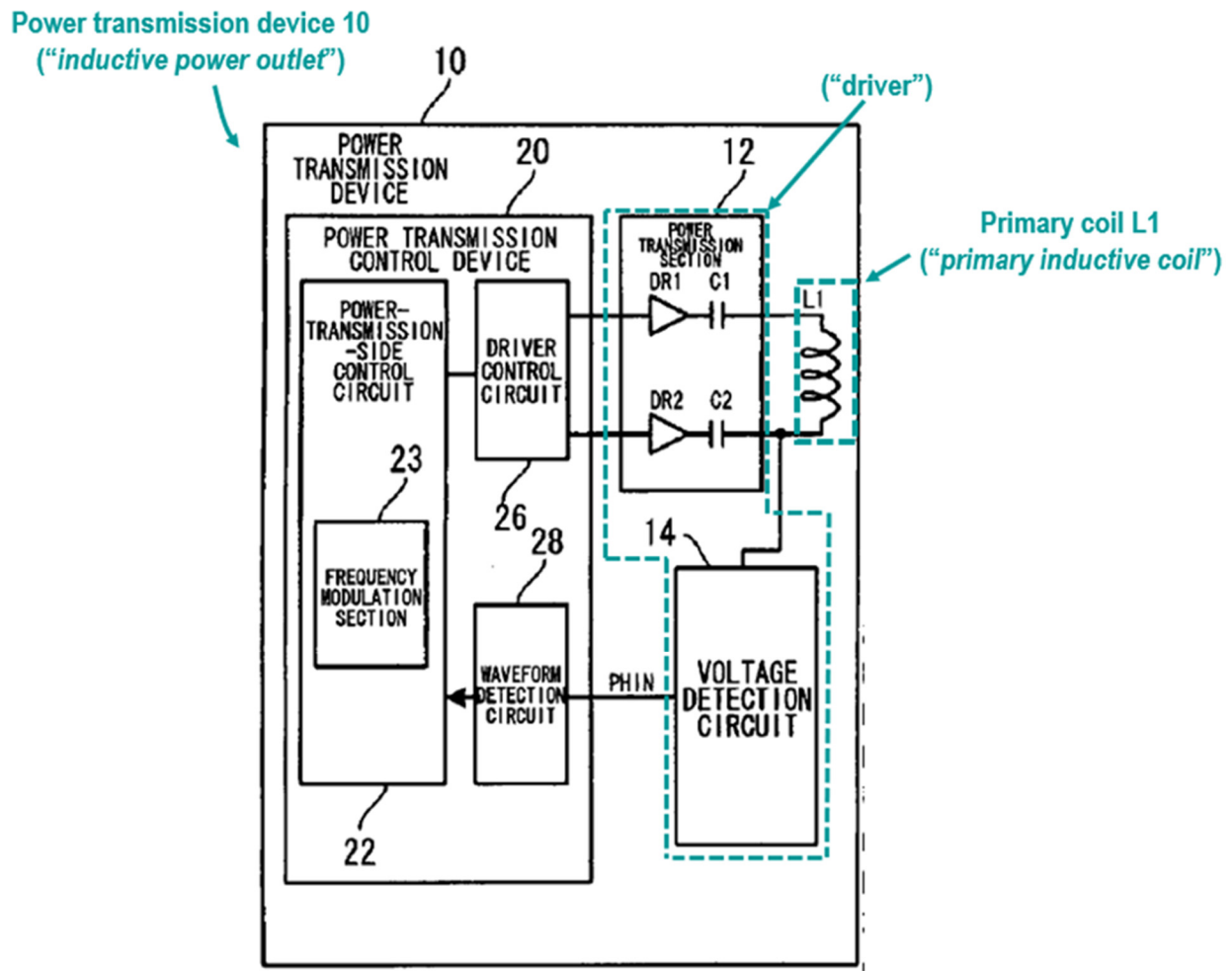
EX1004, FIG. 2 (cropped, annotated).

56. As another example, Onishi's "portable telephone [] (i.e., electronic instrument)," which includes power reception device 40, provides the claimed "inductive power receiver." Onishi anticipates claim 1 regardless of whether the entire electronic instrument or just the power reception device 40 is mapped to the claimed inductive power receiver.

Element [1.4]: *wherein said driver is configured to provide a driving voltage across said primary inductive coil,*

57. Onishi anticipates Element [1.4]. For example, Onishi discloses that the power transmission section 12 (component of the **driver**) provides a driving

voltage across primary coil L1 (**primary inductive coil**). EX1004, [0197] (“The power transmission section 12 generates an alternating-current voltage and drives the primary coil (L1).”), [0133], (“The power transmission section 12 generates an alternating-current voltage at a given frequency during power transmission, and generates an alternating-current voltage at a frequency which differs depending on data during data transfer. The power transmission section 12 supplies the generated alternating-current voltage to the primary coil L1.”), [0135] (“The 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”); *see also id.*, [0132]-[0136], [0143], FIGS. 2, 5.



EX1004, FIG. 5 (cropped, annotated).

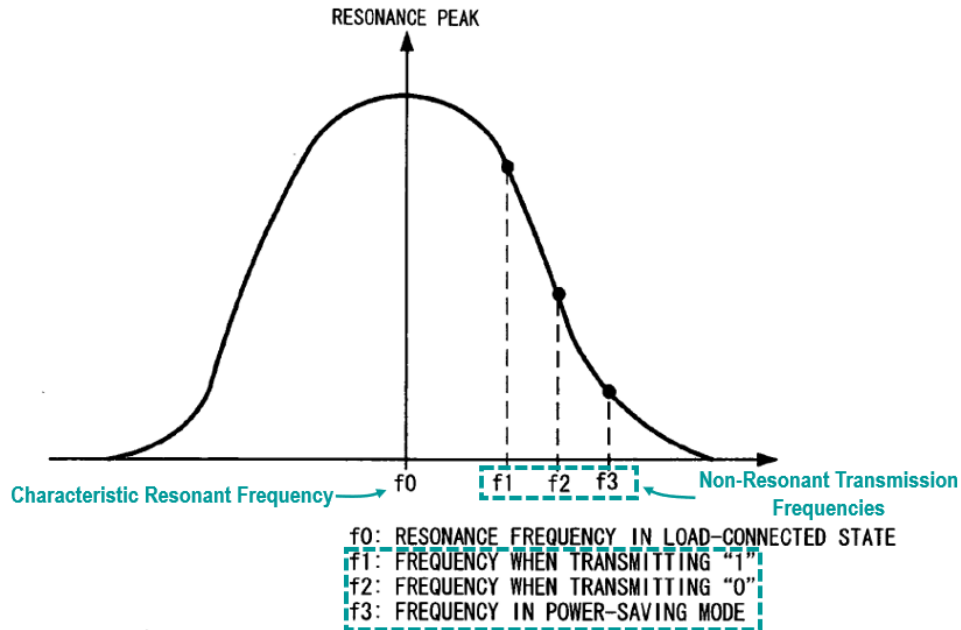
Element [1.5]: said driving voltage oscillating at a non-resonant transmission frequency substantially different from said characteristic resonant frequency of said inductive couple,

58. Onishi anticipates Element [1.5]. For example, Onishi discloses that the driving voltage supplied by power transmission section 12 (component of the **driver**) to primary coil L1 (**primary inductive coil**) oscillates at a non-resonant transmission frequency (e.g., frequencies f1, f2, or f3) substantially different from

said characteristic resonant frequency (e.g., frequency f_0) of said inductive couple.

This can be seen from the illustration provided in FIG. 4, for example:

FIG. 4



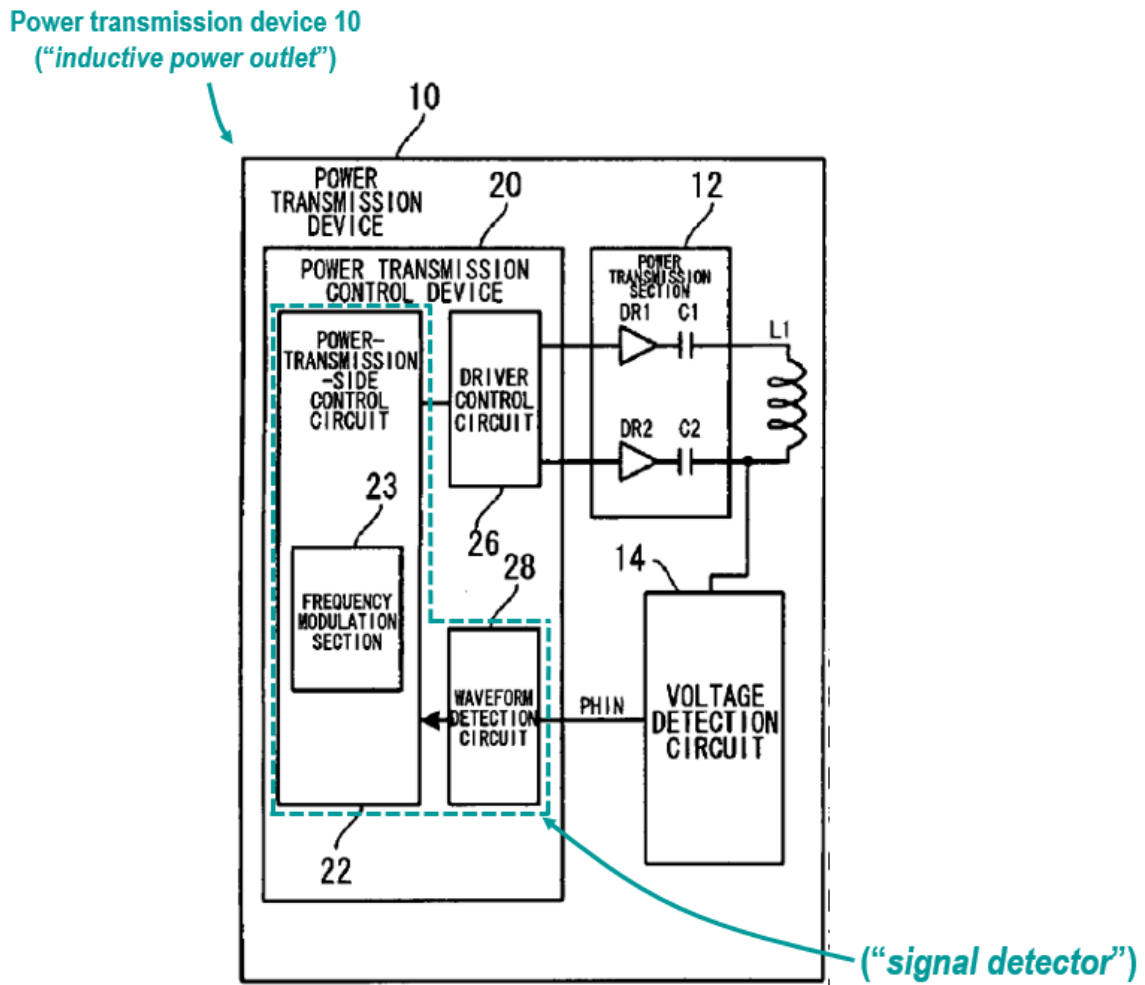
EX1004, FIG. 4 (annotated).

59. 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 (as discussed above, Section VII (citing EX1002, 62)), fall within the scope of being “substantially different” from the characteristic resonant frequency f_0 . The substantially 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 a transmission frequency that is “substantially different” from the characteristic resonant frequency regardless of the outermost scope of this claim term. *Above*, Section VII; EX1001, 21:16-23, 21:56-65, FIG. 6b; EX1002, 62.

*Element [1.6]: wherein said inductive power outlet further
 comprises a signal detector adapted to
 detect a first signal and a second signal,
 and*

60. Onishi anticipates Element [1.6]. For example, Onishi’s power transmission device 10 (**inductive power outlet**) includes a waveform detection circuit 28 that, in connection 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).

61. In the mapping above, the components of Onishi treated as the claimed **"signal detector"** are distinct from the components treated as the claimed **"driver."** Based on my review, however, it is clear that Onishi also anticipates the Challenged Claims when the claimed "signal detector" is taken to be part of the claimed "driver," as also permitted by the claims. In this case, in addition to the power transmission section 12 and voltage detection circuit 14, the components of Onishi mapped to the claimed "driver" can further include Onishi's "signal detector" components (i.e.,

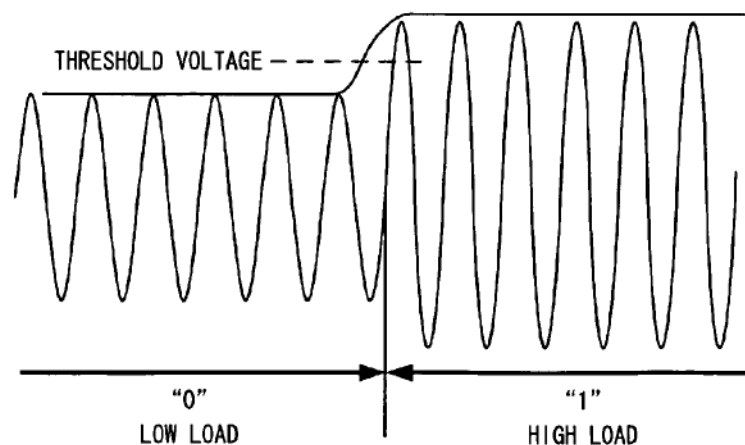
power-transmission side control circuit 22 and waveform detection circuit 28), and optionally, the entire power transmission control device 20.

62. 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 connected to the power reception device 40. EX1004, FIGS. 2, 5. While a battery 94 is being charged, the 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 (e.g., charging is completed), the power transmission device 10 operates in a “power-saving power transmission” mode that delivers a smaller amount of power to the power reception device 40 at a level sufficient to support operation of a charge management function in charge control device 92—but at a level that would be insufficient to support normal charging of the battery 94. *Id.*, [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. *Id.*, [0144]-[0146], [0223]-[0226], FIG. 3b; *see also id.*, [0053], [0064].

63. More specifically, Onishi teaches that signals transmitted from power

reception device 40 to power transmission device 10 induce different voltage 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.” *Id.*, [0144]-[0145].

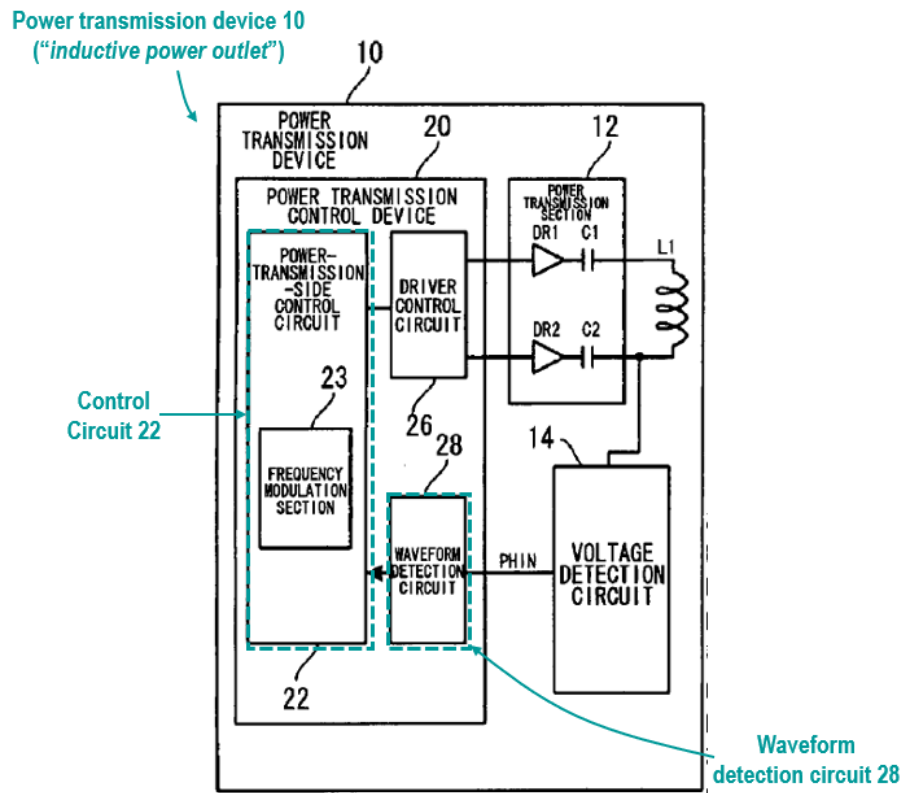
FIG. 3B



EX1004, 3B.

64. 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.” *Id.* “[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.

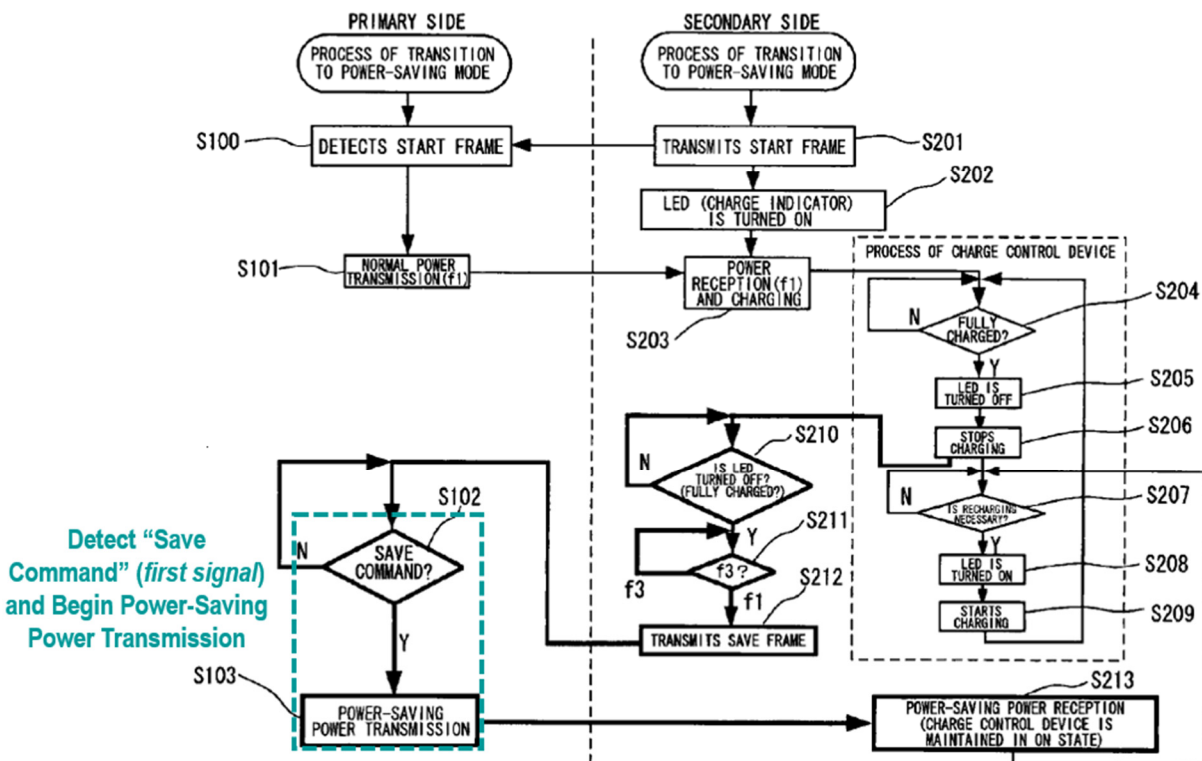


EX1004, FIG. 5 (cropped, annotated).

65. 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 f_3) (step S103).” *Id.*, [0215], FIG. 7.

FIG. 7

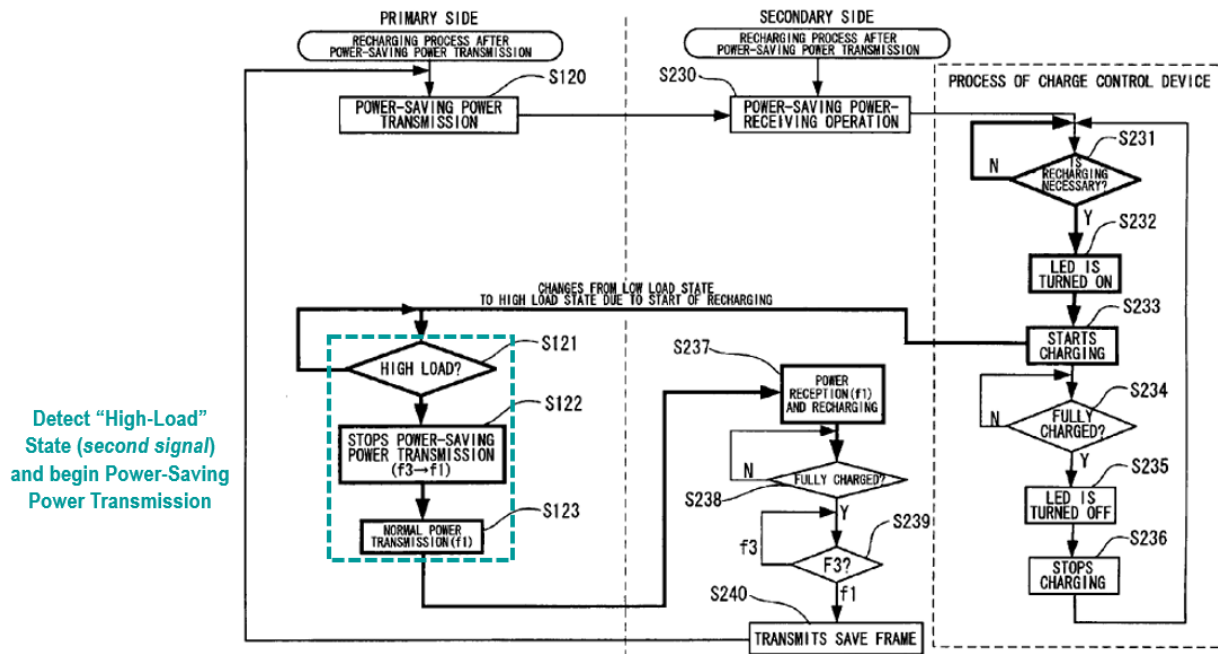


EX1004, FIG. 7 (annotated); *see also id.*, FIG. 9 (S120), FIG. 10 (S113, S110).

66. 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”).

FIG. 9



EX1004, FIG. 9 (annotated).

67. Based on my review, it would have been clear to a POSITA that Onishi's "save command" and Onishi's indication of a change to "high-load state" as communicated over the inductive channel each constitutes a "signal" as that term is used in the '204 patent. The specification of the '204 patent does not expressly define a "signal," but it does describe examples that demonstrate the breadth of this term in the '204 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

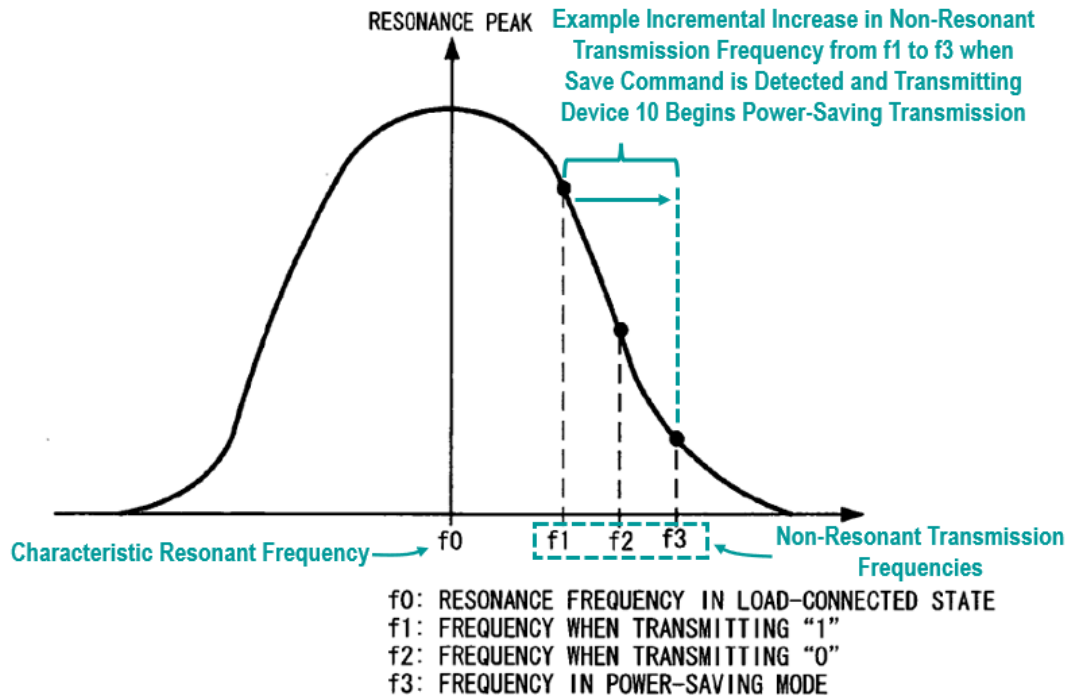
more or less power is required.” EX1001, 22:40-44. These examples show that a signal can, but need not, carry feedback parameters in the ’204 patent. Onishi’s “save command” and Onishi’s indication of a change to a “high-load state” align with the example feedback signals described in the ’204 patent, 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 ’204 specification.

Element [1.7]: said driver is configured to: provide less power by increasing said non-resonant transmission frequency by an incremental value when said first signal is detected by the detector, and

68. Onishi anticipates Element [1.7]. For example, as described above with respect to Element [1.6], 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*, [1.6]. When initiating power-saving power transmission, power transmission section 12 (component of the **driver**) provides less power by increasing the non-resonant transmission frequency by an

incremental value from “f1” or “f2” to “f3,” as shown in FIG. 4:

FIG. 4



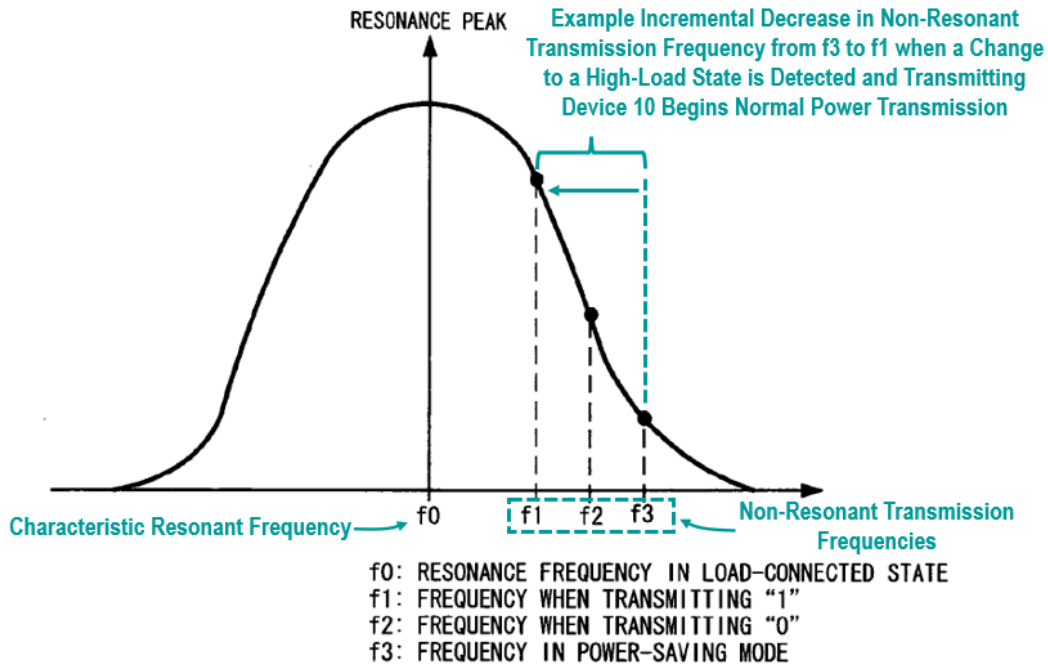
EX1004, FIG. 4 (annotated); *see also id.*, [0053] (“The transmission frequency during power-saving power transmission is set at a frequency apart from the resonance frequency (resonance peak) as compared with the frequency during normal power transmission, for example.”), [0171] (“The power to be transmitted 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 f1 is a frequency used when transmitting ‘1’ during normal power transmission. The frequency f1 is a basic frequency during power transmission. The frequency f2 is a

frequency used when transmitting ‘0’ (see FIGS. 3A and 3B). A frequency f3 is a frequency used in the power-saving mode.”), [0215] (“starts power-saving power transmission (power transmission frequency f3)”), [0133]-[0136] (details of power transmission section 12), FIGS. 2, 5-6.

Element [1.8]: provide more power by decreasing said non-resonant transmission frequency by an incremental value when said second signal is detected by the detector.

69. Onishi anticipates Element [1.8]. For example, as described above with respect to Element [1.6], Onishi discloses that power transmitting device 10 switches from power-saving power transmission to normal power transmission in response to detecting a change in the voltage inducted 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*, [1.6]. When beginning normal power transmission, power transmission section 12 (component of the **driver**) provides more power by decreasing the non-resonant transmission frequency by an incremental value from “f3” to “f1” or “f2”, as shown in FIG. 4:

FIG. 4



EX1004, FIG. 4 (annotated); *see also id.*, [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 2

***Element [2]: The system of claim 1 said signal detector
being configured to adjust said
transmission frequency in response to feed-
back signals.***

70. Onishi anticipates Element [2]. For example, as described in detail above with respect to Elements [1.6]-[1.8], Onishi's waveform detector 28, in connection with power transmission-side control circuit 22, provides a "**signal detector**" adapted to detect feedback signals (e.g., save commands, indications of a change in load,) from the power reception device 40. *Above*, Elements [1.6]-[1.8]; EX1004, [0027]-[0028], [0059]-[0060], [0063]-[0064], [0071], [0076]-[0079], [0099]-[0101], [0144]-[0146], [0151]-[153], [0186]-[0187], [0192], [0215], [0225], FIGS. 7, 9-10. Onishi further discloses that control circuit 22 is configured to adjust the transmission frequency in response to the feedback signals, e.g., by increasing the transmission frequency from f1 or f2 to f3 for power-saving transmission responsive to a save command or decreasing the transmission frequency from f3 to f1 for normal power transmission responsive to a signal indicating a change to a high-load state. EX1004, [0053], [0171], [0181], [0215], [0225], FIGS. 4, 7, 9-10; *above*, Elements [1.7]-[1.8].

Claim 3

***Element [3]: The system of claim 2 wherein said
feedback signals carry data pertaining to
the operational parameters of said electric
load.***

71. Onishi anticipates Element [3]. For example, Onishi discloses that the feedback signals (e.g., save commands, indications of a change in load) from power reception device 40 pertain to the operational parameters of the 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 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].

72. The additional language in claim 3 recites only that the feedback signals “carry data **pertaining to** the operational parameters of said electric load.”

(Emphasis added.) Claim 3 does not require that the feedback signals carry the operational parameters themselves.

Claim 4

Element [4]: The system of claim 3 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.

73. Onishi anticipates Element [4]. Onishi discloses that the feedback signals (e.g., save commands, indications of a change in load) from power reception device 40 pertain to the operational parameters of the electric load 90 (including battery 94). *Above*, Elements [1.6]-[1.8], [2]-[3]. Based on my review, it is clear that Onishi's feedback signals "pertain to" at least a 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], [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 5

Element [5]: The system of claim 1 wherein said signal detector is selected from the list comprising optical detectors, radio receivers, audio detectors and voltage peak detectors.

74. Onishi anticipates Element [5]. For example, Onishi discloses that waveform detector 28—which in connection with control circuit 22 provides the recited “**signal detector**”—includes voltage peak detectors. EX1004, [0200] (“form a peak detection circuit”), FIGS. 2, 5-6; *see also id.*, [0144]-[0146]. For example, the 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.

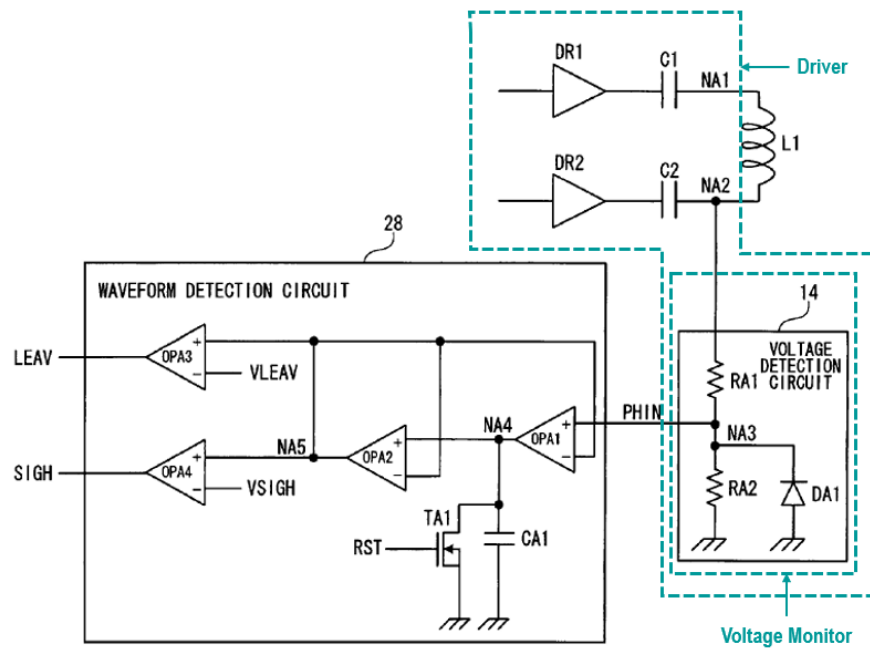
EX1004, [0200] (“[T]he peak voltage of the detection signal PHIN from the voltage detection circuit 14 is held by a node NA4, and the peak voltage signal held by the node NA4 is subjected to impedance conversion ... and is output to a node NA5.”).

Claim 6

Element [6]: The system of claim 1 wherein said driver further comprises a voltage monitor for monitoring the amplitude of a primary voltage across said primary coil.

75. Onishi anticipates Element [6]. For example, Onishi discloses that voltage detection circuit 14—which together with at least the power transmission section 12 provides the recited “**driver**”—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 8

Element [8]:

The system 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.

76. Onishi anticipates Element [8]. For example, Onishi discloses a “power reception section 42” (including a “rectifier circuit 43”) that “converts an alternating-current induced voltage in the secondary coil L2 into a direct-current voltage,” and thus provides an “**AC-to-DC converter**” as claimed. EX1004, [0148], FIGS. 2, 5.

Claim 10

Element [10.P]: A method for regulating inductive power transmission from a primary inductive coil, wired to a power supply via a driver, to a secondary inductive coil, wired to an electric load, said method comprising the following steps:

77. Onishi anticipates Element [10.P]. For example, Onishi's method involves regulating inductive power transmission from a primary coil L1 (**primary inductive coil**) to a secondary coil L2 (**secondary inductive coil**). EX1004, [0053] (describing techniques for reducing "power consumption ... during power-saving power transmission ... by increasing the frequency difference between the resonance frequency (resonance peak) and the transmission frequency"), [0003], [0125], [0128], [0137], FIGS. 2, 5, 7, 9-10; *above*, Element [1.P]. Further, as described *above* with respect to Elements [1.1]-[1.2], Onishi discloses that primary coil L1 is wired to a power supply via a "**driver**" (e.g., power transmission section 12 together with at least the voltage detection circuit 14) and secondary coil L2 is wired to an "**electric load**" (e.g., load 90). *Above*, Elements [1.1]-[1.2].

Element [10.1]: providing an oscillating voltage to said primary inductive coil at an initial transmission frequency f_t substantially different from a characteristic resonant frequency f_R of the system;

78. Onishi anticipates Element [10.1]. For example, Onishi discloses that power transmission section 12 provides an oscillating voltage to the primary coil L1

at an initial transmission frequency f_1 , f_2 , or f_3 that is substantially different from a characteristic resonant frequency f_0 of the inductively coupled system. EX1004, [0133] (“The power transmission section 12 generates an alternating-current voltage at a given frequency during power transmission, and generates an alternating-current voltage at a frequency which differs depending on data during data transfer. The power transmission section 12 supplies the generated alternating-current voltage to the primary coil L1.”), [0053], [0134]-[0135], [0171], [0180]-[0181], FIGS. 3A, 4; *above*, Section VII, Element [1.5].

Element [10.2]: inducing a secondary voltage in said secondary inductive coil;

79. Onishi anticipates Element [10.2]. For example, Onishi discloses inducing a secondary voltage in secondary coil L2. EX1004, [0034] (“an induced voltage in a secondary coil”), [0113] (same), [0137], (“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.”), [0148], [0161], FIGS. 2, 5.

Element [10.3]: monitoring power received by said electric load;

80. Onishi anticipates Element [10.3]. For example, Onishi’s system monitors power received by the electric load 90 (including battery 94). EX1004, [0060], [0086], [0101], [0164]-[0168], [0186]-[0187], [0225]. The system monitors

power to determine whether it is in a low-load state or a high-load state and whether the battery 94 is charging or is fully charged. *Id.* For example, “the waveform detection circuit 28 ... cyclically monitors a change in the load of the power reception device 40 (change from a low-load state to a high-load state) at short intervals, for example, the waveform detection circuit 28 can immediately detect that recharging has started in the power-saving mode so that the mode can be quickly changed to the charging mode.” EX1004, [0187]. Further, “[t]he full-charge detection circuit detects whether or not the battery has been fully charged based on whether or not a light-emitting device (e.g., LED) provided to the load has been turned ON. For example, when the light-emitting device has been successively turned OFF for five minutes or more, the full-charge detection circuit determines that the battery has been fully charged (this method is only an example).” *Id.*, [0086]; *see also id.*, [0060] (“the power reception device detects that the battery has been fully charged, and transmits a save command (i.e., information relating to the full-charge state of the battery) which requests power-saving power transmission”), [0101], [0164]-[0168], [0186], [0225].

Element [10.4]: sending a feedback signal when the monitored power deviates from a predetermined range;

81. As described in detail above with respect to Elements [1.6]-[1.8], Onishi’s power reception device 40 sends a feedback signal (e.g., a save command,

or an indication of a change to a high-load state) when the monitored power deviates from a predetermined range. *Above*, Elements [1.6]-[1.8]; EX1004, [0027]-[0028], [0059]-[0060], [0063]-[0064], [0071], [0076]-[0079], [0099]-[0101], [0144]-[0146], [0151]-[0153], [0186]-[0187], [0192], [0215], [0225], FIGS. 7, 9-10. For example, power reception device 40 sends a save command when the battery 94 is in the full-charge state and the monitored power deviates from a predetermined range corresponding to charging power. *Id.* A feedback signal indicative of a change to a high-load state is sent when battery charging resumes and the monitored power deviates from a predetermined range corresponding to the non-charging power. *Id.*

***Element [10.5]: said driver receiving said feedback signal;
and***

82. Onishi discloses that voltage detection circuit 14—which together with at least the power transmission section 12, provides the recited “**driver**”—receives feedback signals (e.g., a save command, or an indication of a change to a high-load state or) by monitoring the induced voltage of primary coil L1. EX1004, [0197] (“The voltage detection circuit 14 detects the voltage induced in the primary coil (L1).”), [0144] (“[W]hen 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.”), FIG. 3B; *see also id.*, [0139], [0145]-[0146], [0151]-[0153], [0199]-

[0200], [0224], FIGS. 2, 5-6; *above*, Elements [1.6]-[1.8].

Element [10.6]: said driver adjusting said non-resonant transmission frequency.

83. Onishi discloses that power transmission section 12—which together with at least voltage detection circuit 14, provides the recited “**driver**”—can adjust the non-resonant transmission frequency between f_1 and f_2 to signal different data values and between f_1/f_2 and f_3 to switch between normal and power-saving transmission modes. EX1004, [0053], [0133] (“The power transmission section 12 generates an alternating-current voltage at a given frequency during power transmission, and generates an alternating-current voltage at a frequency which differs depending on data during data transfer.”), [0134], [0171], [0180]-[0181], [0214]-[0215], [0232]-[0234], FIGS. 4, 7 (S103), 9 (S122) 10 (S110, S111); *above*, Elements [1.7]-[1.8].

Claim 11

Element [11]: The method of claim 10 wherein the step of sending a feedback signal further comprises: sending a feedback signal of a first type Sa to said driver, whenever said power drops below a predetermined lower threshold, and sending a feedback signal of a second type Sb to said driver, whenever said power exceeds a predetermined upper threshold.

84. Onishi anticipates Element [11]. For example, as described above with respect to Elements [1.7] and [10.4], Onishi discloses sending a feedback signal of

a first type Sa (e.g., a save command) to the driver (which includes Onishi's voltage detection circuit 14) whenever battery charging completes and power drops below a predetermined lower threshold corresponding to a change from a high-load state to a low-load state. *Above*, Elements [1.7], [10.4]. Further, as described above with respect to Elements [1.8] and [10.4], Onishi discloses sending a feedback signal of a second type Sb (e.g., an indication of a change to a high-load state) to the driver (which includes Onishi's voltage detection circuit 14) whenever battery charging resumes and power exceeds a predetermined upper threshold corresponding to a change from a low-load state to a high-load state. *Above*, Elements [1.8], [10.4].

Claim 12

Element [12]: The method of claim 10 wherein said initial non-resonant transmission frequency f_t is higher than the characteristic resonant frequency f_R .

85. Onishi anticipates Element [12]. For example, Onishi discloses that an initial no-resonant transmission frequency (e.g., f_1 in normal power transmission mode or f_3 in power-saving transmission mode) is higher than the characteristic resonant frequency f_0 . EX1004, [0180]-[0181], FIG. 4.

Claim 13

Element [13]: The method of claim 10 wherein the step of said driver adjusting said non-resonant transmission frequency further comprises: said driver reducing said non-resonant transmission frequency by an incremental value $df1$ when the received feedback signal is of the first type Sa , and said driver increasing said non-resonant transmission frequency by an incremental value $+df2$ when the received feedback signal is of the second type Sb .

86. Onishi anticipates Element [13]. For example, as described above with respect to Elements [1.8] and [10.4], Onishi discloses that power transmission section 12 (component of the **driver**) reduces the non-resonant transmission frequency by an incremental value $df1$ (e.g., from $f3$ to $f1$) when the received feedback signal is of a first type Sa (e.g., an indication of a change to a high-load state). *Above*, Elements [1.8], [10.4]. Further, as described above with respect to Elements [1.7] and [10.4], Onishi discloses that power transmission section 12 (**driver**) increases the non-resonant transmission frequency by an incremental value $+df2$ (e.g., from $f1$ or $f2$ to $f3$) when the received feedback signal is of a second type Sb (e.g., a save command). *Above*, Elements [1.7], [10.4].

87. The terms “the first type Sa ” and “the second type Sb ” lack antecedent basis in claim 13, which depends from claim 10 (not claim 11). Because claim 13 depends from claim 10, I understand that claim 13 does not include the further

requirements of claim 11 in which a feedback signal of the first type Sa corresponds to a drop in power below a predetermined lower threshold and a feedback signal of the second type Sb corresponds to power that exceeds a predetermined upper threshold. I further understand that, for this reason, the prior art identified for claim 13 need not be the same as those identified for claim 11. *Id.*

IX. ANALYSIS – OBVIOUSNESS BASED ON ONISHI AND PURDY (GROUND 1B)

A. Purdy (EX1005)

88. Purdy describes systems for charging devices with a rechargeable battery. EX1005, [0024]. Purdy provides additional detail about feedback signals that were well-known in battery charging systems before the earliest possible priority date of the '204 patent. For example, Purdy describes a battery charger for a portable device. EX1005, FIGS. 1-2, [0007]-[0009], [0013]-[0014], [0024]-[0025]. The battery charger includes a controller that causes the portable device to “to identify its corresponding portable device type and its corresponding rechargeable battery type.” *Id.*, [0028]. In a learning mode, the portable device communicates “appropriate charging parameters.” *Id.*, [0046]. The charging parameters can include over- and under- voltage limits, overcurrent limit, constant current, and full battery indicators, max. charge time, and battery capacity. *Id.*, [0036]-[0038]. The charger then charges the battery according to appropriate

charging parameters that improve charging performance and reduces the risk of over-charging, which can otherwise lead damage of the battery or other components in the portable device. *Id.*, [0046], [0006], [0009], [0011].

B. Predictable Combination of Onishi and Purdy

89. Onishi anticipates each of claims 1-6, 8, and 10-13 of the '204 patent for each of the reasons that I described above in Ground 1A. Nonetheless, even if the “first signal” and “second signal” of claim 1 and the “feedback signal” of claim 10 were narrowly construed to require that the signals communicate specific operational parameters, Purdy demonstrates that such feedback signals were commonly used in similar prior art systems to provide known benefits. Indeed, Purdy expressly describes the advantages of using feedback signals that carry specific charging parameters (e.g., in learning mode) and feedback signals that identify which device or battery is to be charged so that the charger can lookup prestored charging parameters for the identified device/battery. *Above*, Section IX.A.

90. Based upon my knowledge and experience in the field of the '204 patent and my review of Onishi and Purdy, it is clear that a POSITA would have been motivated to implement Onishi's charger in accordance with to Purdy's suggestion to receive feedback signals that carry specific operational parameters for the device or battery inductively connected thereto, and to receive feedback that

carry data allowing the charger to lookup and apply known parameters for charging the particular device/battery inductively connected to the charger.

91. First, a POSITA would have been prompted to do so because modifying Onishi's charger to receive feedback signals that identify specific operational parameters like those suggested by Purdy (*see, e.g.,* Purdy's Tables 1-2) would have beneficially allowed Onishi's power transmitting device 10 to accurately target/limit the amount of power transmitted to the charging target (*e.g.,* portable terminal 510 / battery 94) and thereby reduce the risk of damaging the battery. EX1005, [0006], [0009] ("advantageously select one or more actual charging parameters to charge the rechargeable battery based upon a comparison of the different portable device and battery charging parameters to avoid damaging one or the other").

92. Second, a POSITA would have been motivated to implement Onishi's charger in accordance with Purdy's suggestions because providing feedback signals to the charger that identify specific operational parameters (such as those suggested, *e.g.,* by Purdy's Tables 1,2) would have advantageously improved Onishi's power transmitting device 10 to more quickly achieve a full charge of the battery (*e.g.,* in portable terminal 510) by transmitting higher power to power reception device 40 when the operational parameters indicate a higher power, voltage, and/or current, limits. EX1005, [0011], [0036]-[0037].

93. Third, a POSITA would have been motivated to implement Onishi's

charger in accordance with Purdy's suggestions because providing feedback signals to the charger that identify specific operational parameters (such as those suggested, *e.g.*, by Purdy's Tables 1-2) would have beneficially allowed Onishi's power transmitting device 10 to adaptively customize different charging parameters optimized for different types of portable terminals inductively coupled thereto. EX1005, [0006], [0009].

94. Based upon my knowledge and experience in this field and my review of the straightforward teachings in Onishi and Purdy, 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 doing so, especially given the similar technologies at issue in each of Onishi and Purdy. Both Onishi and Purdy are directed to charging systems with circuitry that allows data and feedback signals to be transmitted from the charging target (*e.g.*, a mobile terminal) to the charging device (*e.g.*, a power transmitting device). *See, e.g.*, EX1004, [0144]-[0146], [0151]-[0153]; EX1005, [0028], [0050], FIG. 3. Onishi and Purdy both also disclose known techniques for adjusting the amount of power transmitted from the charger to the target according to feedback received from the target, including by adjusting a non-resonant transmission frequency as taught in Onishi. *See, e.g.*, EX1004, [0171], [0180]-[0181].

C. Application of the Predictable Onishi-Purdy Combination

Claims 1 and 10

95. Even if the “first signal” and “second signal” of claim 1 (Elements [1.6]-[1.8]) and the “feedback signal” of claim 10 (Elements [10.4]-[10.5]) are interpreted to require that the signals communicate specific operational parameters, Purdy demonstrates that the use of such feedback signals was commonly implemented in similar battery charger systems before the '204 Patent. EX1005, [0036], [0037]; *see also id.*, [0012]-[0013], [0045]-[0046], FIG. 3; *above*, Section IX.A. As described *above* (*above*, Section IX.B), it would have been obvious to apply Purdy’s suggestion to Onishi, and in the resulting Onishi-Purdy combination, the power reception device 40 would predictably send feedback signals that carry specific operational parameters (e.g., charging parameters and a charge level) to the power transmitting device 12 (e.g., in a learning mode) and feedback signals (e.g., first and second signals) that identify the charging target whose parameters are known (e.g., as part of a save frame and signals indicating a change to a high-load state). *Id.*; *below*, Claims [3], [4].

Claims 2, 3 and 4

96. The Onishi-Purdy combination would have rendered obvious the feedback signals as recited in claim 2, including the feedback signals carrying data pertaining to operational parameters of the electric load as recited in claim 3, which

include including operational parameters selected from the group recited in claim 4. *Above*, Section IX.B. For example, Onishi already teaches that its control circuit 22 is configured to adjust the transmission frequency in response to the feedback signals (*above*, Ground 1A Element [2]), and Purdy further suggests the known benefits of adjusting the charging output characteristics based on specific operational parameters communicated from the target device. *Above*, Section IX.B. Indeed, Purdy suggests that, in addition to its current charge level, the portable device can transmit feedback signals to the charger pertaining to each of the following charging parameters:

TABLE 1

<u>Exemplary Device Charging Parameters</u>		
Device Charging Parameter	Device Type #1	Device Type #2
Overvoltage limit (V)	6.0	5.25
Undervoltage limit (V)	4.0	4.8
Overcurrent limit (mA)	800	400
Constant current (mA)	750	350
Battery full (mA)	40	20
Battery full (V)	4.15	4.22

TABLE 2

<u>Exemplary Battery Charging Parameters</u>		
Battery Charging Parameter	Battery Type #1	Battery Type #2
Max. Charge time (Hours)	4.0	8.0
Battery Capacity (mAh)	1000	2000

EX1005, [0036], [0037]; *see also id.*, [0012]-[0013] & [0045]-[0046] (parameters transmitted in learning mode), [0028] (“the controller 27 causes the portable device 21 (i.e., the microprocessor 30) to identify its corresponding portable device type

and its corresponding rechargeable battery type from among a plurality of different portable device types and different battery types, at Block 41”), [0050] (“For example, the battery charge level may be communicated to the controller 27 by the microprocessor 30 along with the portable device and battery types (Block 41). The battery charge level may also be sent to the controller 27 during charging, if desired, to help determine when the battery 22 has reached its full charge.”), FIG. 3. In the combination, the power transmitting device 10 would predictably adjust the transmission frequency in response to the feedback signals that identify specific operational parameters like those disclosed in Purdy. EX1005, [0049] (“Once the actual charging parameters are established, the charger 23 then causes the charging circuit 26 to charge the battery 22 in accordance with these actual charging parameters, at Block 47.”); EX1004, [0053], [0171], [0180]-[0181], FIG. 4.

97. Purdy’s suggestions for over- and under-voltage limits plainly pertain to a required operating voltage for the electric load, the over- and under-current limits pertain to a required operating current for the electric load, and each of the battery full parameters, current charge level, max. charge time, and battery capacity pertain to a required operating power for the electric load.

Claims 2, 5-6, and 8, 10-13

98. For each of the reasons that I described above in Ground 1A, the Onishi-Purdy combination would have provided the limitations recited in claims 5-

6 and 8, 10-13. *See above*, Ground 1A, Elements [5]-[6], [8], [10]-[13].

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

A. Baarman392 (EX1006)

99. Baarman392 describes “an inductive charging system for recharging a battery.” EX1006, Abst.; *see also* [0011],[0032]. Baarman392’s system includes a charger circuit 6 and a secondary circuit 8. EX1006, [0032], [0047] *see also* Abstract, [0004], [0007], [0008], [0023], [0031], FIGS. 2, 4A-4B. 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]. Secondary circuit 8 includes a secondary coil 30 electromagnetically coupled to the primary coil 15. EX1006, [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.*

100. Baarman392’s secondary circuit 8 further includes components configured to generate a surge of current in secondary coil 30 when either an over-voltage or an over-current condition is detected. EX1006, [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.

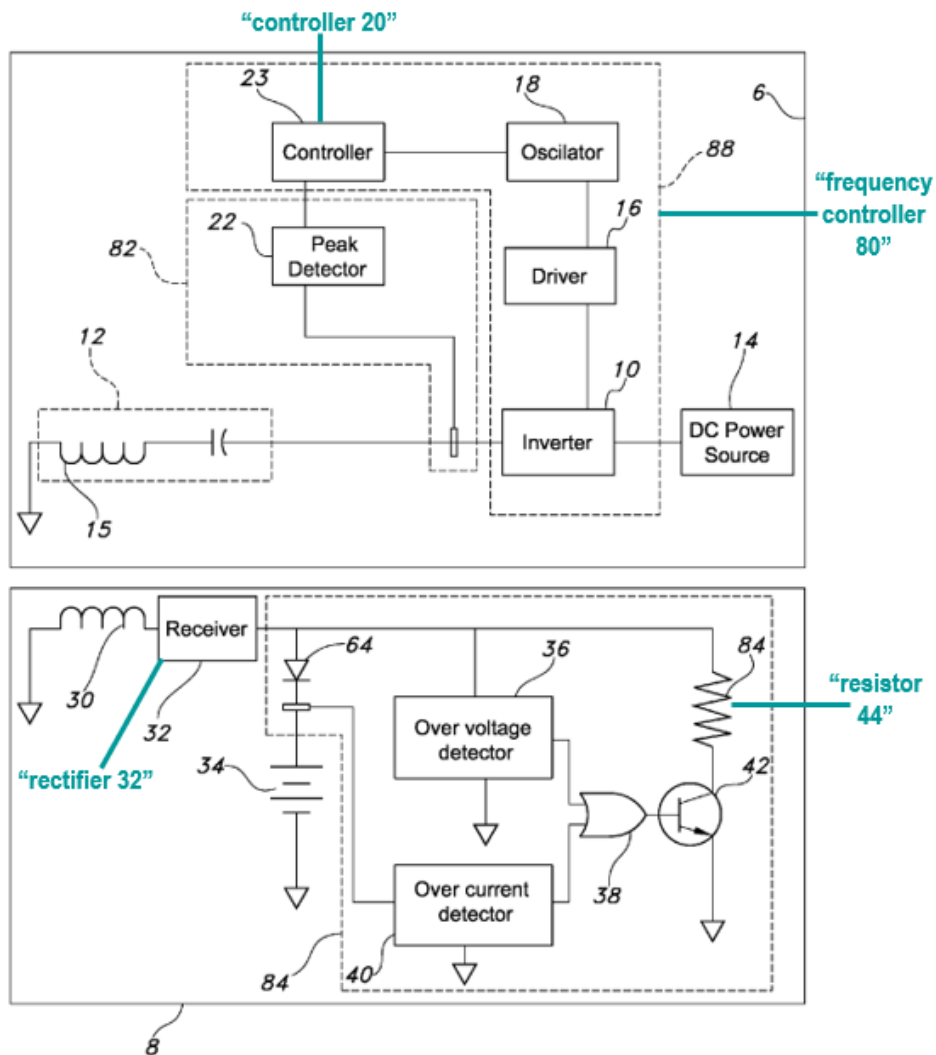


FIG. 2

EX1006, 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* EX1006, FIG. 2, *with id.*, [0032]-[0037]. These minor typographical errors do not meaningfully impact Baarman392’s applicability to the Challenged Claims. For clarity, Petitioner has annotated each of the reproductions of FIG. 2 in this Petition 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. EX1006, [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 frequencies A and B in FIG. 3. EX1006, [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.” EX1006, [0038].

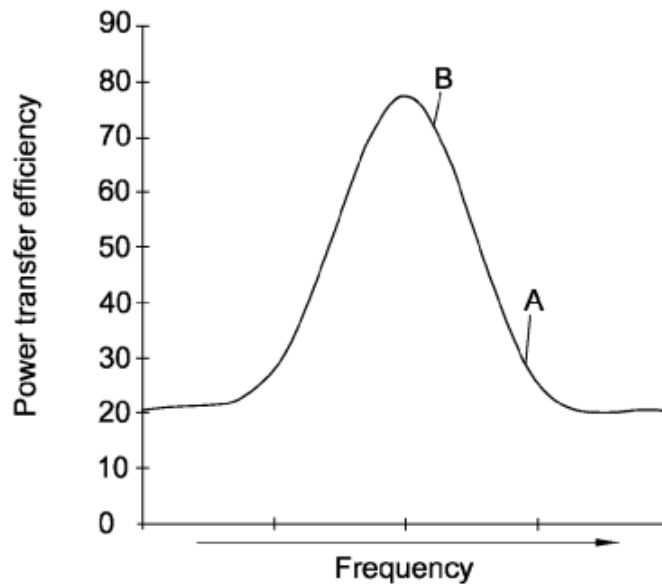


FIG. 3

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.” EX1006, [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. EX1006, [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. EX1006, [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 $2 * \Delta \text{FREQ}$) to decrease the power transferred to the secondary circuit. EX1006, [0059]-[0061], FIG. 7.

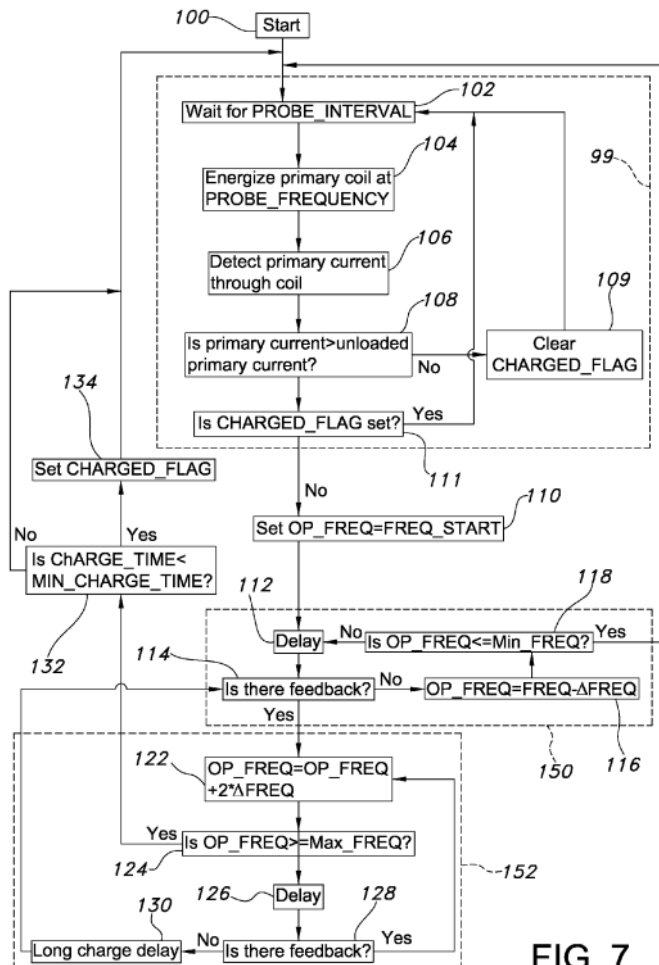


FIG. 7

B. Tocci (EX1009)

103. Tocci is a textbook that covered basic principles of digital systems

before the earliest possible priority date of the '204 patent (March 17, 2008). 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.

C. Predictable Combination of Baarman392 and Tocci

104. As I addressed above (Section X.A), Baarman392 discloses a charger circuit 6 that takes different actions to 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). EX1006, [0019], [0055]-[0061], FIG. 7; *above*, Section X.A. 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 adjusting the transmission frequency farther from resonance. EX1006, [0019], [0055]-[0061]. When the charger circuit 6 has not detected 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.*

105. Although Baarman392 frames the description of 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.

106. Based upon my knowledge and experience in the field of the '204 patent and my review of Baarman392 and Tocci, it is clear that a POSITA would have been motivated to implement Baarman392's charging condition feedback using conventional Boolean variables as suggested by Tocci. In the resulting Baarman392-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.* 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.

107. 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). The determination of suitable current ranges to correspond to LOW and HIGH logic levels in Baarman392's system would have been obvious. Notably, however, no changes would necessarily be required to the configuration of the circuits disclosed in Baarman392 to implement Tocci's suggestion since the LOW logic level would predictably correspond to a range of 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 a range of primary coil currents when these events are detected.

108. First, a POSITA would have been motivated to implement Baarman392'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.

109. Second, a POSITA would have been motivated to implement Baarman392's charging condition feedback using a conventional Boolean variable (as suggested by Tocci) so as to advantageously align Baarman392'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 '204 patent and implementing Baarman392's charging condition feedback as a Boolean variable would have better aligned Baarman392's system with ordinary digital logic systems.

110. Third, a POSITA would have been motivated to implement Baarman392'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'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.

111. Based upon my knowledge and experience in this field and my review of the relatively straightforward and predictable structures in Baarman392 and Tocci, a POSITA would have possessed the level of skill necessary to implement this combination and would have had a reasonable expectation of success doing so. Indeed, considering the traditional conventional “textbook” nature of Boolean variables suggested by Tocci’s textbook and Baarman392’s original solution for detecting the binary charging feedback conditions provided in Baarman392’s original solution, a POSITA would have considered the combination to be straightforward and predictable. Implementing Baarman392’s system using integrated circuits/digital logic (FIGS. 4A-5, [0036]-[0049]) and conventional Boolean variables/Boolean algebra suggested by Tocci, a POSITA would have been understood to be achieved with a high expectation of success.

D. Application of the Predictable Baarman392-Tocci Combination

Claim 1

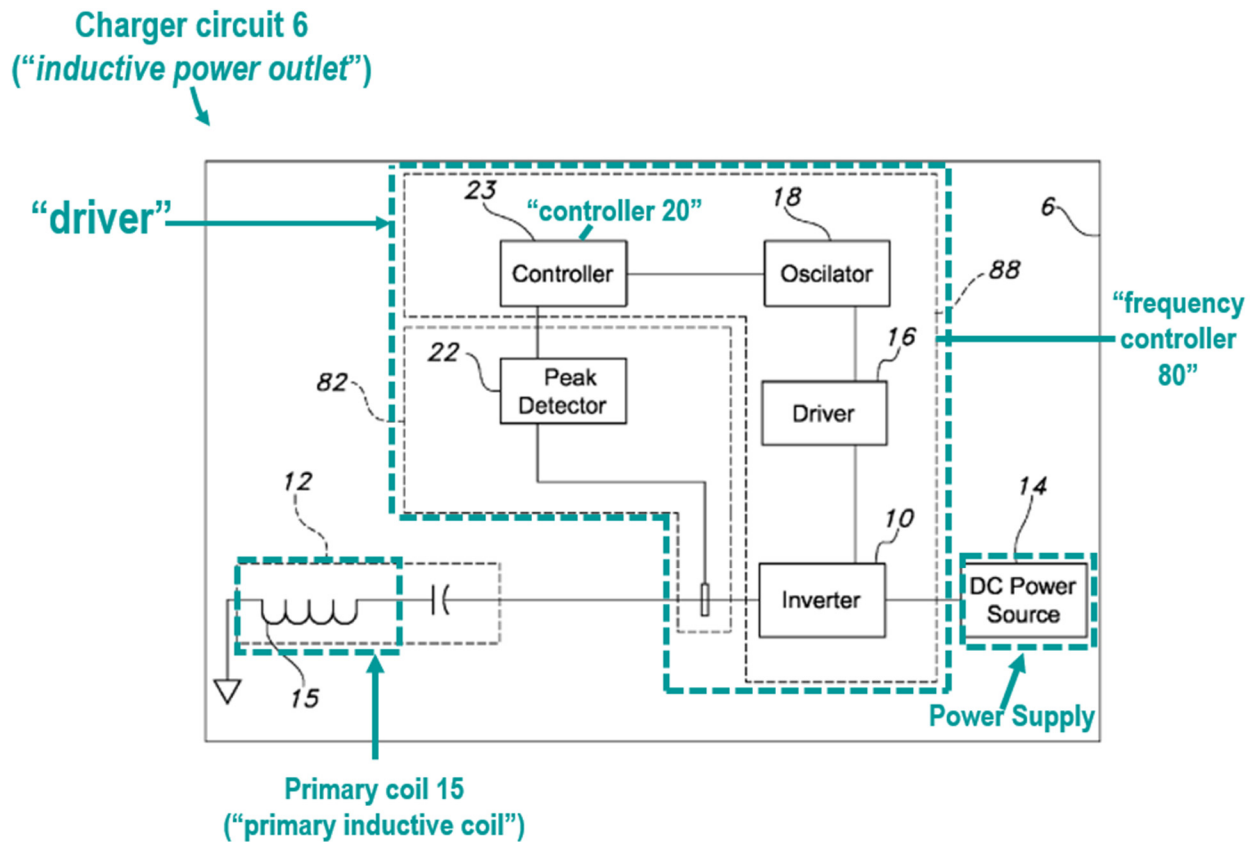
Element [1.P]: An inductive power transfer system comprising

112. The Baarman392-Tocci combination provides Element [1.P]. For example, Baarman392 discloses an inductive charging system 4 (**inductive power transfer system**) that transfers power from a charger circuit 6 to a secondary circuit

8. EX1006, [0032] (“The inductive charging system 4 is configured to inductively charge a battery having a nonlinear charging profile, such as a Li-Ion battery. The system 4 generally includes a charger circuit 6 and secondary circuit 8.”), Abstract, FIGS. 2, 4A-4B.

*Element [1.1]: at least one inductive power outlet
 comprising at least one primary inductive
 coil wired to a power supply via a driver;*

113. The Baarman392-Tocci combination provides Element [1.1]. For example, Baarman392 discloses an inductive battery charger that incorporates a charger circuit 6 (**inductive power outlet**) having a primary coil 15 (**primary inductive coil**) wired to a DC power source 14 (**power supply**) via an inverter 10—which together with Baarman392’s driver 16, oscillator 18, controller 20 and peak detector 22—provides the recited “**driver**.” EX1006, [0032]-[0037], FIG. 2; *see also id.*, FIGS. 4A-4B.



EX1006, FIG. 2 (cropped, annotated); EX1004, [0033] (“[I]nverter 10 provides AC (alternating current) power to the tank circuit 12 from a source of DC (direct current) power 14. The tank circuit 12 includes the primary coil 15. ... [T]he driver 16 provides the signals necessary to operate the switches within the inverter 10.”).

114. Baarman392’s inverter 10 together with Baarman392’s driver 16, oscillator 18, controller 20, and peak detector 22 perform the functions of the claimed “driver.” As I noted above, dependent claim 6 clarifies that the scope of the claimed “driver” is not restricted solely to the circuit component that directly drives the primary inductive coil; rather, it also includes, for example, a “voltage monitor”

for monitoring a voltage of the primary coil. EX1001, Cl. 6. In this context, Petitioner thus addresses the claimed “driver” as including the peak detector 22 in connection with the inverter 10, the driver 16, oscillator 18, and controller 20 (i.e., the frequency controller 80).

Element [1.2]: said primary inductive coil for forming an inductive couple having a characteristic resonant frequency with at least one secondary inductive coil wired to an electric load,

115. The Baarman392-Tocci combination provides Element [1.2]. For example, Baarman392 discloses that secondary circuit 8 includes a secondary coil 30 (**secondary inductive coil**) that forms an inductive couple with primary coil 15 in the charger circuit 6. EX1006, FIG. 2. 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). 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. EX1006, [0038] (“the power transfer is highest when the inverter 10 is operating at resonance”).

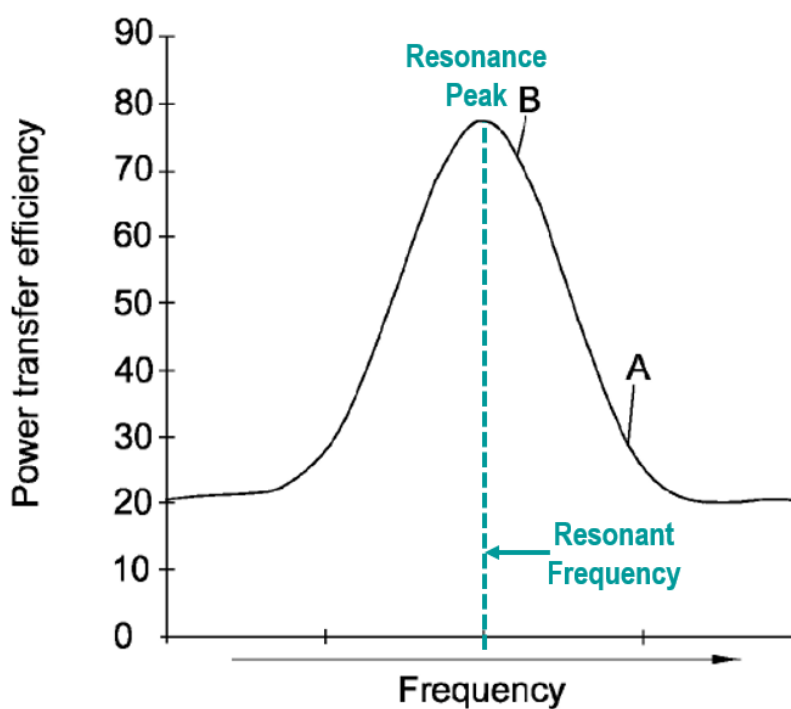
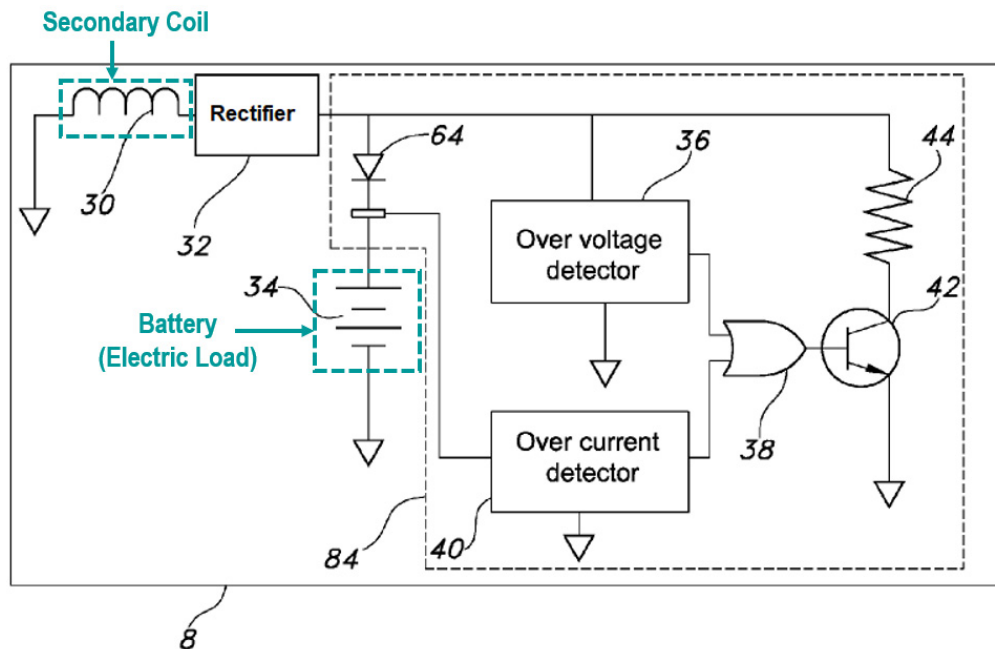


FIG. 3

EX1006, FIG. 3 (annotated).

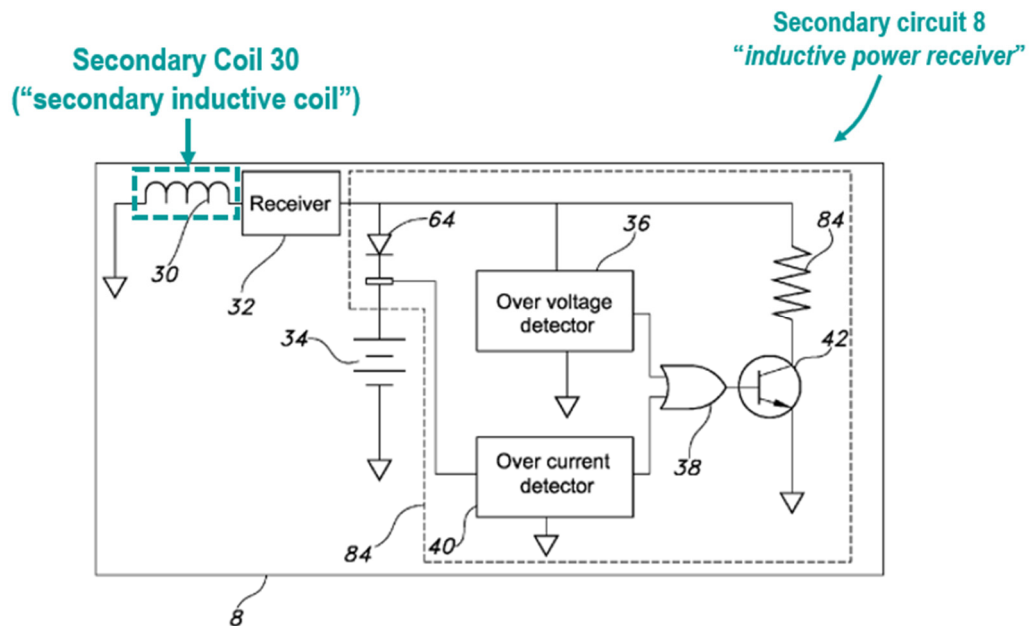
116. Baarman392 further discloses that the secondary coil 30 is wired to a battery 34 (**electric load**), as shown in FIG. 2:



EX1006, FIG. 2 (modified, cropped, annotated); *see also id.*, [0032], [0040]-[0044], FIG. 5.

Element [1.3]: said secondary inductive coil associated with an inductive power receiver

117. The Baarman392-Tocci combination provides Element [1.3]. For example, as described above with respect to Element [1.2], Baarman392 discloses a secondary coil 30 (**secondary inductive coil**) associated with a portable electronic device including a secondary circuit 8 (**an inductive power receiver**). *Above*, Element [1.2]; EX1004, [0032], [0035], [0038], [0040], FIGS. 2, 5.



Element [1.4]: *wherein said driver is configured to provide a driving voltage across said primary inductive coil,*

118. The Baarman392-Tocci combination provides Element [1.4]. For example, Baarman392 discloses that the inverter 10 in charger circuit 6 “provides AC (alternating current) power to the tank circuit 12 from a source of DC (direct current) power 14.” EX1006, [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 the inverter 10 in connection with driver 16 (components of the recited “**driver**” as described in Element [1.1] above) provides a driving voltage across the primary

inductive coil 15, whether in series resonant or parallel resonant tank circuit configuration.

Element [1.5]: *said driving voltage oscillating at a non-resonant transmission frequency substantially different from said characteristic resonant frequency of said inductive couple,*

119. The Baarman392-Tocci combination provides Element [1.5]. 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.*

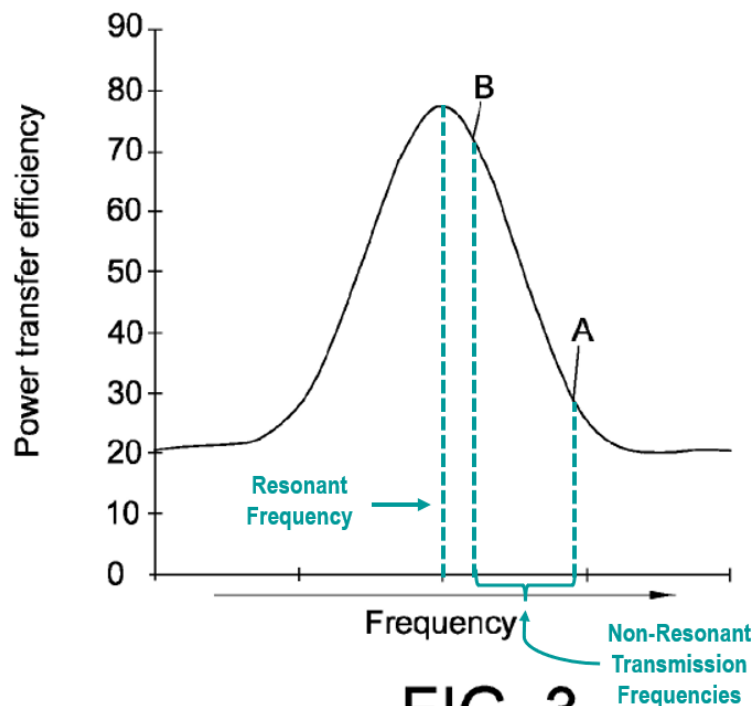


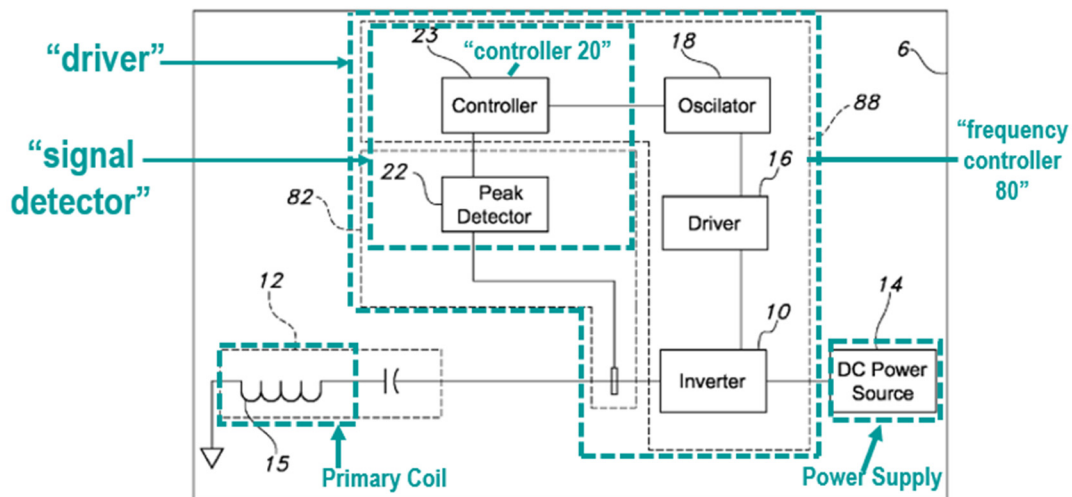
FIG. 3

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. Baarman392’s inverter 10 (in connection with driver 16) produces a driving voltage at a non-resonant transmission frequency within a near-linear region of the power transfer curve. Based on my review, and consistent with the specification and file history of the ’204 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. This is evident at least from the 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 ’204 specification. Baarman392 thus 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.

Element [1.6]: *wherein said inductive power outlet further comprises a signal detector adapted to detect a first signal and a second signal, and*

121. The Baarman392-Tocci combination provides Element [1.6]. 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). EX1006, [0034]-[0037], [0039], [0045]-[0046], FIGS. 2, 4A-4B, 5.



EX1006, FIG. 2 (annotated); *see also below*, Element [2]. 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). EX1006, [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.” EX1006, [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).

122. 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-Tocci combination. *See above*, Section X.C. 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 can be 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 X.C; EX1009, 57.

123. 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 X.C. In contrast, the first Boolean logic signal (**first signal**) would have been communicated to the charger circuit 8 by turning on 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.*; EX1006, [0020].

124. 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-Tocci combination each constitutes a "signal" as that term is used in the '204 patent. The specification of the '204 patent does not expressly define a "signal," but it does describe examples that demonstrate the breadth of this term in the '204 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 ’204 patent. The Baarman392-Tocci combination’s Boolean logic signals align with the example feedback signals described in the ’204 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 ’204 specification.

Element [1.7]: said driver is configured to: provide less power by increasing said non-resonant transmission frequency by an incremental value when said first signal is detected by the detector, and

125. The Baarman392-Tocci combination provides Element [1.7]. For example, Baarman392 discloses that the frequency controller 80 (a component of the claimed **driver**) is configured to provide less power by increasing the non-resonant transmission frequency by an incremental value when a feedback signal is detected that indicates an abnormal charging condition (e.g., an over-current or over-voltage situation). EX1004, [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 [sic: coil] 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 ΔFREQ ”), [0056] (“ ΔFREQ could be a constant, or it could be determined by obtaining the value from a lookup table”), [0033], [0038], FIGS. 3, 7.

126. Furthermore, as described above in Element [1.6], the predictable Baarman392-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 X.C; Element [1.6]; EX1009, 57. In this context, Baarman392-Tocci’s driver would have predictably provided less power by increasing the non-resonant transmission frequency by twice the value of ΔFREQ when the first Boolean logic signal is detected by the peak detector 22 and controller 20 (collectively, the claimed **signal detector**).

Element [1.8]: provide more power by decreasing said non-resonant transmission frequency by an incremental value when said second signal is detected by the detector.

127. The Baarman392-Tocci combination provides Element [1.8]. For example, Baarman392 discloses that the frequency controller 80 (a component of the claimed **driver**) 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). EX1004, [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 ΔFREQ . Step 116.”), [0056] (“ ΔFREQ could be a constant, or it could be determined by obtaining the value from a lookup table”), [0033], [0038], FIGS. 3, 7.

128. And, as described above in Element [1.6], the predictable Baarman392-Tocci combination can be implemented so that a normal charging condition would be represented by a second Boolean logic signal. (**second signal**), as HIGH. *Above*, Section X.C; Element [1.6]; EX1009, 57. In this context, Baarman392-Tocci’s driver would have predictably provided more power by decreasing the non-resonant transmission frequency by ΔFREQ when the second Boolean logic signal is detected by the peak detector 22 and controller 20 (collectively, the claimed **signal detector**).

Claim 2

***Element [2]: The system of claim 1 said signal detector
being configured to adjust said
transmission frequency in response to
feedback signals.***

129. The Baarman392-Tocci combination provides Element [2]. For example, Baarman392 discloses that controller 20—which, together with peak detector 22 provides the recited **signal detector** increases or decreases the non-resonant transmission frequency by an incremental value depending on the detection of feedback signals indicating either a normal or abnormal charging condition associated with battery 34. EX1004, [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. Based on Tocci’s suggestions, the signal detector of the Baarman392-Tocci combination would have predictably adjusted the transmission frequency in response to Boolean logic signals (**feedback signals**) that indicate either a normal or abnormal charging condition. *Above*, Section X; Elements [1.6]-[1.8].

130. Considering the usage of “said signal detector” in claim 2 (“said signal detector being configured to adjust ...”) compared to the usage of “said driver” in other claims of the ’204 patent (e.g. claim 10 (“said driver adjusting ...”)) and the

related '696 patent's claim 3 ("said driver being configured to adjust ..."), the '204 patent contemplates that the **"signal detector"** may be a part of the **"driver."** EX1001, Cl. 10; EX1016, Cl. 3. This is consistent with the fact that the specification describes the "driver" as adjusting the transmission frequency and then claim 2 recites the "signal detector being configured to adjust said transmission frequency." EX1001, 4:14-17, 4:65-5:7, 21:47-55, 22:40-44; 27:51-61.

Claim 3

*Element [3]: The system of claim 2 wherein said
feedback signals carry data pertaining to
the operational parameters of said electric
load.*

131. The Baarman392-Tocci combination provides Element [3]. For example, in the resulting combination detailed above, the first Boolean logic signal (a first **"feedback signal"**) is communicated to and detected by the signal detector at charger circuit 6 in response to a detected over-voltage or over-current situation with respect to battery 34 at secondary circuit 8. EX1006, [0013]-[0014], [0035]-[0036], [0046], FIGS. 2, 5, 7; *above*, Section X.C, Elements [1.6]-[1.7], [2]. The first Boolean logic signal thus carries data pertaining to the operating voltage and current (**operational parameters**) of the battery 34 (**electric load**).

132. Likewise, in the resulting combination detailed above, the second Boolean logic signal (a second **"feedback signal"**) is communicated to and detected

by the signal detector at charger circuit 6 when the battery 34 is not operating in an over-current or over-voltage situation. EX1006, [0013]-[0014], [0035]-[0036], [0046], FIGS. 2, 5, 7; *above*, Section X.C, Elements [1.6], [1.8], [2]. The second Boolean logic signal thus also carries data pertaining to the operating voltage and current (**operational parameters**) of the battery 34 (**electric load**).

Claim 4

Element [4]: The system of claim 3 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.

133. The Baarman392-Tocci combination provides Element [4]. Based on my review, and as I discussed above with respect to claim 3, it is clear that the first and second Boolean logic signals representing normal or abnormal charging conditions in the Baarman392-Tocci combination carry data “pertaining to” a measured operating voltage and a measured operating current (**operational**

parameters) of the battery 34 (**electric load**). *Above*, Claim 3; *see also* EX1006, [0013]-[0014], [0035]-[0036], [0046], FIGS. 2, 5, 7; *above*, Section X.C, Elements [1.6]-[1.8]; [2]. The operating voltage and current parameters in this context are a “**measured operating voltage for said electric load**” and a “**measured operating current for said electric load**,” as recited in claim 4. This follows given that the over-voltage detector 36 and over-current detector 40 measure an operating voltage and current of the battery 34, respectively, relative to defined thresholds, to determine whether the voltage and current fall within normal or abnormal ranges. EX1006, [0035] and FIG. 2; *see also id.* [0043]-[0044], [0050], FIG. 5.

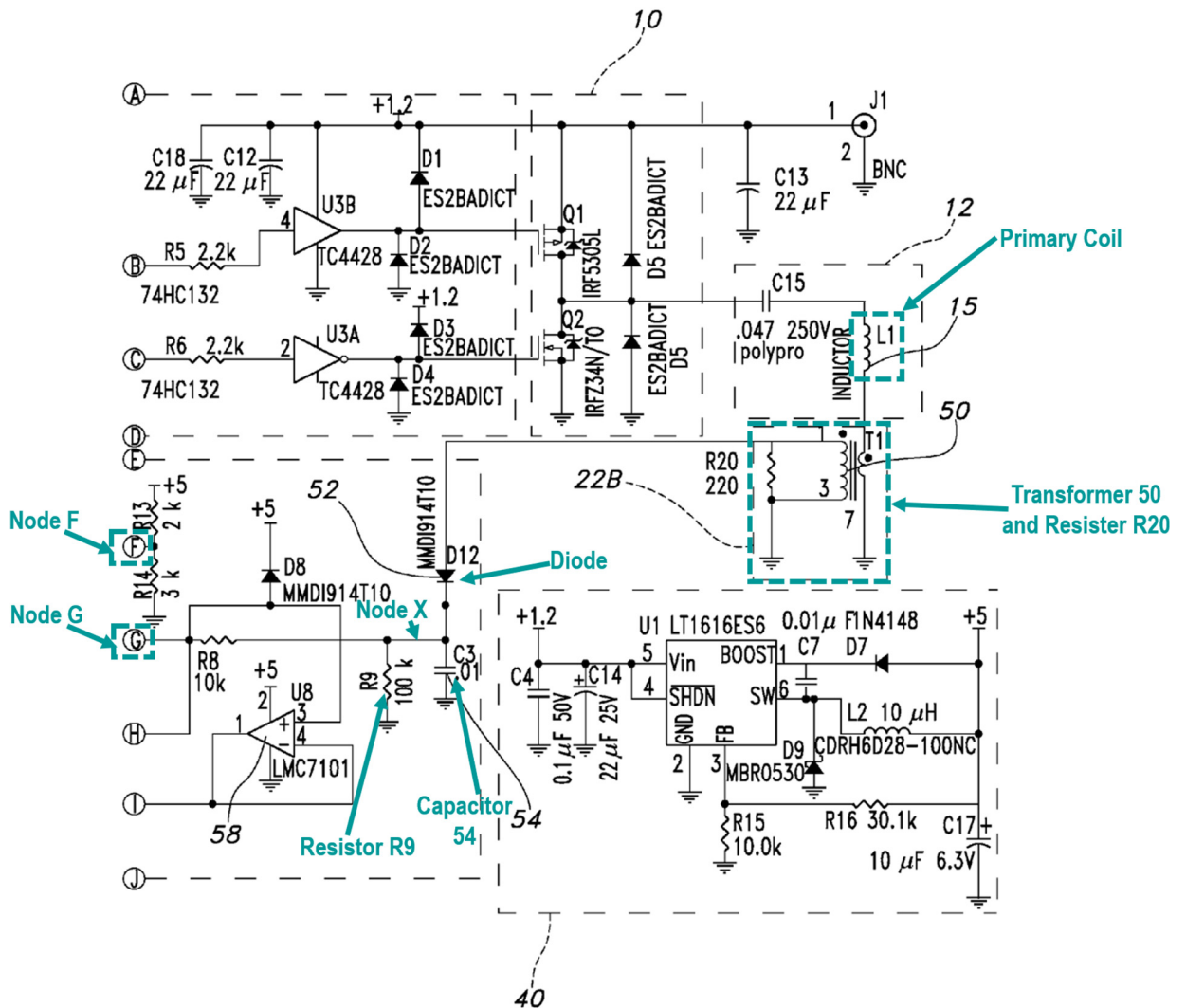
Claim 5

Element [5]: The system of claim 1 wherein said signal detector is selected from the list comprising optical detectors, radio receivers, audio detectors and voltage peak detectors.

134. The Baarman392-Tocci combination provides Element [5]. 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.” EX1006, [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.*

135. To elaborate on Baarman392, the information from the secondary circuit 8 to be measured by controller 20 takes two paths: (1) a path that generates a digital (Boolean) 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). Path (1) is relevant to Claim 5.

136. 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 inductor (Fig. 4B).



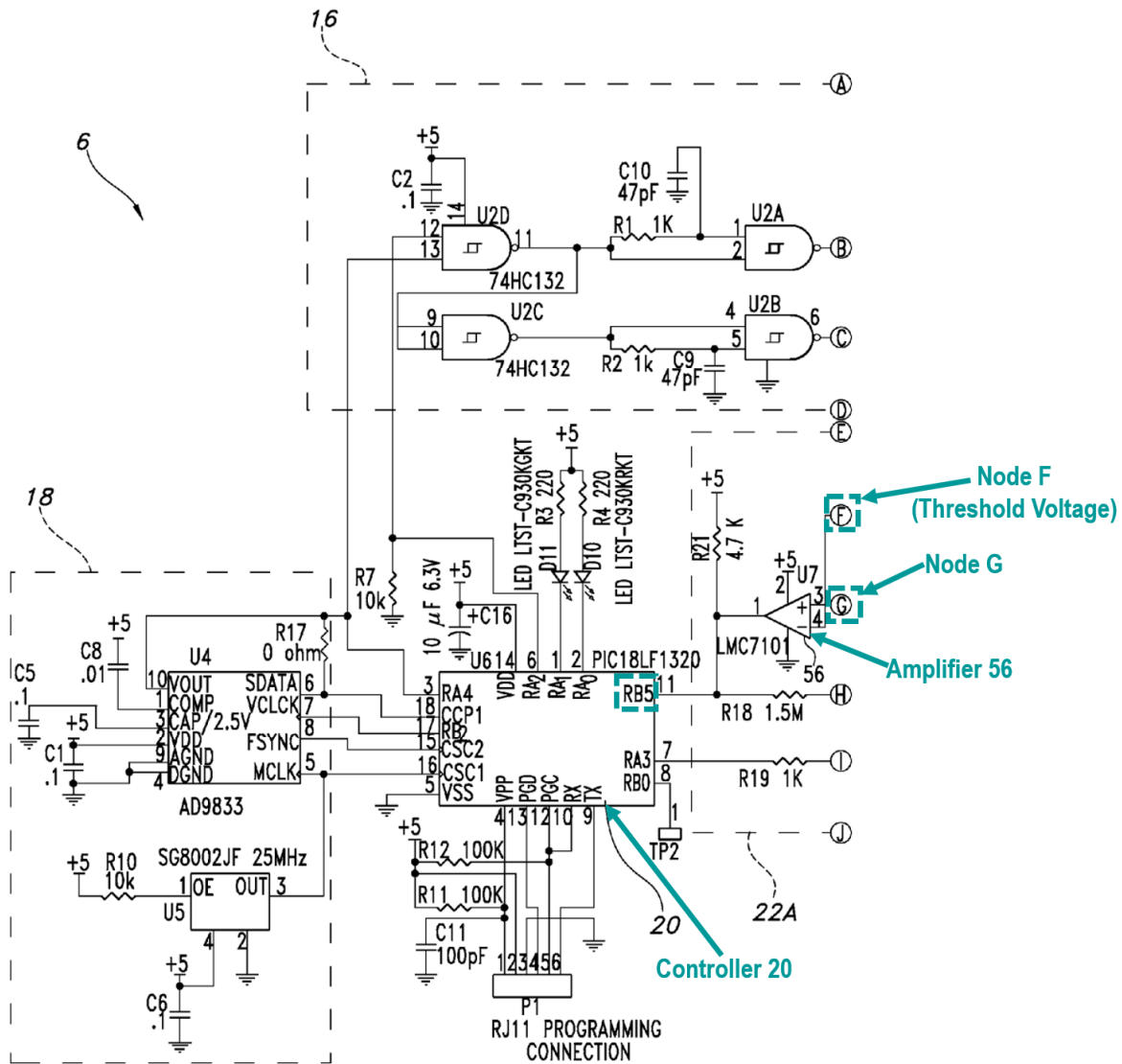
EX1006, FIG. 4B (annotated).

137. 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 the 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).

138. 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.

139. 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).

140. 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.” EX1006, [0045].

141. 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.

142. 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 based on component values shown 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. *See* EX1006, FIG. 4B.

Claim 6

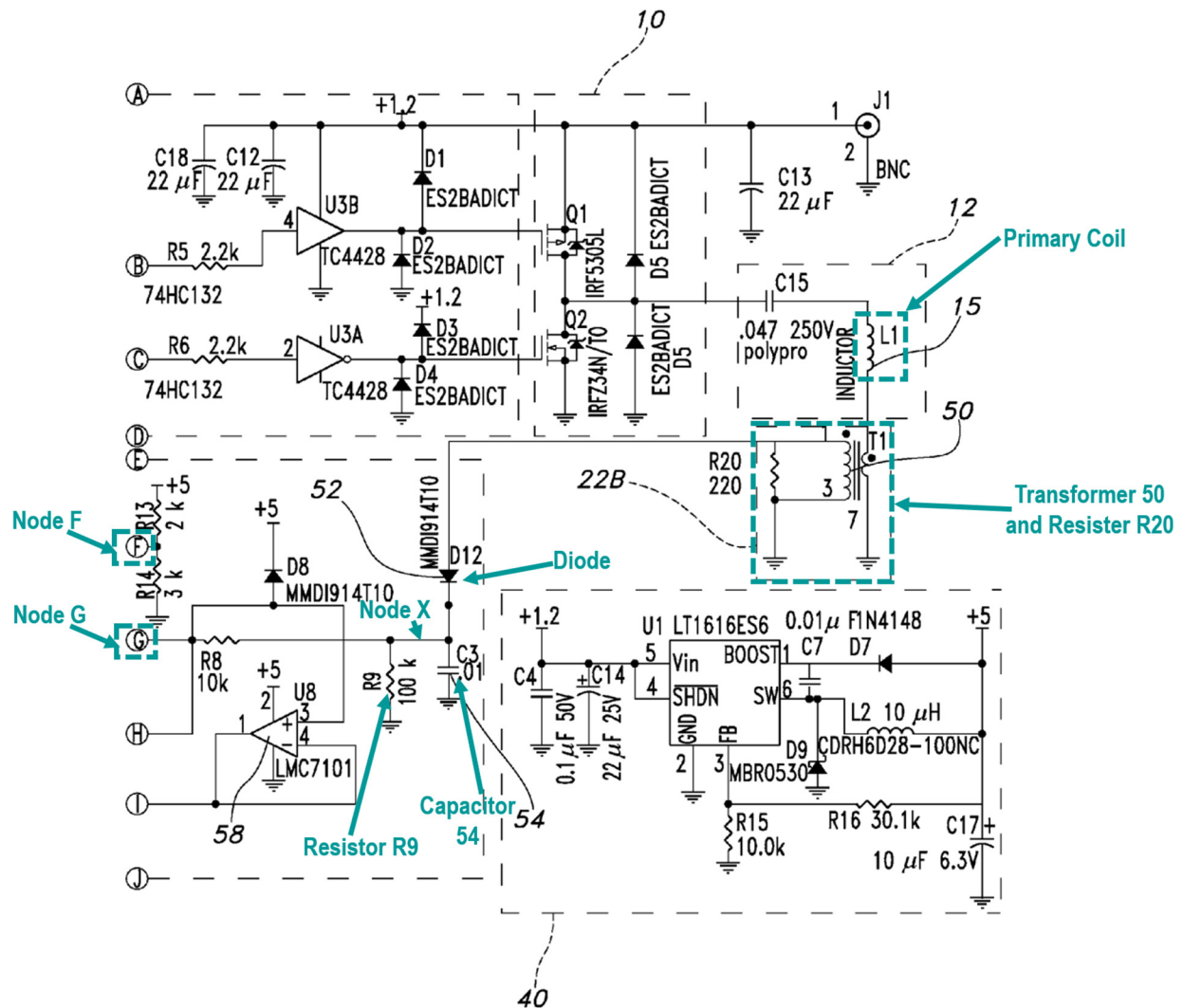
Element [6]: The system of claim 1 wherein said driver further comprises a voltage monitor for monitoring the amplitude of a primary voltage across said primary coil.

143. The Baarman392-Tocci combination provides Element [6]. As I have explained above (Claim 5) 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.

144. Baarman392 discloses that peak detector 22 (a component of the claimed **driver**) implements voltage amplitude detection and voltage peak detection for reasons described in further detail below and in the analysis of claim 5 above.

145. 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 6.



EX1006, FIG. 4B (annotated).

146. 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

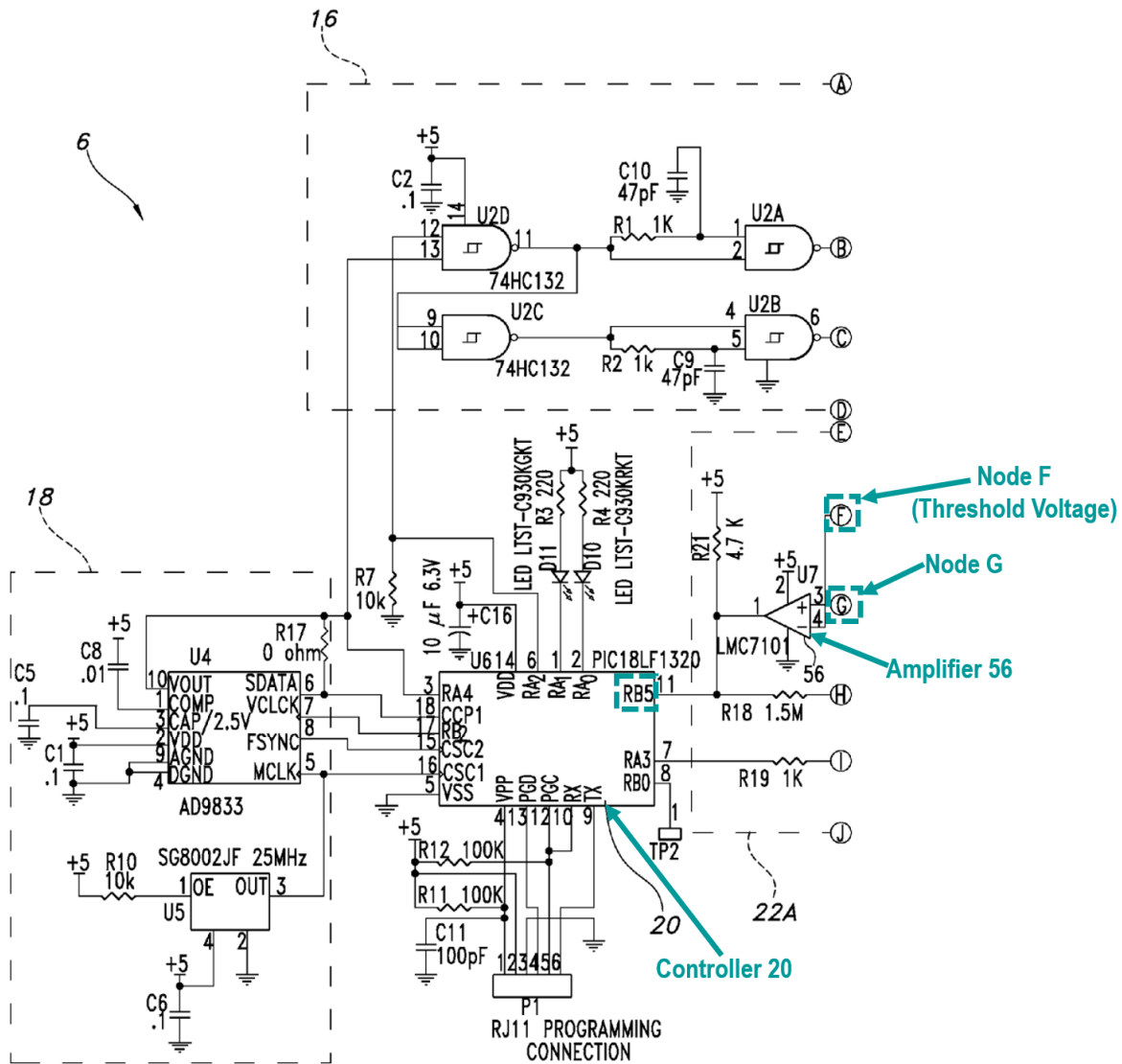
frequency B. Frequency B is somewhat less than the resonant frequency. Between frequency A and frequency B, the power transfer curve can be piece-wise linearized by a software lookup table located in the controller 20.”)

147. 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 the current in a circuit element 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 amplitude and phase of the current, one can obtain the amplitude and phase of the voltage 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.

148. 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).

149. 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).

150. Even if Baarman392 does not expressly describe its peak detector 22 as a voltage monitor, Baarman 392 nonetheless contemplates monitoring “other characteristics of the power in the charger circuit 6 may be evaluated to provide charge information regarding the battery.” EX1008, [0034]. In this context, 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. Additionally, voltage and current monitors were commonly implemented before the Critical Date and different types of monitoring circuits were commonly substituted while achieving predictable results and meeting the needs/constraints of a given design. *Id.* For example, a POSITA would have sought to use a different voltage monitoring circuit with less expensive components than Baarman392’s current peak detector 22 in many designs.

Claim 8

Element [8]: The system 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.

151. The Baarman392-Tocci combination provides Element [8]. For example, Baarman392 discloses a “rectifier 32” (**AC-to-DC converter**) in the secondary circuit 8 that receives AC power from the secondary coil 30 and rectifies the AC power to “provide[] DC power to charge the battery 34.” EX1006, [0035], FIG. 2; *see also id.*, [0040] (“A rectifier 32 produces a DC current from the AC current supplied by secondary coil 30.”), FIG. 5.

Claim 10

Element [10.P]: A method for regulating inductive power transmission from a primary inductive coil, wired to a power supply via a driver, to a secondary inductive coil, wired to an electric load, said method comprising the following steps:

152. The Baarman392-Tocci combination provides Element [10.P]. For example, Baarman392 discloses an inductive charging system 4 comprising a primary inductive coil 15, wired to a power supply (e.g., DC power source 14) via a driver (e.g., inverter 10 in connection with driver 16 and peak detector 22), to a secondary inductive coil 30, wired to an electric load (e.g., battery 34). *Above*, Elements [1.P]-[1.3]. Baarman392 further discloses the recited method for regulating inductive power transmission. *See, e.g.*, EX1006, [0019], [0038], [0048]-[0064], FIG. 7 (flowchart depicting method for regulation of inductive power transmission).

Element [10.1]: providing an oscillating voltage to said primary inductive coil at an initial transmission frequency f_t substantially different from a characteristic resonant frequency f_R of the system;

153. The Baarman392-Tocci combination provides Element [10.1] for each of the reasons that I described above with respect to Elements [1.4]-[1.5]. For example, Baarman392 discloses providing an oscillating voltage to the primary inductive coil 15 at an initial transmission frequency (e.g., a frequency between “A”

and “B” in FIG. 3) substantially different from a characteristic resonant frequency of the system. EX1006, [0038]; *see also id.*, [0015]-[0019], [0055]-[0057], FIGS. 2-3, 7; *above*, Elements [1.4]-[1.5]; Section VII.

Element [10.2]: inducing a secondary voltage in said secondary inductive coil;

154. The Baarman392-Tocci combination provides Element [10.2]. For example, Baarman392 discloses inducing a secondary voltage in secondary inductive coil 30. EX1006, [0035] (“The secondary coil 30 inductively receives power from the primary coil 15.”), (“The secondary circuit 8 generally includes a secondary coil 30 for receiving inductive power from the charger circuit 6”), [0038], FIGS. 2-3, 7.

Element [10.3]: monitoring power received by said electric load;

155. The Baarman392-Tocci combination provides Element [10.3]. For example, Baarman392 discloses that secondary circuit 8 includes an over-voltage detector 36 and an over-current detector 40 to monitor for over-voltage and over-current conditions with respect to the battery 34. EX1006, [0035]-[0036], [0043]-[0044], [0050], FIGS. 2, 5. Voltage and current are each a component of electrical power and detectors 36, 40 thus monitor power received by the battery 34.

Element [10.4]: sending a feedback signal when the monitored power deviates from a predetermined range;

156. The Baarman392-Tocci combination provides Element [10.4] for each of the reasons that I described above with respect to Elements [1.6]-[1.7]. For example, Baarman392 discloses that secondary circuit 8 sends a feedback signal to charger circuit 6 indicative of an abnormal charging condition when detectors 36, 40 detect an over-current or over-voltage situation with respect to the battery 34. EX1006, [0035]-[0036], [0043]-[0044], [0050], FIGS. 2, 5; *above*, Elements [1.6]-[1.7]. In the predictable Baarman392-Tocci combination, this feedback signal is expressed as a Boolean logic signal (e.g., HIGH). EX1009, 57; *above*, Section X.C. Voltage and current are each a component of electrical power, and the feedback signal is thus sent when the monitored power deviates from a predetermined range (e.g., when the voltage across and/or current received by the battery 34 exceed a threshold value that defines the recited “predetermined range”). EX1006, [0035]. The threshold values are pre-determined by the values of multiple components such as R2-R4, R13-15, R20, C3, and also by parameters set in the firmware of controller 20. [Figs 4A, 4B, 5]

***Element [10.5]: said driver receiving said feedback signal;
and***

157. The Baarman392-Tocci combination provides Element [10.5]. For example, Baarman392 discloses that peak detector 22—i.e., a component of the recited “**driver**” along with inverter 10, driver 16, and oscillator 18—receives

feedback signals communicated from the secondary circuit 8 (including feedback signals represented by surging current induced in primary coil 15). EX1006, [0034]-[0037], [0039], [0045]-[0046], FIGS. 2, 4A-4B, 5. “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.” *Id.*, [0037], [0034], FIG. 6; *see also id.*, [0039], [0045]-[0046], FIG. 6. Further, in the system resulting from the predictable Baarman392-Tocci combination, the feedback signal that the peak detector 22 receives is a measure of current through the primary coil 15 within a range defined for a first Boolean logic signal. EX1009, 57; *above*, Section X.C, Elements [1.6], [10.4].

Element [10.6]: said driver adjusting said non-resonant transmission frequency.

158. The Baarman392-Tocci combination provides Element [10.6]. For example, Baarman392 discloses that frequency controller 80 (components of the “**driver**”) adjusts the non-resonant transmission frequency depending on whether feedback is received from the secondary circuit 8 indicating an abnormal charging condition (e.g., an over-voltage or over-current state of battery 34). EX1006, [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 of the tank circuit,

while 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], [0032]-[0033], [0038], [0056], [0059], FIGS. 3, 7.; *above*, Section X.C, Elements [1.7]-[1.8].

Claim 11

Element [11]: The method of claim 10 wherein the step of sending a feedback signal further comprises: sending a feedback signal of a first type Sa to said driver, whenever said power drops below a predetermined lower threshold, and sending a feedback signal of a second type Sb to said driver, whenever said power exceeds a predetermined upper threshold.

159. The Baarman392-Tocci combination provides Element [11]. For example, as I described above in the overview of the Baarman392-Tocci combination (Section X.C) and with respect to Elements [1.7]-[1.8], the Baarman392-Tocci system predictably sends to the charger circuit 6 (including peak detector 22—a component of the claimed “**driver**”) a first form of feedback corresponding to a first Boolean logic signal (**a feedback signal of a first type Sa**) indicative of a normal charging condition, whenever the voltage and current of the battery 34 do not exceed a threshold value (i.e., **whenever said power drops below a predetermined lower threshold**). *Above*, Section X.C; Elements [1.7]-[1.8]; EX1006, [0034]-[0037], [0050], [0019], [0055], FIG. 7. The resulting Baarman392-

Tocci system also predictably sends to the charger circuit 6 (including peak detector 22—a component of the claimed “**driver**”) a second form of feedback corresponding to a second Boolean logic signal (**a feedback signal of a second type Sb**) indicative of an abnormal charging condition, whenever the voltage or current of the battery 34 exceed a threshold value (i.e., **whenever said power exceeds a predetermined upper threshold**). *Id.*; see also EX1006, [0059].

Claim 12

Element [12]: The method of claim 10 wherein said initial non-resonant transmission frequency f_t is higher than the characteristic resonant frequency f_R .

160. The Baarman392-Tocci combination provides Element [12]. For example, Baarman392 discloses that an initial non-resonant transmission frequency f_t is a frequency in the near-linear region (e.g., between frequencies A and B in FIG. 3) is higher than the characteristic resonant frequency f_R . EX1006, (“In this embodiment, 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 of the tank circuit, while 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 of the tank circuit.”), [0038] (“Generally, the inverter 10 is operated between frequency A and frequency B.”), [0054]-[0055]

(“FREQ_START”), FIG. 7 (110), FIG. 3.

Claim 13

Element [13]: The method of claim 10 wherein the step of said driver adjusting said non-resonant transmission frequency further comprises: said driver reducing said non-resonant transmission frequency by an incremental value $df1$ when the received feedback signal is of the first type Sa , and said driver increasing said non-resonant transmission frequency by an incremental value $+df2$ when the received feedback signal is of the second type Sb .

161. The Baarman392-Tocci combination provides Element [13]. For example, the combination provides a driver that reduces the non-resonant transmission frequency by an incremental value $df1$ when the received feedback signal is of the first type Sa for the reasons described above with respect to Element [1.8]. *Above*, Element [1.8]. The combination also provides that the driver increases the non-resonant transmission frequency by an incremental value $+df2$ when the received feedback signal is of the second type Sb for the reasons described above with respect to Element [1.7]. *Above*, Element [1.7]; Section X.C. Here, the feedback signal of the first type Sa of claim 13 corresponds to the second signal in claim 1 and the feedback signal of the second type Sb of claim 13 corresponds to the first signal in claim 1.

XI. OVERVIEW OF CONCLUSIONS FORMED

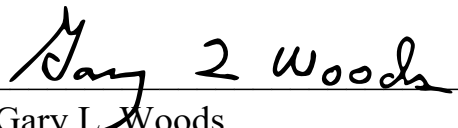
162. This declaration explains the conclusions that I have formed based on my independent analysis. To summarize those conclusions:

- Based upon my knowledge and experience, and my review of the materials listed above, Claims 1-6, 8, and 10-13 of the '204 patent are anticipated by Onishi (EX1004). *See above*, Ground 1A—Section VIII.
- Based upon my knowledge and experience, and my review of the materials listed above, Claims 1-6, 8, and 10-13 of the '204 patent are rendered obvious by Onishi (EX1004) in view of Purdy (EX1005). *See above*, Ground 1B—Section IX.
- Based upon my knowledge and experience, and my review of the materials listed above, Claims 1-6, 8, and 10-13 of the '204 patent are rendered obvious by Baarman³⁹² (EX1006) in view of Tocci (EX1009). *See above*, Ground 2—Section X.

XII. CONCLUSION

163. 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 13th day of August, 2024.



Dr. Gary L. Woods

APPENDIX A

Gary L. Woods *Curriculum Vitae*

Updated Jan. 2024

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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.

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Conference papers and presentations

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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.