UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.
Petitioner

v.

MOJO MOBILITY INC.
Patent Owner

Patent No. 11,316,371

**DECLARATION OF R. JACOB BAKER, PH.D., P.E.
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 11,316,371**

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IX. THE PRIOR ART DISCLOSES OR SUGGESTS ALL RECITED FEATURES OF CLAIMS 28 and 29 OF THE '371 PATENT 100

A. Ground 1: *Okada* in view of *Odendaal*, *Shima*, *Hui-027*, and *Kook* Discloses and/or Suggests the Features of Claim 28 100

1. Claim 28 100

a) A system for providing power inductively to a portable device comprising a battery and an inductive receiver unit including a receiver coil and a receiver circuit, the system comprising: 100

b) a primary coil that is substantially planar and parallel to a surface of the system for providing power inductively to the portable device, wherein the primary coil comprises a flexible Printed Circuit Board (PCB), multi-turn coil having multiple layers of substantially similar patterns of substantially spiral-shaped conductors of 1 to 4 ounce copper thickness for each layer and having coil patterns electrically connected with vias between the layers; 115

c) Limitation 28(c) 145

(1) a drive circuit, including a FET driver, a capacitor and a FET switch, coupled to a DC voltage input and coupled to the primary coil, ... 146

(2) wherein during operation the drive circuit is configured to apply an alternating electrical current to the primary coil at an operating frequency within a range of 100 kHz to 1 MHz and duty cycle to generate an alternating magnetic field in a direction substantially perpendicular to the surface of the primary coil to provide power inductively to the portable device; 162

d) a sense circuit to monitor current flow through the primary coil during operation of the drive circuit to sense a current modulation in the primary coil from a modulation of a current in the receiver coil; and.....167

e) a communication and control circuit, including a microcontroller coupled to the drive circuit and the sense circuit, configured to:.....174

f) detect, through the sense circuit, a received communication of information in the current modulation in the primary coil; 180

g) operate the drive circuit to inductively transfer sufficient power to the inductive receiver unit to activate and power the receiver circuit to enable the receiver circuit to communicate the information in the current modulation in the primary coil;.....181

h) from the information communicated by the receiver circuit, determine a power parameter; and 187

i) operate the drive circuit according to the power parameter to provide power inductively from the primary coil to the receiver coil to power the microcontroller and to charge the battery of the portable device,.....187

j) wherein to charge the battery of the portable device the communication and control circuit is further configured to: receive additional information in the current modulation in the primary coil from modulation of the current in the receiver coil corresponding to a voltage or current at an output of the receiver circuit while charging the battery of the portable device; and.....194

k) regulate in a closed loop feedback manner, the voltage or current at the output of the receiver circuit in accordance with the received additional information corresponding to the voltage or current at the output of the receiver circuit by adjusting at least one of the operating frequency, the duty cycle, and the DC voltage input to the drive circuit during charging of the battery of the portable device. 198

B. Ground 2: *Okada* in view of *Odendaal*, *Shima*, *Hui-027*, *Kook*, and *Kazutoshi* Discloses and/or Suggests the Features of Claim 29 200

1. Claim 29 200

a) The system of claim 28, wherein: the sense circuit includes a low pass filter and an amplifier; and 200

b) the closed loop feedback manner comprises a Proportional-Integral-Derivative (PID) control technique for regulating the voltage or current at the output of the receiver circuit. 203

X. CONCLUSION 209

I, R. Jacob Baker, Ph.D., P.E., declare as follows:

I. INTRODUCTION

1. I have been retained by Samsung Electronics Co., Ltd. ("Petitioner") as an independent expert consultant in this proceeding before the United States Patent and Trademark Office ("PTO") against Mojo Mobility Inc. ("Patent Owner") regarding U.S. Patent No. 11,316,371 ("the '371 patent") (Ex. 1001).[1] I have been asked to consider whether the prior art discloses or suggests the features recited in claims 28 and 29 ("the challenged claims") of the '371 patent. My opinions are set forth below.

2. I am being compensated at a rate of $765/hour for my work in this proceeding. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other interest in this proceeding.

[1] Where appropriate, I refer to exhibits that I understand are to be attached to the petition for *Inter Partes* Review of the '371 patent.

II. BACKGROUND AND QUALIFICATIONS

3. I presently serve as a Professor of Electrical and Computer Engineering at the University of Nevada, Las Vegas (UNLV). All of my opinions stated in this declaration are based on my own personal knowledge and professional judgment. In forming my opinions, I have relied on my knowledge and experience in designing, developing, researching, and teaching regarding integrated circuit design and power electronics.

4. I am over 18 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein. I understand that a copy of my current curriculum vitae, which details my education and professional and academic experience, is being submitted by Petitioner as Exhibit 1003. The following provides an overview of some of my experience that is relevant to the matters set forth in this declaration.

5. I have been teaching electrical engineering at UNLV since 2012. Prior to this position, I was a Professor of Electrical and Computer Engineering at Boise State University from 2000. Prior to my position at Boise State University, I was an Associate Professor of Electrical Engineering between 1998 and 2000 and Assistant

Professor of Electrical Engineering between 1993 and 1998 at the University of Idaho. I have been teaching electrical engineering since 1991.

6. I received my Ph.D. in Electrical Engineering from the University of Nevada, Reno in 1993. I also received a MS and BS in Electrical Engineering from UNLV in 1988 and 1986, respectively.

7. As described in my CV, I am a licensed Professional Engineer and have more than 35 years of industry and academic experience, including extensive experience in power electronics circuit design. My Ph.D. dissertation developed a way to stack power MOSFETs to increase the maximum voltage that they could switch in nanoseconds. The work from this dissertation was published in the paper "Transformerless Capacitive Coupling of Gate Signals for Series Operation of Power MOS Devices," and published in the IEEE Transactions on Power Electronics. The work was well-received and it won the best paper award from this journal in 2000. Further, my research has focused on the design of inductors using novel fabrication techniques. One of my Master's students fabricated a three-dimensional inductor using thru-vias to minimize the inductor's size. This work was reported in the Thesis "Design Guide for CMOS Process On-Chip 3D Inductors using Thru-Wafer Vias" published in 2011. More recently I have been looking at

ways to supply power to remote regions of the world. This effort resulted in a doctoral student finishing his dissertation entitled "Designing, Building, and Testing a Solar Thermoelectric Generation, STEG, for Energy Delivery to Remote Residential Areas in Developing Regions" published in 2015.

8. I have taught courses in integrated circuit design (analog, digital, mixed-signal, memory circuit design, etc.), linear circuits, microelectronics, communication systems, power electronics, and fiber optics. As a professor, I have been the main advisor to over 100 Master's and Doctoral students.

9. I am the author of several books covering the area of integrated circuit design including: DRAM Circuit Design: Fundamental and High-Speed Topics (two editions), CMOS Circuit Design, Layout, and Simulation (four editions), and CMOS Mixed-Signal Circuit Design (two editions). I have authored, and coauthored, more than 100 papers and presentations in the areas of solid-state circuit design, and I am the named inventor on over 150 granted U.S. patents.

10. I have received numerous awards for my work, including the Frederick Emmons Terman (the "Father of Silicon Valley") Award. The Terman Award is bestowed annually upon an outstanding young electrical/computer engineering educator in recognition of the educator's contributions to the profession.

11. I am a Fellow of the IEEE for contributions to memory circuit design. I have also received the IEEE Circuits and Systems Education Award (2011).

12. I have received the President's Research and Scholarship Award (2005), Honored Faculty Member recognition (2003), and Outstanding Department of Electrical Engineering Faculty recognition (2001), all from Boise State University. I have also received the Tau Beta Pi Outstanding Electrical and Computer Engineering Professor award four of the years I have been at UNLV.

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

III. MATERIALS REVIEWED

14. The opinions contained in this Declaration are based on the documents I reviewed, my professional judgment, as well as my education, experience, and knowledge regarding electrical engineering, and energy transfer systems and components, including inductive-based power transfer and related technologies.

15. In forming my opinions expressed in this Declaration, I reviewed the following materials and information:

Ex. 1001	U.S. Patent No. 11,316,371
Ex. 1004	Prosecution History of U.S. Patent No. 11,316,371
Ex. 1005	Translation of Japanese Patent Application Publication No. 2006-141170A ("*Okada*")[2]
Ex. 1006	U.S. Patent No. 6,912,137 ("*Berghegger*")
Ex. 1007	U.S. Patent Application Publication No. 2006/0145660A1 ("*Black*")
Ex. 1008	U.S. Patent No. 6,960,968 ("*Odendaal*")
Ex. 1009	U.S. Patent No. 6,489,745 ("*Koreis*")
Ex. 1010	U.S. Patent No. 6,366,817 ("*Kung*")

[2] Exhibit 1005 includes the original Japanese version and a certified English translation. Citations to *Okada* are to the English translation.

Ex. 1011	Physics, Henry Semat et al., Rinehart & Co., Inc., 1958, Chapters 29-32 ("*Semat*")
Ex. 1012	U.S. Patent No. 5,702,431 ("*Wang*")
Ex. 1013	International Patent Application Publication No. WO1996040367 ("*WangII*")
Ex. 1014	Handbook of Radio and Wireless Technology, Stan Gibilisco, McGraw-Hill, 1999 ("*Gibilisco*")
Ex. 1015	U.S. Patent No. 4,942,352 ("*Sano*")
Ex. 1016	Fundamentals of Electric Circuits, 2d., Charles Alexander et al., McGraw-Hill, 2004 ("*Alexander*")
Ex. 1017	International Patent Application Publication No. WO1994/18683 ("*Koehler*")
Ex. 1019	U.S. Patent Application Publication No. 2005/0068019 ("*Nakamura*")
Ex. 1020	U.S. Patent Application Publication No. 2007/0109708 ("*Hussman*")
Ex. 1021	U.S. Patent Application Publication No. 2003/0210106 ("*Cheng*")
Ex. 1023	U.S. Patent Application Publication No. 2004/0201988 ("*Allen*")
Ex. 1024	U.S. Patent No. 7,378,817 ("*Calhoon-817*")
Ex. 1025	International Patent Application Publication No. WO2003/096361 ("*Cheng*")
Ex. 1026	International Patent Application Publication No. WO2004/038888 ("*ChengII*")

Ex. 1027	Spiral Inductor Design for Quality Factor, Sang-Gug Lee et al., Journal of Semiconductor Technology and Science, Vol. 2. No. 1, March 2002 ("*Lee*")
Ex. 1028	U.S. Patent Application Publication No. 2001/0055207 ("*Barbeau*")
Ex. 1029	AN710 Antenna Circuit Design for RFID Applications
Ex. 1030	U.S. Patent No. 6,606,247 ("*Credelle*")
Ex. 1032	U.S. Patent No. 5,808,587 ("*Shima*")
Ex. 1034	U.S. Patent Application Publication No. 2005/0135129A1 ("*Kazutoshi*")
Ex. 1036	International Patent Application Publication No. WO2003/105308A1 ("*Hui*")
Ex. 1037	U.S. Patent No. 5,780,992 ("*Beard-1*")
Ex. 1044	U.S. Patent Application Publication No. 2007/0145830A1 ("*Lee-II*")
Ex. 1045	U.S. Patent Application Publication No. 2007/0267718A1 ("*Lee-Via*")
Ex. 1046	U.S. Patent Application Publication No. 2007/0026826A1 ("*Wilson*")
Ex. 1047	U.S. Patent Application Publication No. 2006/0202665 ("*Hsu*")
Ex. 1048	International Patent Application Publication No. WO2009155000A2 ("*Lin*")
Ex. 1049	U.S. Patent Application Publication No. 2008/0067874 ("*Tseng*")

Ex. 1050	U.S. Patent No. 9,356,473 ("*Ghovanloo*")
Ex. 1056	U.S. Patent No. 6,459,383 ("*Delatorre*")
Ex. 1057	International Patent Application Publication No. WO1999050806A1 ("*Cunningham*")
Ex. 1058	International Patent Application Publication No. WO2004026129A1 ("*Due-Hansen*")
Ex. 1059	U.S. Patent Application Publication No. 2009/0261778 ("*Kook*")
Ex. 1063	ATMEL e5530 Data Sheet (2002)
Ex. 1064	U.S. Patent Application Publication No. 2009/0243799A1 ("*Tetlow*")
Ex. 1068	U.S. Patent Application Publication No. 2003/0095027 ("*Hui-027*")
Ex. 1075	Watson, J., Mastering Electronics, Third Ed., McGraw-Hill, Inc. (1990) ("*Watson*")
Ex. 1076	Sedra, A., *et al.*, Microelectronic Circuits, Fourth Ed., Oxford University Press (1998) ("*Sedra*")
Ex. 1077	GB Patent Application Publication No. 2202414 ("*Logan*")
Ex. 1078	U.S. Patent No. 7,226,442 ("*Sheppard*")

16. I also reviewed any other materials I refer to in this Declaration in support of my opinions.

17. My opinions contained in this declaration are based on the documents I reviewed and my knowledge and professional judgment. My opinions have also been guided by my appreciation of how a person of ordinary skill in the art would have understood the state of the art, the prior art, and the claims and the specification of the ’371 patent at the time of the alleged invention.

18. I understand that the ’371 patent issued from U.S. Patent Application No. 17/507,323, filed on October 21, 2021, which is a continuation or continuation-in-part of a sequence of applications dated as early as January 30, 2007. (Ex. 1001, Cover, 2.) The ’371 patent also lists multiple provisional applications dated as early as January 31, 2006. (*Id*.) For purposes of rendering my opinions, I have been asked to initially consider that the time of the alleged invention of the challenged claims of the ’371 patent to be around the timeframe from April 2007 to December 2007. In particular, I have been asked to consider the following dates as representative of the alleged inventions for the following challenged claims:

- claim 28: around April 30, 2007 to July 30, 2007;
- claim 29: around September 12, 2007 to December 12, 2007.

My opinions reflect how one of ordinary skill in the art (which I described below) would have understood the ’371 patent, the prior art to the patent, and the state of

the art at the time of the alleged invention (e.g., from April 2007 to December 2007) as I was asked to consider noted above. My opinions concerning a person of ordinary skill in the art (including, for example, such a person's state-of-art knowledge, understandings and appreciations of the teachings of the prior art (and state-of-art), the '371 patent, etc.) are the same regardless of the dates in such identified date range.

19. Based on my experience and expertise, it is my opinion that the prior art discloses and/or suggests all the features recited in challenged claims 28 and 29 of the '371 patent, as I discuss in detail below.

IV. PERSON OF ORDINARY SKILL IN THE ART AND THE TIME OF THE ALLEGED INVENTION

20. Based on my knowledge and experience, I understand what a person of ordinary skill in the art would have known at the time of the alleged invention for the challenged claims here, which I discussed above in Section III as encompassing the April 2007 to December 2007 timeframe. (See Section III above.) My opinions herein are, where appropriate, based on my understandings as to a person of ordinary skill in the art at that time. In my opinion, based on the materials and information I have reviewed, and based on my experience in the technical areas relevant to the '371 patent, a person of ordinary skill in the art at the time of the alleged invention of the '371 patent would have had at least a master's degree in electrical engineering, or a similar discipline, and two or more years of experience with wireless charging systems, including, for example, inductive power transfer systems. More education can supplement practical experience and vice versa. I apply this understanding in my analysis herein.

21. All of my opinions in this declaration are from the perspective of one of ordinary skill in the art, during the relevant timeframe (e.g., the time of the alleged invention), which I discussed above as encompassing the April 2007 to December 2007 timeframe. (See Section III above.) My opinions in this declaration are also

applicable from the perspective of such a skilled person at other related timeframes (e.g., early-2007 to mid-2007 (claim 28), mid-to-late 2007 (claim 29) timeframes), and thus to the extent the time of the alleged invention was determined to be in such timeframes, my opinions in this declaration would not change.

V. TECHNICAL BACKGROUND

22. As I discuss further below in Sections VIII and IX, it is my opinion that the features recited in the '371 patent are disclosed or suggested in the prior art. Many of the claimed features relate to technologies/techniques that were conventional and known to persons of ordinary skill in the art at the time before the time of the alleged invention of the '371 patent.

23. Below, I present a brief overview of certain aspects of technologies/techniques/concepts that were known to a person of ordinary skill in the art prior to and at the time of the alleged invention of the '371 patent (see above at Section IV). The features, functionalities, and concepts I describe in this technical background section reflect the state of the art that a person of ordinary skill in the art would have had knowledge of and understood prior to and at the time of the alleged invention of the '371 patent. I rely on, and incorporate as applicable (even if not expressly mentioned below in Section IX), the following disclosures and opinions to support my opinions in this Declaration, including those opinions relating to how the prior art discloses and/or suggests the challenged claims of the '371 patent and how and why a person of ordinary skill in the art would have been motivated to consider and combine the disclosures and suggestions from one or more prior art

references as I explain below in Section IX. The concepts below would have been within the knowledge and mindset of a person of ordinary skill in the art at the time.

A. Electronic Circuits and Components

24. It was well known to a person of ordinary skill in the art prior to the alleged invention date that matter is made up of atoms, which include electrons orbiting a nucleus. (Ex. 1075, 7.) Free electrons, which are electrons that are not bound to any nucleus, are contained in large numbers in materials called conductors (e.g., metals such as copper), which conduct the flow of electrons in a uniform direction (this flow of electrons is called current, and is expressed in units of amperes). (*Id.*, 8-10.) On the other hand, "[m]aterials that are classed as insulators contain only a very few free electrons" and do not conduct current well. (*Id.*, 8.) It was well known in electrical engineering that current is at the heart of virtually all electrical principles and technologies.

25. A person of ordinary skill would have known that whereas current may flow continuously in one direction through a circuit (direct current), "[c]urrent that flows first one way and then the other is called *alternating current*, and a voltage source supplying such a current is called an *alternating voltage*." (*Id.*, 12 (emphasis in original).) It was known that "[a]lternating current is used for all mains power

supplies because a.c. [i.e., alternating current] permits the user of *transformers* to increase and decrease the voltage, so that the power can be transmitted from place to place using efficient high-voltage transmission lines." (*Id.* (emphasis in original).) It was known that alternating current and alternating voltage are periodic, and "[t]he rate at which the voltage reverses is the *frequency* of the alternation." (*Id.* (emphasis in original).)

26. A person of ordinary skill would have known that "[i]n addition to measuring the current flow, we also need to measure another factor, the potential difference between two points," which "is the energy difference between" the two points. (*Id.*, 10 (emphasis in original).) The potential difference is also called voltage and is expressed in units of volts. (*Id.*, 10.)

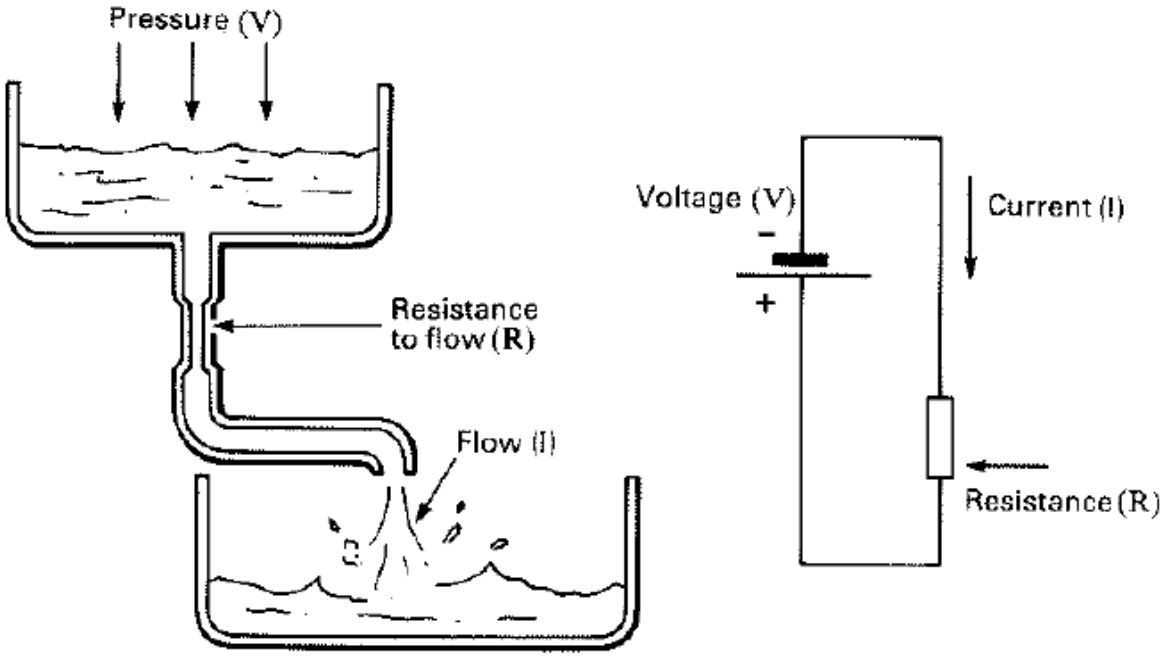
27. Additionally, a person of ordinary skill would have known that resistance is another fundamental concept involved in the flow of electrons. "Resistance is a property of all materials that reduces the flow of electricity through them," so that "[t]he higher the resistance, the more difficult it is for current to flow." (*Id.*, 10.) Resistance is expressed in units of ohms. (*Id.*, 11.)

28. A person of ordinary skill would have known that most circuit components are described as being *active* or *passive* components. (*Id.*, 19.) "Active

components use the movement of electrons ... to perform some function in the circuit," whereas "[p]assive devices ... do not control the movements of the electrons, but rather allow the electrons to flow through them." (*Id.*) A person of ordinary skill would have known that the most commonly encountered passive circuit component is the resistor, which is a "component[] intended to insert a known amount of resistance into an electrical circuit." (*Id.*)

29. The relationship between current (denoted by the letter I), voltage (denoted by the letter V), and resistance (denoted by the letter R) is given by Ohm's Law, V = I * R (i.e., voltage is current multiplied by resistance). (*Id.*, 10-11.) These three terms are shown in Figure 2.5 of *Watson* (a textbook regarding electronics), which shows how electrical principles are similar to principles relating to the flow of water.

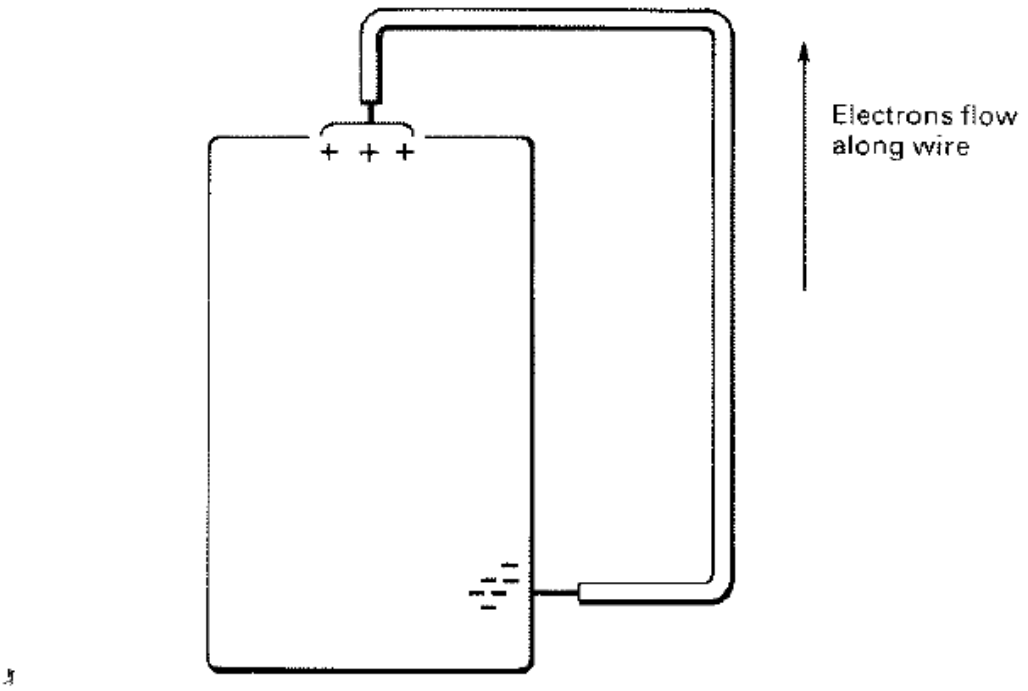
fig 2.5 *a plumbing analogy: voltage, current and resistance all have their equivalents in the water system*



(*Id.*, FIG. 2.5.)

30. A person of ordinary skill would have known that electrons (and thus current) flow in a circuit, as shown at the right side of Figure 2.5 above, and also in Figure 2.3 below.

fig 2.3 *electrons flowing in a circuit*



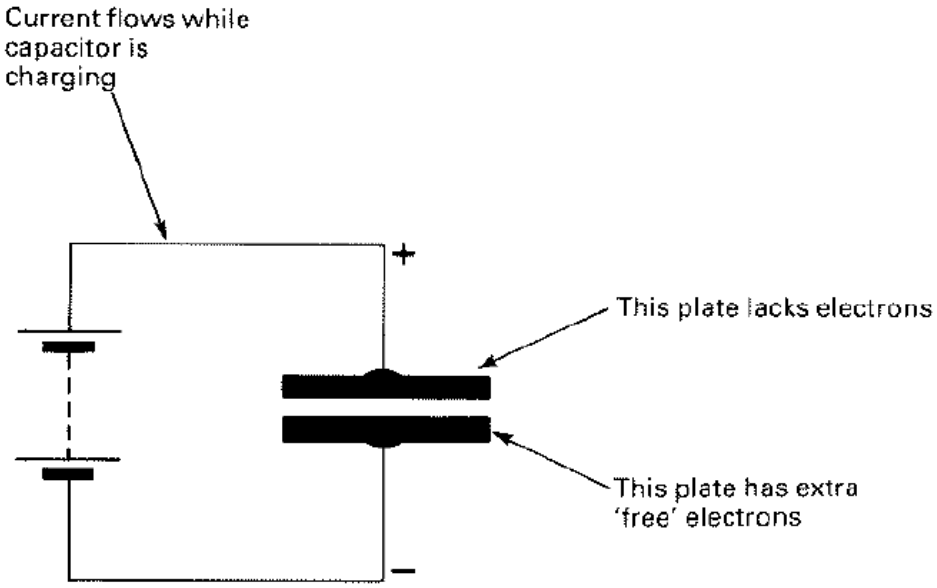
(*Id.*, FIG. 2.3.) A person of ordinary skill would have known that without such a closed path (e.g., as shown above in Figure 2.3), current cannot flow. (*Id.*, 8-11, FIGS. 2.3-2.5.)

31. It was well known that the amount of energy dissipated per unit time (power, expressed in units of watts) is expressed as the following formula: $P=VI$. (*Id.*, 19-20.)

32. A person of ordinary skill would have also known that "[n]ext to resistors, the most commonly encountered component is the *capacitor*," which is

another passive circuit component. (*Id.*, 25 (emphasis in original).) "A capacitor is a component that can store electric charge," and "[i]n essence, it consists of two flat parallel plates, very close to each other, but separated by an insulator." (*Id.*) A person of ordinary skill would have known that "[w]hen the capacitor is connected to a voltage supply, a current will flow through the circuit" as shown below in Figure 3.8 of *Watson*, and "[e]lectrons are stored in one of the plates of the capacitor" and "in the other there is a shortage of electrons." (*Id.*, 25-26.)

fig 3.8 *a capacitor connected to a power supply; current will flow until the capacitor is charged*



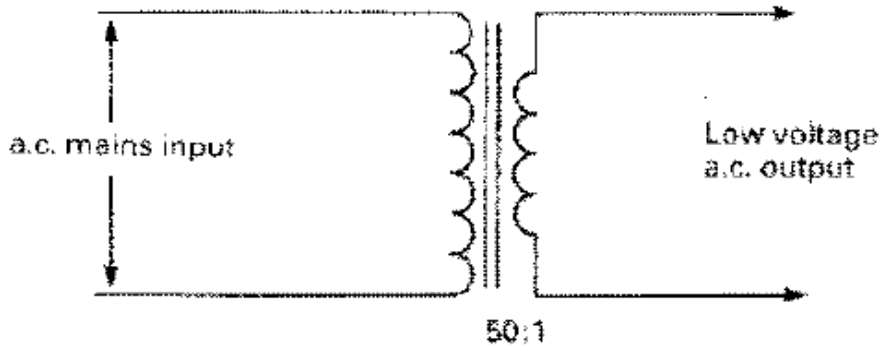
(*Id.*, FIG. 3.8.) A person of ordinary skill would have known that "[i]n this state the capacitor is said to be *charged*," and [i]f the charged capacitor is connected in a

circuit, it will, for a short time, act as a voltage source, just like a battery." (*Id.*, 27 (emphasis in original).) It was known to use capacitors, such as variable capacitors that may be varied in capacitance value, in radio frequency (RF) circuits, e.g., to tune the circuit and "improve efficiency." (*Id.*, 200-201; *see also id.*, 31 (describing "[v]ariable capacitors" as "[c]apacitors ... that can be varied in value."), 201 ("the capacitors are variable, so that the circuit can be tuned accurately," i.e., "tuned to the exact frequency" for the RF transmitter to work properly).)

33. A person of ordinary skill would have known that "[t]he third major passive component is the inductor," which may be a coil of wire. (*Id.*, 33.) "When a coil is connected in a circuit ... the flow of current through the coil causes an electromagnetic field to be created around the coil." (*Id.*, 33-34.) This phenomenon was well known and commonly applied to construct a transformer, which was a known device that was widely used to reduce an AC voltage to a lower level. (*Id.*, 12; *see also id.*, 36 (FIG. 3.17, reproduced below), 37 ("A transformer is used to reduce the voltage of the a.c. mains to something more usable in electronic circuits..."), 37-41 (describing power supplies that utilize transformers and rectifiers to convert AC power to DC power).) Transformers make use of "mutual inductance," where "a current flowing in a coil produces an electromagnetic field,

which in turn induces a current to flow in a second coil wound over the first one." (*Id.*, 34-35, FIG. 3.16.) It was known that by adjusting the "turn ratios" of a transformer, i.e., the ratio of the turns in the two coils of the transformer, the output voltage of the transformer is modified. (*Id.*, 36.)

fig 3.17 ***circuit symbol for a transformer with a laminated core***



(*Id.*, 36 (FIG. 3.17, showing "circuit symbol for a transformer").)

34. A person of ordinary skill in the art would have known that in circuits, "L" signifies inductance and "C" signifies capacitance. (Ex. 1076, 884 ("The oldest technology for realizing filters makes use of inductors and capacitors, and the resulting circuits are called passive LC filters."), 909 (FIG. 11.17).)

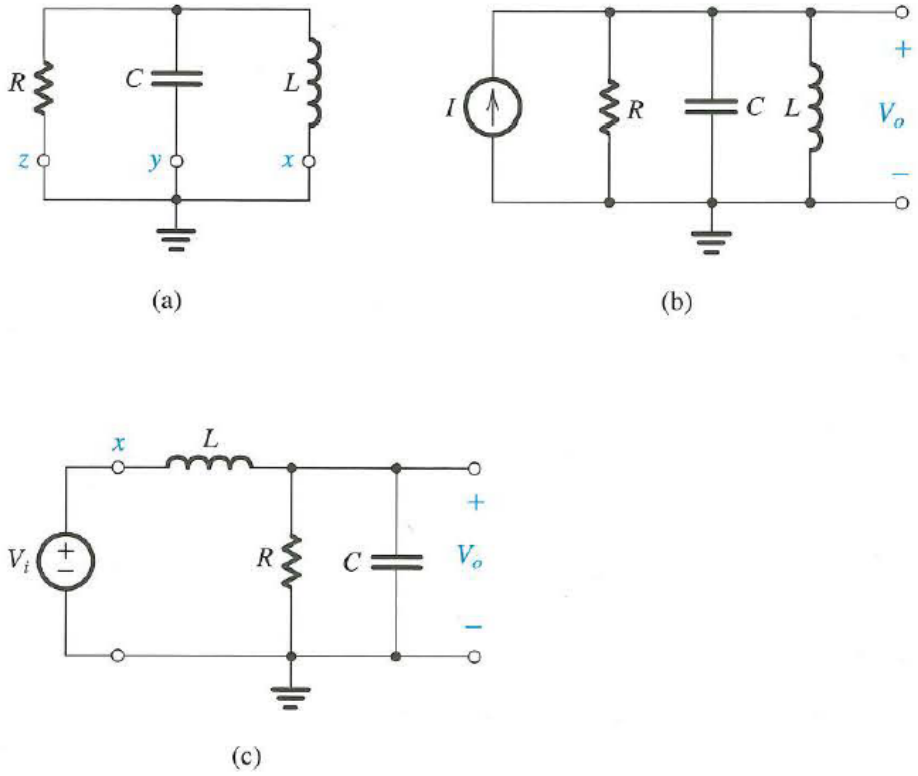


Fig. 11.17 **(a)** The second-order parallel LCR resonator. **(b)** and **(c)** Two ways for exciting the resonator of (a) without changing its *natural structure*. The resonator poles are the poles of V_o/I and V_o/V_i.

(*Id.*, 909 (FIG. 11.17).)

B. Contactless Power/Data Transfer

35. A person of ordinary skill in the art would have understood that many contactless power or data transfer applications rely upon the principle of inductive coupling. Here I begin with an introduction to the well-known principles of inductance and inductive coupling that a person of ordinary skill in the art would have understood, been aware of, and considered when designing, configuring,

implementing, or modifying inductive power transfer system and/or circuits/components thereof. I then discuss applications of such known contactless power/data transfer techniques and technologies, including the use of planar inductive coils, and, the control/regulation of contactless power transfer.

1. Inductance and Inductive Coupling

36. It has long been known that a current carrying wire generates a magnetic field around it. (Ex. 1011, 557-558.) For example, the magnetic field generated near a straight length of a current carrying wire is circular and **in a plane perpendicular to the flow of current**. (*Id.*, 558.)

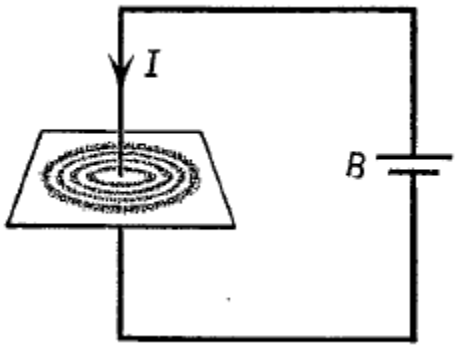


Fig. 30-2 Pattern formed by iron filings showing the circular magnetic field around a wire carrying current.

(*Id.*, 558.)

37. Similarly, if current flows through a wire loop, a magnetic field is generated inside the loop and **perpendicular to the plane of the loop**. (*Id.*, 558-59,

FIG. 30-4 (figure caption "The magnetic field at the center is at **right angles** to the plane of the loop.").)

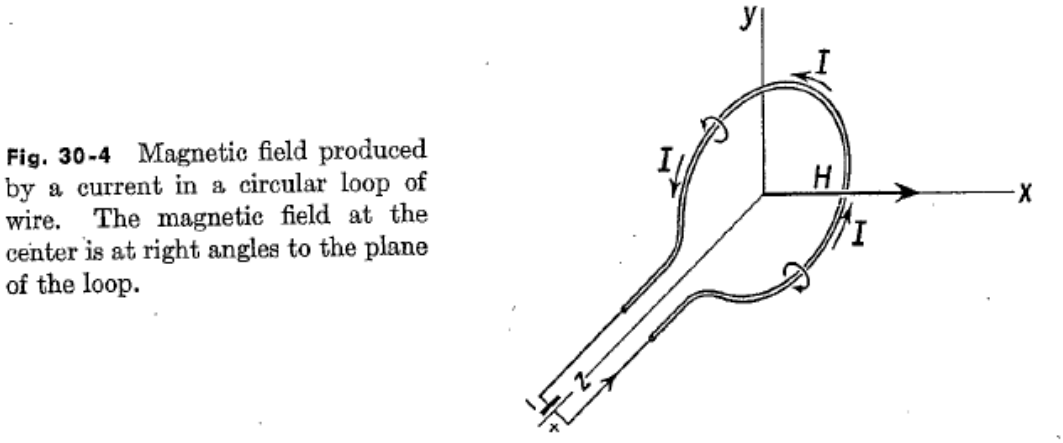


Fig. 30-4 Magnetic field produced by a current in a circular loop of wire. The magnetic field at the center is at right angles to the plane of the loop.

(*Id.*, 559.)

38. The intensity of the magnetic field at any point around a current carrying conductor, including a coil, can be calculated using Ampère's law, which relates the magnetic field intensity H as **proportional to current I**. (*Id.*, 561-62.) A change in current propagating through the conductor results in a change in the corresponding magnetic field. (*Id.*)

39. A magnetic field results in an associated magnetic flux through a coil. **Changes in the coil current result in changes in the magnetic field and the magnetic flux**. (*Id.*, 601 ("When current is sent through a coil, a magnetic field is established through it, and any changes in the current generate changes in the

magnetic flux through the coil.").) **This change in magnetic flux results in an electromotive force (EMF) being induced in the conductor that opposes the change in current.** (*Id.*) The amount of EMF induced is proportional to the rate of change of current. (*Id.*) This effect is sometimes called inductance. (*Id.*) "A device having inductance is called an inductor" and "is represented schematically" as shown below:

Fig. 32-11 Schematic representation of an inductor.

(*Id*.)

40. The above phenomenon, which is a property of nature, can be leveraged to transfer energy between a first circuit that includes a first coil and a second circuit that includes a second coil. For example, if the second coil is positioned relative to the first coil, a changing magnetic flux generated by the first coil could result in an EMF being induced in the second coil and the resulting EMF can then provide a current to a load connected to the second coil. This is the basic principle behind transformers.

41. The use of inductive coupling to cause current flow in a second circuit was independently discovered in the early 1800s by both Michael Faraday and

Joseph Henry. (*Id.*, 593.) The circuit Faraday used in his experiments, which is illustrated below, is helpful in understanding the concept of inductive coupling. As shown below, a first circuit, which is referred to as the primary circuit, includes a battery B, a switch or key K, and a primary coil P. (*Id.*, 593-94.)

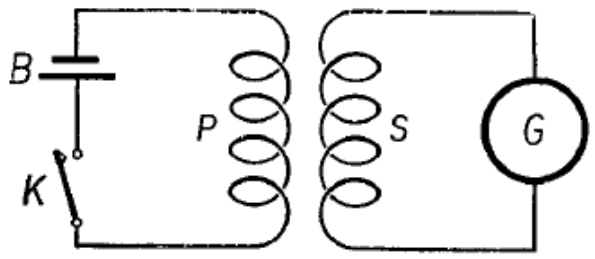


Fig. 32-3 Faraday's experiment on electromagnetic induction.

(*Id.*, 594, FIG. 32-3.)

42. A secondary circuit includes a secondary coil S and a galvanometer G that is used to detect electrical current. (*Id.*, 593.) Faraday observed that when the switch (key) was opened and closed, and **the current flow through the primary coil P was changed, the resulting change in the magnetic flux generated by the primary coil P caused a change in the magnetic field around the secondary coil S**. (*Id.*, 593-94.) The changing magnetic flux through the secondary coil S induces an EMF in the secondary coil and produces a resulting current in the secondary circuit that Faraday measured with a galvanometer. (*Id.*)

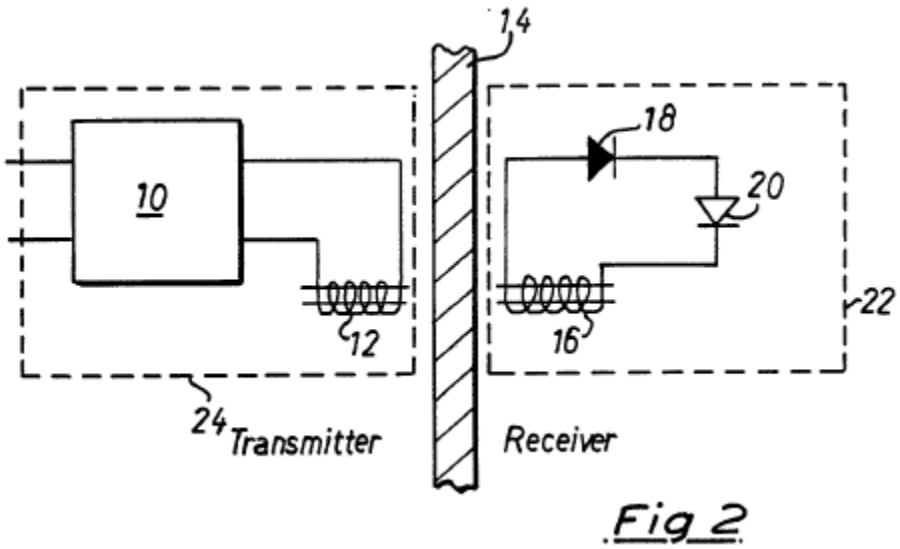
43. Therefore, in order to maintain current in the secondary circuit, the current in the first circuit can be continuously varied. By varying the current in the first circuit, the magnetic field (and therefore, magnetic flux) generated by the primary coil P is continuously varied, thereby inducing a corresponding EMF in the secondary circuit based on the inductive coupling between the primary coil P and the secondary coil S.

2. Applications of Contactless Power/Data Transfer

44. A person of ordinary skill would have been well versed in techniques and technologies for contactless (e.g., wireless) transmission of power and/or data signals between a transmitter and a receiver. For example, such a person would have understood that contactless power/data transfer may be performed between inductively coupled coils, e.g., between a primary coil and a secondary coil.

45. For example, *Logan* notes that "[i]t is, of course, known in principle to transmit power and data using radio waves." (Ex. 1077, 1:10-12.) It was well known to use inductor coils to facilitate wireless signal transmission. (Ex. 1078, 5:39-66 (describing "receiv[ing] power from an electromagnetic (EM) energy source" and "a coil for the receipt of electromagnetic energy"); Ex. 1077, Abstract, FIGS. 1-2, 3:19-23, 4:12-14, 6:3-5.) It was known in the art to energize a transmitter coil using

an alternating electromagnetic field to wirelessly send information to a receiver with a receiver coil. For example, *Logan* discloses features consistent with that known by a person of ordinary skill in the art regarding transmitting data wirelessly. (Ex. 1077, Title, Abstract, FIG. 2 (reproduced below).) *Logan* demonstrates it was known to use an "electromagnetic signal … of sinusoidal form" to convey power between a transmitter 24 and a receiver 22. (*Id.*, 6:12-14, FIG. 2.) Likewise, *Logan* provides guidance about "energising a transmitter coil 12 to create an alternating electromagnetic flux," which "induces an E.M.F. in a receiver coil 16" (*id.*, 3:19-23) "to [wirelessly] convey information to a demodulator in the receiver" (*id.*, 3:24-25).



(*Id.*, FIG. 2.)

46. Thus, the use of inductor coils to facilitate the wireless transmission of power/data was known by those of ordinary skill in the art at the time, including the circuitry and components, and techniques and characteristics of those circuits/components to provide such contactless power/data transfer. (Ex. 1078, 5:39-66 (describing "receiv[ing] power from an electromagnetic (EM) energy source" and "a coil for the receipt of electromagnetic energy"); Ex. 1077, Abstract, FIGS. 1-2, 3:19-23, 4:12-14, 6:3-5.) Additionally, *Koreis* discloses using a contactless power supply to charge a battery:

> Referring to the drawings, **a contactless power supply** according to the present invention is illustrated and generally indicated by reference numeral 10 in FIG. 1. The **contactless power supply comprises an inductive coil 12 disposed within a charging unit 14**, along with a receptor 16 disposed within or on a computing device 18, wherein the computing device 18 is positioned proximate the charging unit 14 as shown. **When energized, the *inductive coil 12 generates magnetic fields to provide electrical current to the receptor 16*, which powers the computing device 18. Further, the electrical current may also be used to charge batteries** (not shown) of the computing device 18 in addition to supplying power. . . .

> More specifically, the contactless power supply 10 comprises a two-part transformer, wherein the transformer has a flat configuration so as to fit within, for example, a seatback tray or a desktop. The first part of the transformer is located within the seatback tray and is coupled to a source of AC power. The second part of the transformer, hereinafter referred to as receiving coil and core, is located within the computing device 18 and is coupled to a rectifier that converts AC power to DC power. When magnetic field lines are approximately 90 degrees to the first part of the transformer when the *receiving coil* and core are placed within the field, *current is induced into the computing device 18*.

(Ex. 1009, 2:46-3:8; *see also id.*, FIG. 1.)[3]

[3] I have added any emphasis herein unless indicated otherwise.

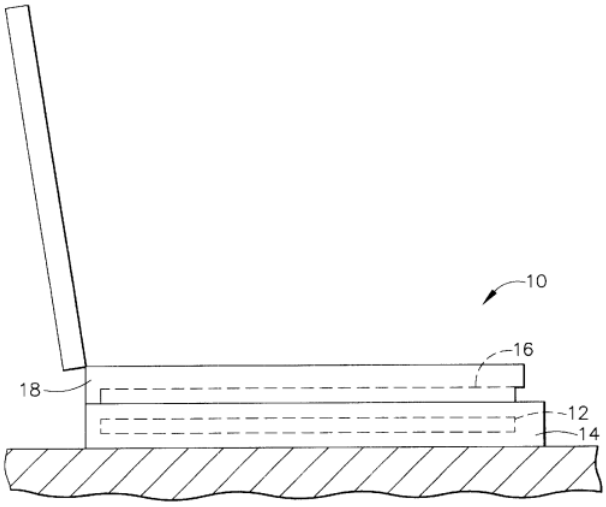


FIG. 1

(*Id.*, FIG. 1.)

47. *Odendaal* also shows that contactless power transfer technology has been used in various applications:

> **Contactless power transfer** has been used in applications such as the non-intrusive charging of pacemaker batteries, the charging of hybrid vehicle batteries, etc. **In such applications, inductive coupling is used** exclusively **so that a *current is induced from a power station to a load.*** In such systems, the power transfer is exclusively accomplished by means of coupling **magnetic flux of the power station and the load.**
>
> For example, road systems that would encourage the use of electric vehicles have been studied by states such as

> California. In such a system, **inductively coupled flat coils are embedded in the roadway**, or cables that are embedded in the roadway **are energized, so that an *induction coil of the vehicle receives induced current from the roadway coils* to permit battery charging and/or even propulsion.**

(Ex. 1008, 1:13-27; *see also* Ex. 1013, Abstract ("[c]urrent is induced in a secondary coil"), 4:29-5:2; Ex. 1025, 1:10-15, 12:5-9, FIG. 1.)

48. As a further example, *Kung* discloses "identif[ying] those primary coils that are closest to the secondary coil, and a current director that, responsive to the proximity detector, selectively directs time-varying currents through the closest primary coils."

> An electromagnetic field source (EFS) for **providing electromagnetic energy to a secondary coil**, including **two or more primary coils that each carry a time-varying current** to produce an electromagnetic field, and a controller that selectively provides current to one or more primary coils **based on their position with respect to the secondary coil**… The controller includes a **proximity detector that identifies those primary coils that are closest to the secondary coil**, and **a current**

> **director that, responsive to the proximity detector, selectively directs time-varying currents through the closest primary coils**. The controller may also include an orientation detector, coupled to the current director, that determines an orientation of the secondary coil with respect to the closest primary coils. In one implementation, the proximity detector identifies the quantity of closest primary coils utilizing a resonance frequency shift detector that detects a shift in inductance of one or more primary coils due to the proximity of the secondary coil.

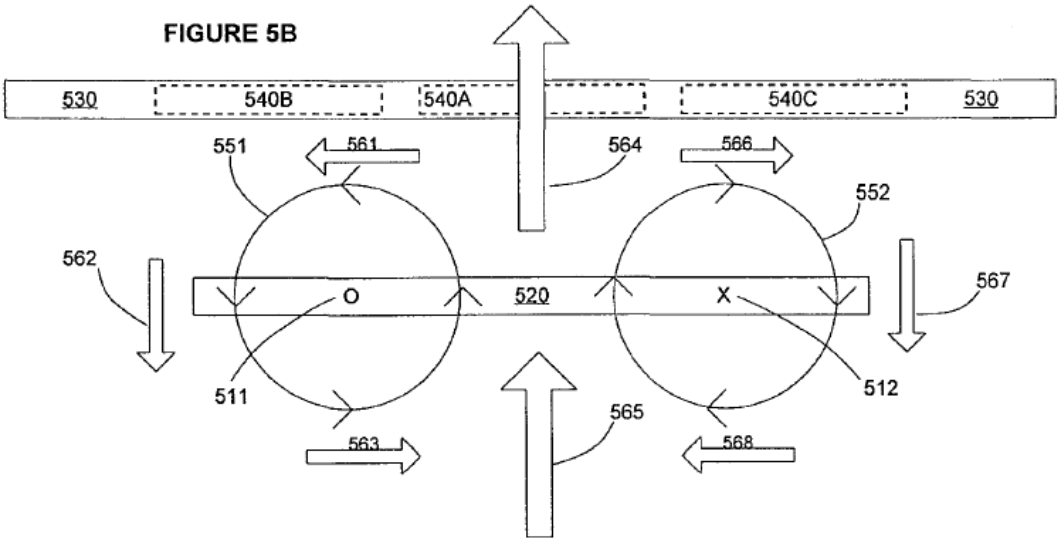
(Ex. 1010, Abstract.)

49. *Kung* also explains how the generated magnetic field traverses across the space. For example, *Kung* shows that a magnetic field represented by arrows 564 and 565 is perpendicular to plane 520 of charger and primary coil 510 and/or plane 540A of secondary coil 230.

> Components of the magnetic fields generated by loop segments 511 and 512 generally reinforce each other in certain areas, such as the interior area of coil 510. These reinforced **magnetic field components are represented by large arrows 564 and 565 that are directed upward from plane 520 toward plane 530**. More specifically,

> magnetic fields represented by exemplary iso-magnetic contour lines 551 and 552 are oriented in the same direction (upward toward plane 530), and thus are reinforcing, in the regions of arrows 564 and 565. Elsewhere, such as in the regions of small arrows 561 and 566, there is no such reinforcement.
>
> If secondary coil 230 is in position 540A, i.e., in a plane parallel to that of primary coil 510 and generally vertically aligned with the interior of coil 510, then, as is well known by those skilled in the relevant art, primary coil 510 induces a current to flow in secondary coil 230. The magnetic field that induces this current flow is represented by arrows 564 and 565. In contrast, if secondary coil 230 is disposed in plane 530 at a position generally outside of the interior of coil 510, such as positions 540B or 540C, then primary coil 510 generally does not induce a current to flow in secondary coil 230.

(*Id.*, 8:55-9:52.)



(Ex. 1010, FIG. 5B; *see also id.*, FIGS. 1-5A, FIGS. 6A-10, 7:21-8:54, 9:53-10:22, 11:27-14:67; Ex. 1011, 557-562, 593-594, 601; Ex. 1029, 3-4, 27-50.)

3. Use of Planar Coils

50. Because the inductive coils, such as those mentioned above, were often integrated into a portable device and/or a power transmitting device having a thin form factor (e.g., charging pad, etc.), a person of ordinary skill in the art would have considered the form factor of the coils to be installed in a portable device, such as cell phones, computers, PDAs, or in an inductive charger or a host object of such a charger, such as pads, desks, tabletops, and other supporting surfaces. A planar coil, given its relatively flat and thin structure, is known to be suitable for use in portable devices or in thin objects/surfaces. For example, *Odendaal* explains that the planar

coils of the planar power resonator "may have a thin and/or relatively flat top coil surface" and the coils "are preferably **integrated into a planar (flat/thin) structure**." (Ex. 1008, 2:44-64, 3:3-5.)

51. *Lee*, for example, also discusses the known use of a planar spiral coil inductor consistent with the knowledge of a person of ordinary skill in the art:

> Since the arrival of the silicon-based RF IC era, much effort has been put into the **spiral inductor designs**. The main focus of the endeavor was to improve the quality factor. The major concern for the silicon-based spiral inductors has been the resistivities of the metal and the silicon substrate. **Numerous techniques have been proposed** to reduce the resistivities of the interconnect lines and the silicon substrates [1,2]. Yet, **many planar spiral inductor structures have been designed and evaluated** without a clear understanding for the layout dependences of the quality factor. Simple and clear guidelines of inductor layout rules for optimum quality factor are presented for the required inductance and process information. . . . **Figure 1 shows the top view of a square spiral inductor layout.** Mohan [3] reported a simple and very accurate expression for the **planar spiral inductor inductances.** Modifying the Mohan's work, for

> the inductor dimensions shown in Fig. 1, the inductance can be expressed as . . .

(Ex. 1027, 1; *see also id.*, 1-3.)

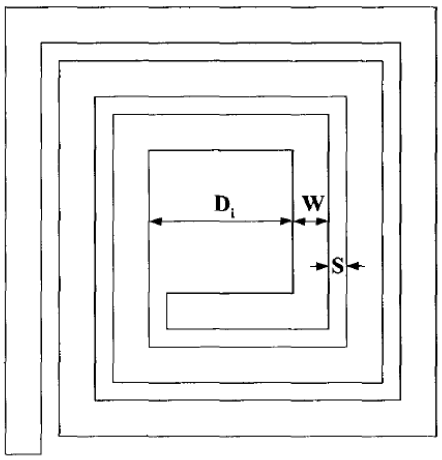


Fig. 1. A planar square spiral inductor structure.

(*Id.*, FIG. 1 (showing a "**planar square spiral inductor** structure").)

52. Additionally, *Sano* (Ex. 1015) discusses the known use of a thin coil and a flat disk-like core.

> Currently, the preferred form of the power receiving coil 54 is a **thin coil** which facilitates efficient interlinkage of the magnetic flux developed from the power supplying coil 18 with the power receiving coil 54. More particularly, the currently preferred power receiving **coil** 54 is a **flat disc-like core** on which is formed a single layer or several layers of wire-like electrical conductors. Such conductors can be formed, for example, by depositing

> conductive material on a side of the disc-like core that faces the power supplying apparatus 10. FIG. 3 is a front view of such a **sheet coil** and FIG. 4 is a vertical sectional view taken along its middle plane.

(Ex. 1015, 3:39-51; *see also id.*, FIGS. 1-2, 3-4, 7-12, Abstract, 1:5-2:29, 2:64-3:27, 5:5-47, 5:48-9:5.)

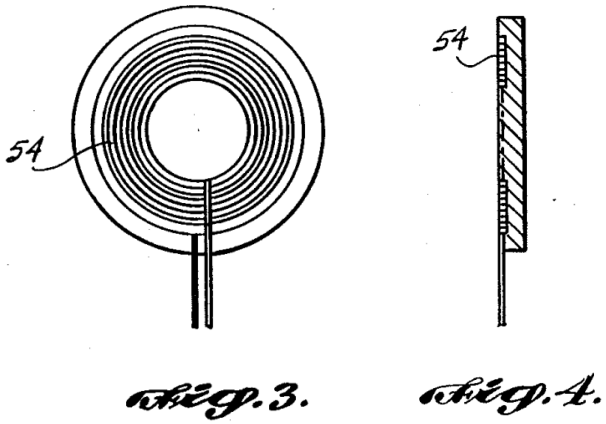


Fig. 3. Fig. 4.

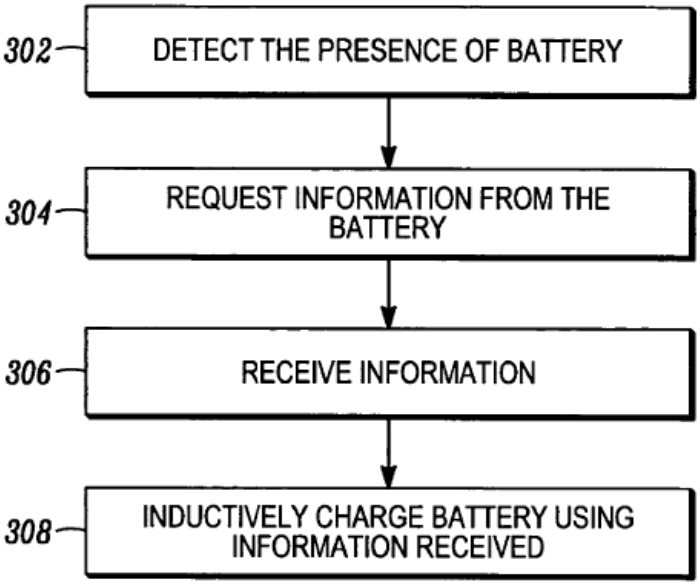
(*Id.*, FIGS. 3-4.)

53. There are other state of the art references that demonstrate and exemplify the knowledge of a person of ordinary skill in the art associated with using planar coils. (Ex. 1047, FIGS. 1-3, 6, 8A-9, ¶¶0002, 0006-0007, 0018-0025-0034; Ex. 1025, FIGS. 1, 3, 8-9, 13, 1:10-2:3, 2:5-12 (reasons to consider thin coil designs), 2:14-3:2, 4:19-32, 7:25-9:28, 12:27-32 (very thin printed coil), 14:4-17; Ex. 1026, FIGS. 1-2, 5 (conventional primary coil array arrangement), 9A-9C, Abstract, 1:3-

4:4 (conventional designs), 4:6-9:4, 11:4-15 (concentric selectively active flat coils); Ex. 1009, Abstract, FIGS. 1-3, 1:4-51, 1:54-2:26, 2:47-3:8 (flat configurations), 3:9-39 (thin flat coil), 4:18-60; Ex. 1024, FIGS. 3, 8-9, 1:12-15, 1:39-2:29, 9:41-53, 10:45-57, 11:60-13:4; Ex. 1029, 1-4, 9-19 (planar, spiral coils); Ex. 1030, FIGS. 3-7B, 1:5-9, 1:59-61, 3:19-56, 4:62-567, 5:25-44.) A person of ordinary skill in the art would have understood complementing a primary/secondary-side planar coil with a second/primary-side planar coil would provide for efficient transmission of energy between the two planar coils in an inductive charging/power systems, especially where the coils were aligned to face each other to allow the perpendicular magnetic field generated from the transmitting planar coil to be received by the receiving planar coil. (*See* my discussions above in Section V.B.1.) Thus, in my opinion, where design applications in an inductive power transfer system called for planar transmitting or receiving coil designs (e.g., to provide for thin, compact, versatile devices), such a skilled person would have had reasons to likewise consider design options where the receiving or transmitting coil likewise incorporated planar-type coil(s).

4. Controlling and Regulating Contactless Power/Data Transfer

54. A person of ordinary skill in the art would have known that different types of batteries or electronic devices may have different requirements for the amount or level of power/voltage/current supplied to the batteries or devices. Mechanisms have existed in the early 2000s that provide communications between the charger and the device subject to charging such that the charger may determine relevant parameters or settings used during the charging process. For example, *Black* discloses a procedure for "device identification and charging" that I summarized below. (Ex. 1007, ¶0020.)



(Ex. 1007, FIG. 3.) The procedure involves the charger first detecting the **presence** of a battery placed near the charger, then requesting **information from the battery**, such as the ID of the battery/device. (*Id.*, ¶0020.) The battery may also provide information to the charger, such as "encryption information, battery characteristics or charging profile or the like." (*Id.*, ¶¶0021-0022.) *Black* explains that the charger uses the provided information "[t]o determine **how** to inductively charge the battery." (*Id.*) In fact, it was known that "[c]onsideration of the…charging characteristics" of a battery is "**necessary for maximizing the amount of energy the battery will hold and to prevent overcharging of the battery**" and also for avoiding some potentially serious safety issues. (Ex. 1037, 1:56-2:6.)

> An incorrectly charged, improperly charged, overcharged or undercharged battery may **lose the ability to store an electric charge, may produce a voltage less than the nominal voltage or may combust or explode**, for example. Additionally, the number of charge cycles the battery is capable of undergoing may be significantly reduced **causing premature battery failure** which may require specialized reconditioning in order to return the battery to a proper operational state. Improper battery charging may also lead to **permanent premature battery failure**. Thus, the battery charging process **must account**

> **for the characteristic charging behavior** of the particular electrochemical cells in order to ensure proper functioning and maximized output and lifespan of the battery to be utilized.

(Ex. 1037, 1:59-2:6.)

55. Additionally, mechanisms for identifying whether a device subject to charging is **present** and **properly placed** on the charger (e.g., primary and secondary coils are properly aligned) were also well known. A way to do this is for the charger to send a signal to the device subject to charging. If there is a response from the device, and, based on the strength of the responsive signal, the charger can determine whether a device is present and properly placed/aligned on the charger. This is to ensure that the charger does not transmit power to unknown object(s) and also that the power transmission is performed where there is a high power transmission efficiency. For example, *Nakamura* discusses such features consistent with that known by a person of ordinary skill in the art at the time. (*See, e.g.*, Ex. 1019, ¶¶0080-0083, FIGS. 11A-11B.) *Nakamura* explains:

> [T]he power transmission enable/disable determination circuit 33 determines whether or not power reception equipment is placed on the power transmission apparatus

> 1, based on the "code indicating being power reception equipment" (step S3). **If a predetermined "code indicating being power reception equipment" is received, it is determined that power reception equipment is placed on the power transmission apparatus 1** and it is **determined whether or not the power reception equipment is correctly placed on the power transmission apparatus 1** (step S4). On the other hand, unless the predetermined "code indicating being power reception equipment" is received, it is determined that no power reception equipment is placed on the power transmission apparatus 1, and the carrier wave is outputted again (step S2).

(Ex. 1019, ¶0078.)

> Next, as for **determination on whether or not the power reception equipment is correctly placed on the power transmission apparatus 1**, the meaning of this phrase is whether or not the coil of the power receiving side and the coil of the power transmission side are **arranged at positions where a high power transmission efficiency** in a non-contact power supply system is obtained. In other words, whether or not the transmission apparatus 1 and the portable telephone 2 which is power reception equipment,

> shown in FIG. 2, are arranged at positions where a high coupling degree in magnetic coupling is established between the primary side core 15 of the power transmission apparatus 1 and the secondary side core 16 of the portable telephone 2.

(*Id.*, ¶0079.)

56. Additionally, once the power transmission process has started, mechanisms were known to adjust the power output to the device subject to charging based on the device's power demand. This is to accommodate the fact that the power demand may be variable in time. For example, *Berghegger* (which I also discuss below in Sections VIII and IX) discloses using a detection means 42 to measure the power demand at the load (e.g., power demand by a battery), and then providing the power demand information to a drive circuit of the charger in order to adjust or control the power transmission to the load. (Ex. 1006, 5:65-6:37.)

C. Issues Relating to Harmonics in Contactless Power/Data Transfer

57. It was known to a person of ordinary skill in the art that alternating or pulsed signals, such as those provided to a primary coil in a contactless powering/charging system, included harmonic waves/signals that were multiple of the frequency of the reference wave/signal. Such harmonics were known to create

unwanted radiation that generated heat, resulting in inefficiencies in signal transmission, such as power signals transferred in a contactless inductive power transfer system.

58. For example, *WangII* (also discussed below in Sections VIII and IX) describes features consistent with that known in the art at the time, such as:

> The primary and secondary coils form a transformer so that electrical current in the primary induces current in the secondary coil. An approximation to a half-wave sinusoidal voltage is developed across the primary winding by the action of a field effect transistor (FET) switching a direct current (DC) voltage source across a tuning capacitor. Because, however, of the construction of the energy transmission device, **high frequency harmonic components are present in the waveform**. These high frequency components induce eddy currents in the implanted device which houses the electronics. The can temperature increases in response to the eddy currents. **A rise in temperature** of the outer surface of the can may be detrimental to operation of the medical device and surrounding body tissue. To prevent this temperature rise, the prior art charging devices must be operated at very low power levels.

(Ex. 1013, 3:29-4:5.)

> It would be desirable, therefore, to provide a battery charging system that overcomes these and other problems associated with rechargeable implantable devices. In particular, it would be **desirable to construct a battery charging device which can efficiently charge a battery** in an implanted medical device at a relatively high power **without excessively heating the device**….

(Ex. 1013, 4:19-28.)

59. Likewise, *Lee-II* explains that

> When a power MOSFET is switched while its source drain current is still nonzero, the flywheel actions of the choke and the main inductor will try to maintain the current during the switch transition, **thereby creating large voltage spikes with high harmonic content which lowers the overall power efficiency as well as distorting the output waveform**.

(Ex. 1044, ¶0084.)

60. Since unmanaged harmonics would reduce energy transmission efficiency, and lead to unwanted heating of surrounding/nearby electronic components, there were known ways to mitigate these issues, which I discuss below.

61. To mitigate the negative effects of harmonics, resonant circuits including a capacitor and/or other components were widely utilized and known to reduce harmonics in power and/or data transmission applications.

62. For example, the textbook, Fundamentals of Electric Circuits, 2d., Charles Alexander et al., McGraw-Hill, 2004 ("*Alexander*") (Ex. 1016), explains that filters may be formed using a combination of components including a capacitive component to reduce harmonics.

> [r]esonance is a condition in **an RLC circuit** in which the **capacitive** and inductive reactances are equal in magnitude, thereby resulting in a purely resistive impedance. **Resonant circuits (series or parallel) are useful for constructing filters**.

(Ex. 1016, 631.)

> [a] bandpass **filter** is designed to pass all frequencies within a band of frequencies, w1 < w < w2. . . . the bandpass filter in Fig. 14.35 is a series resonant circuit.

(*Id.*, 641.)

> **a bandpass filter** . . . [i]f the filter is made highly selective . . ., the filter passes only the fundamental

> component (n=1) of the input and **blocks out all higher harmonics**.

(*Id.*, 798.)

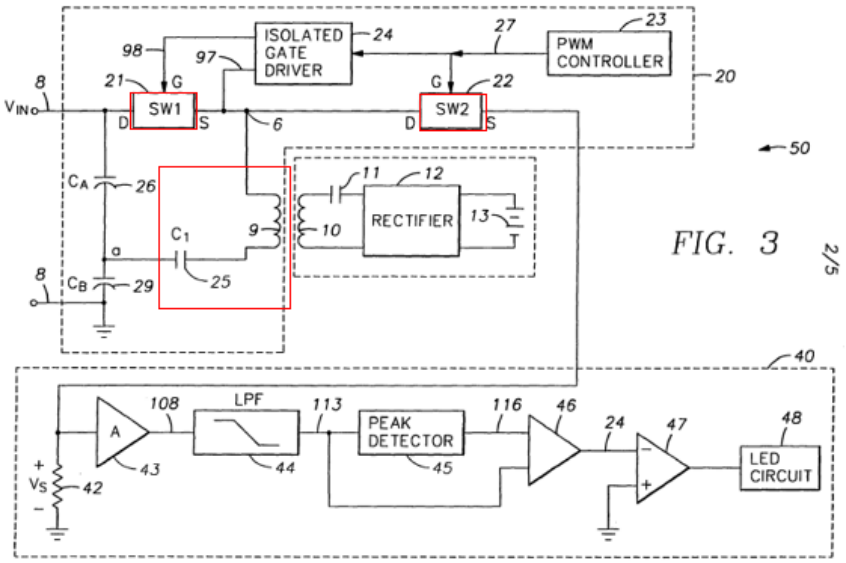
63. Likewise, *Lee-II* explains that:

> **The series LC resonator 101 and 115** provides a high "Q" environment to **filter out higher harmonics** and enhance the fundamental frequency to produce a substantially sinusoidal waveform at the output ports 102 and 103.

(Ex. 1044, ¶0083.)

64. *WangII* also discusses the use of capacitive components to reduce harmonics. For example, *WangII* discloses using capacitor-based resonant circuit with switches that provides full sinusoidal wave to "**reduce harmonics** and eddy current" to minimize heat and "without causing excessive energy loss." (Ex. 1013, 4:29-5:7; *see also* Abstract, 3:29-4:5 (discussing prior art where primary/secondary coils arrangement using a switching DC voltage across a tuning capacitor where "high frequency harmonic components are present in the waveform," which "induce eddy currents" that increase temperature that is detrimental to operation of the device), 4:19-28 (battery charging device to efficiently charge a battery in device

without excessive heat), 7:24-8:14, 8:17-23 (tuning capacitor 25 designed so that a sinusoidal waveform "flows through the primary coil 9 with **little high order frequency content**"), 24-31, 9:26-12:27.)



(Ex. 1013, FIG. 3 (annotated); *see also id.*, FIG. 6.)

65. Other references provide similar disclosures consistent with a person of ordinary skill in the art at the time. (Ex. 1012, FIGS. 2, 5 (C1 25, inductor 9), 8 (same), 3:30-62, 8:47-9:51; Ex. 1014, 67-68 ("In a narrowband transmitter, a low-pass filter might be built in for ***reduction of harmonic output***"); *id.*, 62-68; Ex. 1015, FIGS. 1-2, 5-12, Abstract, 1:55-2:10, 3:28-51, 4:22-44 (providing a capacitor 20 in parallel with power supply coil "so that [there is] a resonance"), 5:45-6:4 ("the resonant frequency f_R" is set to a level as low as approximately 1.5 times of the

output frequency f*o* of the frequency converter 16 . . . [and] oscillation at a frequency of 2 f*o* was optimal from the standpoint of maximum circuit efficiency"); Ex. 1020, Abstract, (disclosing tuning capacitor 22 in a resonant circuit in an inductively coupled power transfer system that results in reduce harmonics); Ex. 1025, ¶¶00164-0165 ("[i]t was known in the art to drive coils using parallel or series resonant circuits" to allow "maximum current flow[] through the primary coil"); Ex. 1029, 19 ("antenna coils . . . can be formed by a metallic or conductive trance on PCB board or on flexible substrate"), 22-25; Ex. 1017, 1:9-8:22 (discussing known issues with harmonics and conventional and revised ways to reduce harmonics in AC-DC/DC-AC conversion power systems with application to "battery chargers"); Ex. 1023, FIGS. 1-4, 6A-6C, 14, Abstract, ¶¶0007-0024, 0027, 0032-34, 0074-0078 (describing mechanisms/techniques to reduce harmonics in AC and DC driven lighting systems and benefits for doing so).)

VI. OVERVIEW OF THE '371 PATENT

66. The '371 patent relates "generally to power supplies, power sources, and particularly to a system and method for inductive charging of portable devices." (Ex. 1001, 1:54-55.) For example, the patent explains that " a system for providing power inductively to a portable device comprising a battery and an inductive receiver unit including a receiver coil and a receiver circuit … includes a first primary coil, a first drive circuit, a first sense circuit, and a communication and control circuit. The communication and control circuit is configured to detect, through the first sense circuit, a received communication of information in the current modulation in the first primary coil. The communication and control circuit is also configured to operate the first drive circuit to inductively transfer power from the first primary coil to the receiver coil to activate and power the receiver unit to enable the receiver circuit to communicate information detected in the current modulation in the first primary coil." (*Id.*, 4:45-59.)

67. In my opinion, a person of ordinary skill in the art would have recognized and understood that these features, and other features recited in the challenged claims of the '371 patent, were known and consistent with contactless/inductive power/data transfer technologies and techniques, and related

circuit designs, at the time of the alleged invention, as I discussed above and further below. (*See* my discussions above in Section V and below in Sections VIII-IX.)

VII. CLAIM CONSTRUCTION

68. I understand that claim terms are typically given their ordinary and customary meanings, as would have been understood by a person of ordinary skill in the art at the time of the alleged invention. For the claims I address in this declaration, namely claims 28 and 29, I have been asked to apply the plain and ordinary meaning of the terms in those claims (although I may address other interpretations that I have been asked to consider below in my analysis of those claims in Section IX if applicable). My opinions concerning the interpretation of the claim terms are based on the time of the alleged invention I have been asked to consider as I noted above in Sections III and IV. I understand that in considering the meaning of the claims, one must consider the language of the claims, the specification, and the prosecution history of record. I have done so to support my opinions in this Declaration where appropriate.

VIII. OVERVIEW OF THE PRIOR ART

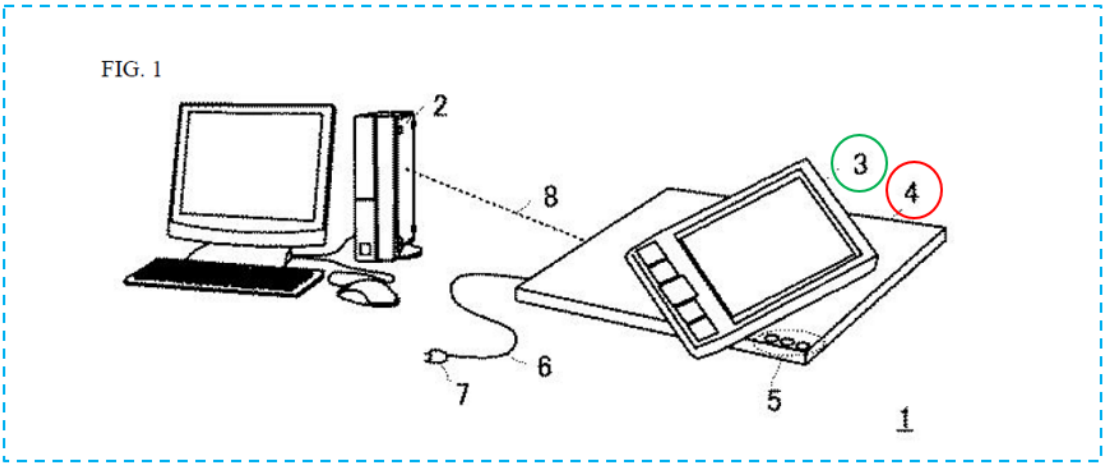
69. I rely on the disclosures and analysis thereof of the prior art discussed in this section VIII for my opinions regarding their respective teachings and

suggestions as applied to the challenged claims of the '371 patent below in Section IX. Accordingly, the following discussions are incorporated into my analysis below in Section IX.

A. *Okada* (Ex. 1005)

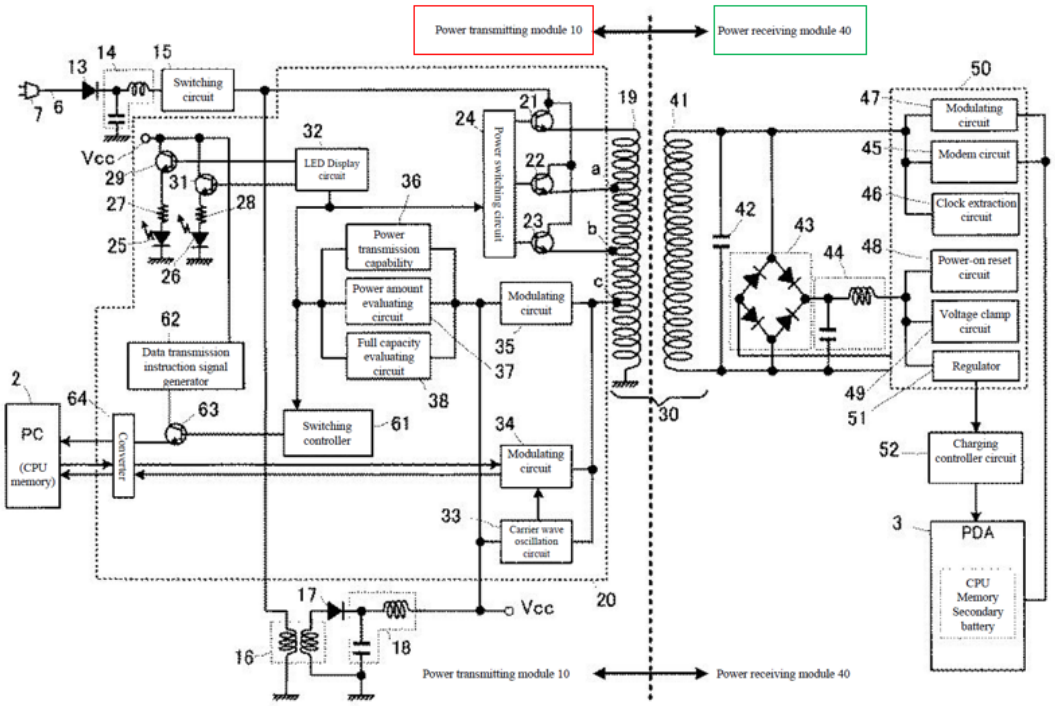
70. I understand that *Okada* is a published Japanese patent application. (Ex. 1005, Cover.) I rely on (and cite to in support of my opinions) the English translation of *Okada* that accompanies the copy of the original *Okada* published patent application. My understanding is that *Okada* was published June 1, 2006. (*Id.*) I rely on the disclosures and analysis thereof of *Okada* discussed in this section VIII for my opinions regarding *Okada*'s teachings and suggestions as applied to the challenged claims of the '371 patent below in Section IX.

71. *Okada* discloses a system for inductive powering or charging of portable devices such as mobile phones and PDAs with batteries. (Ex. 1005, Abstract, ¶¶0001, 0015, 0047, FIG. 2, claim 4.) *Okada*'s FIG. 1 shows a power supply system 1 (**blue**) including PC 2, PDA 3 (**green**), and cradle 4 (**red**), which receives commercial power via cord 6 and AC plug 7. (Ex. 1005, ¶¶0034-0036.)



(Ex. 1005, FIG. 1 (annotated).) *Okada* explains that "magnetic coupling" occurs between cradle coil(s) (primary coil(s)) and PDA 3 coil (secondary/receiver coil), which "induces voltage at both ends of the coil in the PDA" to "suppl[y] power to the PDA." (*Id.*, ¶0035; *see also id.*, ¶0051 ("The primary-side coil 19 together with the secondary-side coil 41 constitute the transformer 30 and magnetic coupling induces a voltage on both ends of the secondary-side coil 41.").)

72. *Okada*'s FIG. 2 describes an exemplary system, where each of cradle 4 and PDA 3 includes circuitry/components and at least one coil. (Ex. 1005, ¶¶0035, 0037 ("PDA equipped with the power receiving module 40"), FIG. 2.) Cradle 4 includes a **power transmitting module 10** ("PTM10"), and PDA 3 includes a **power receiving module 40** ("PRM40"). (*Id.*, FIG. 2, ¶¶0035-0037, 0038-0058, FIG. 8, ¶¶0110-0111.)

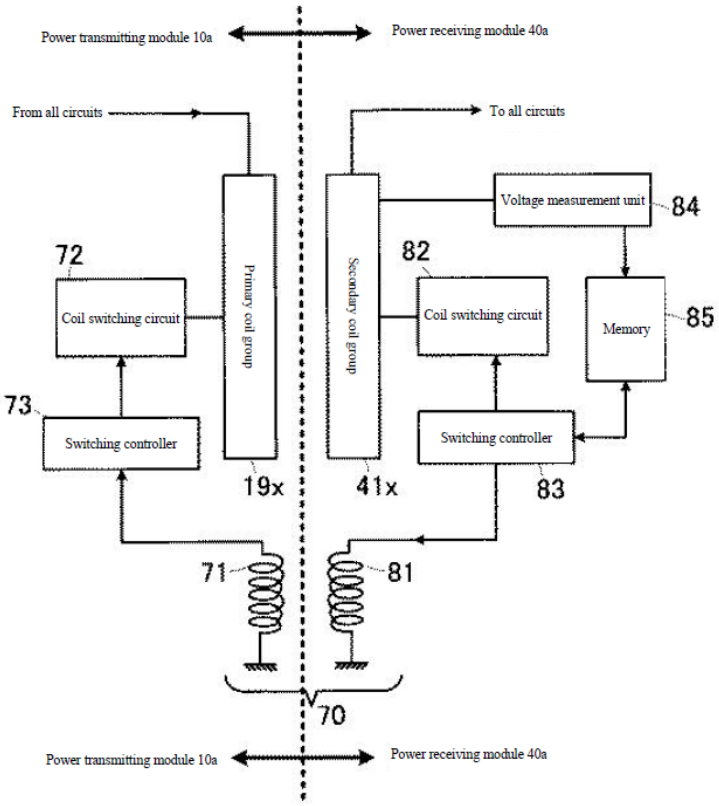


(Ex. 1005, FIG. 2 (annotated).)

73. *Okada* explains that PTM10 converts received power (e.g., via cord/plug 6/7) to a DC signal via circuits 13-14. (Ex. 1005, ¶¶0038, 0049.) Switching circuit 15 generates a switching pulse signal using the DC signal (*id.*), which is converted to a DC signal (V_{CC}) powering PTM10 components (via circuits 16-18). (*Id.*, ¶0039.) *Okada* also explains that the switching pulse signal is also supplied to primary coil 19 via one of switches 21/22/23 respectively connected to different coil taps. (*Id.*, ¶¶0040, 0049-0051.) A power switching circuit 24 selects a switch 21/22/23 to allow the switching pulse signal to traverse selected turns of

coil 19, enabling the system to select/adjust the power level inductively transmitted from PTM10 (e.g., cradle 4) to PRM40 (e.g., PDA 3). (*Id.*, ¶¶0040, 0051, 0057, 0069-0073, FIG. 2.)

74. *Okada* discloses various configurations/applications of such a system (e.g., inductive power transfer system) providing similar functionalities associated with PTM10 and PRM40, in connection with, for example, FIGS. 2, 7-17. (Ex. 1005, ¶¶0009-0032, 0094-0154). For one example, FIG. 7 (below) shows PTM10 including multiple primary coils (e.g., group 19x) and PRM40 including multiple secondary coils (e.g., group 41x). (Ex. 1005, FIG. 7, ¶¶0094-0096.)



(Ex. 1005, FIG. 7.) *Okada* explains that circuits in PTM10 and PRM40 selectively activate coils "having a highest power transmission efficiency" for power transmission, to, e.g., accommodate shifted positions of PDA 3 relative to cradle 4. (*Id.*, ¶¶0103-105; *see also id.*, ¶¶0097-0102, 106-109.)

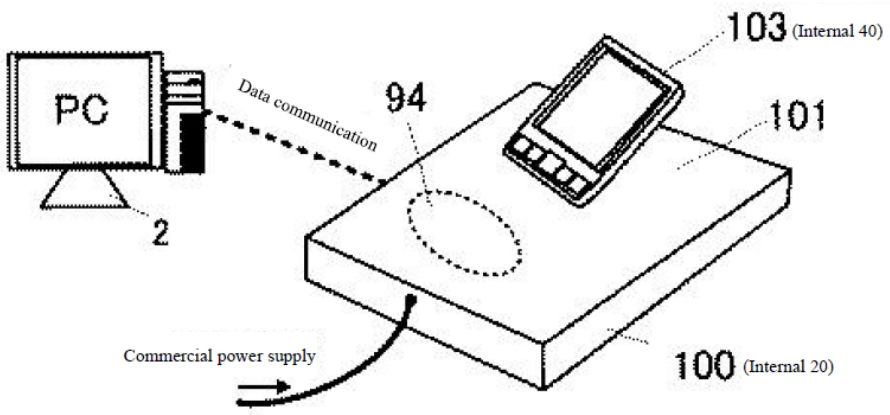
75. A person of ordinary skill in the art would have understood that applications/disclosures of these features of *Okada* (that I discussed above and below in this section) are also described in *Okada* with respect to (and are applicable to) other exemplary system(s)/configuration(s)/figure(s). (Ex. 1005, ¶0107 ("one of

these [modules] consists of [multiple] coils and the other consists of one coil"), FIG. 9 (below), ¶¶0116-0118 (tabletop with charging pad having "a plurality of the primary-side coil 19"), FIG. 10, ¶0119 (charging multiple devices), FIGS. 11(a)-(b) (below), ¶¶0120-0122 (multiple PTM10s powering/charging multiple devices each with PRM40), FIGS. 12(a)-(b) (below), ¶¶0123-0126, FIGS. 13(a)-(b) (below), ¶¶127-132 (mouse pad with multiple coils 19).) For example, *Okada* explains:

> With the power supply system of the present invention, electric power is supplied by placing an electronic device such as a PDA, mobile phone, or the like, equipped with the power receiving device of the present invention on a common cradle or the like equipped with the power transmitting device of the present invention . . . Furthermore, the power transmitting device of the present invention can be incorporated into all types of products, not just a common cradle, but also showcases, mouse pads, and the like, and therefore the device is highly versatile, because an electronic device incorporating the power receiving device of the present invention can receive power supplied from the product.

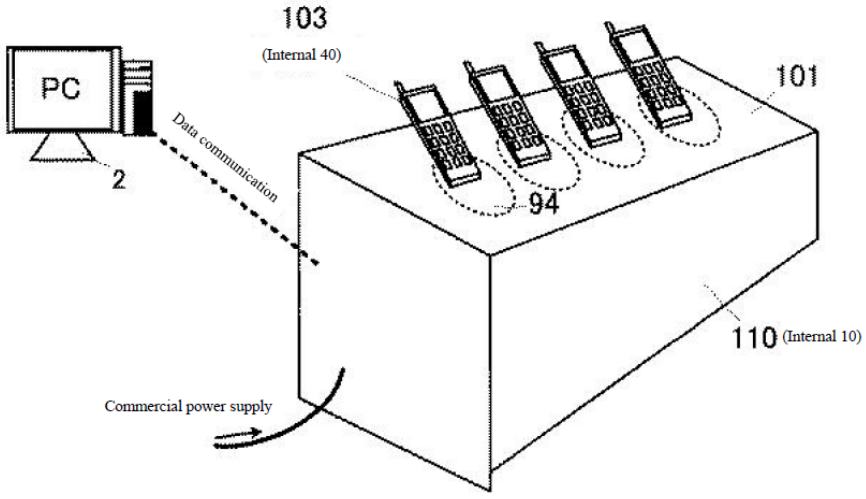
(Ex. 1005, ¶0030.)

FIG. 9



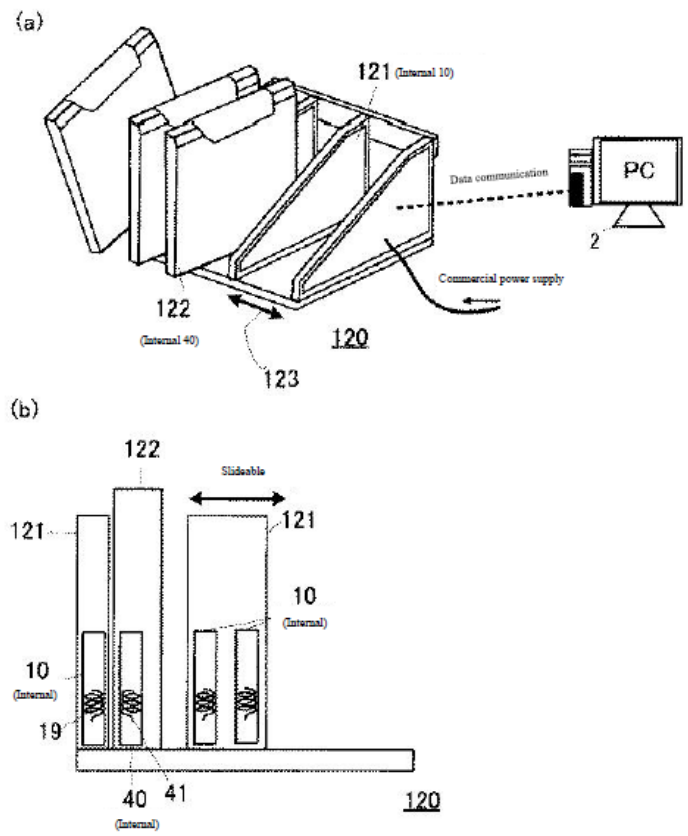
(Ex. 1005, FIG. 9.)

FIG. 10



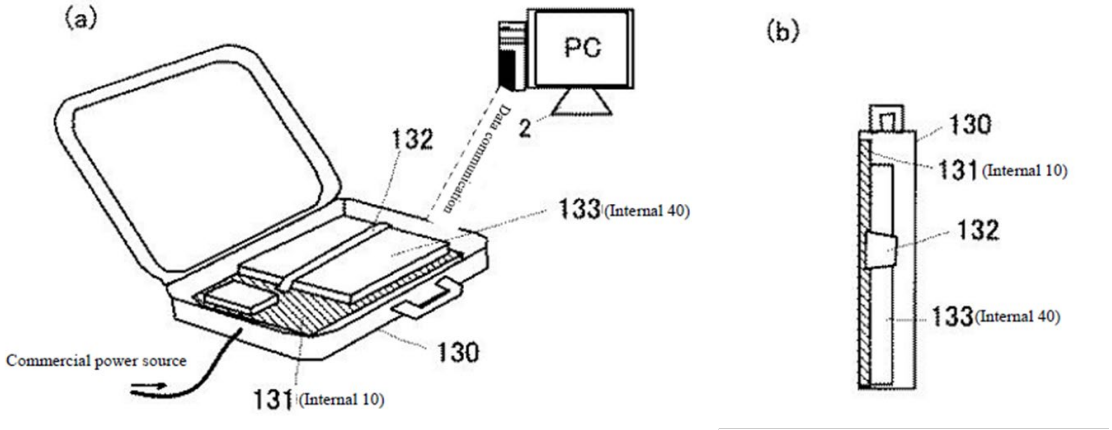
(*Id.*, FIG. 10.)

FIG. 11

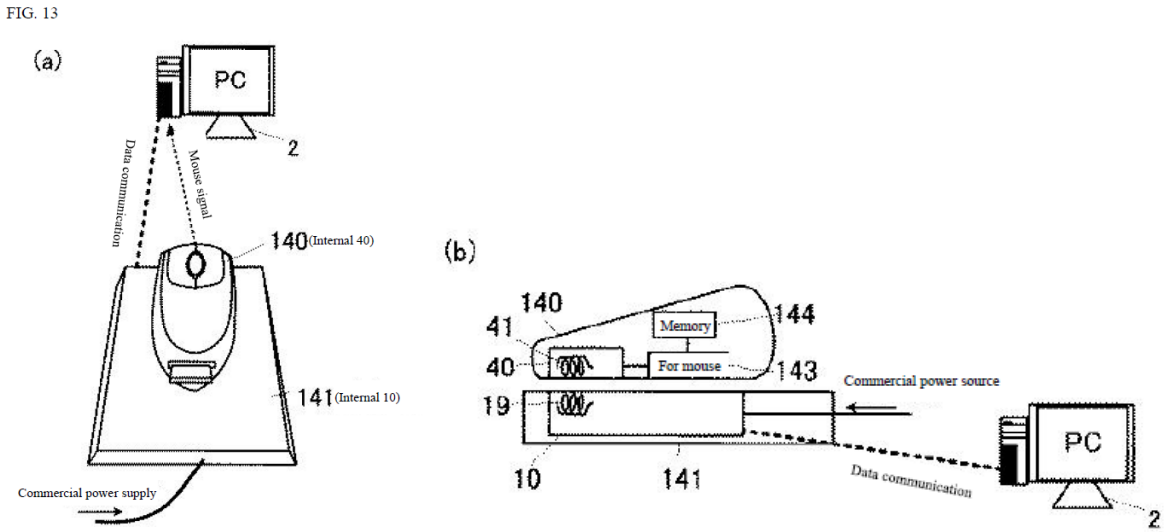


(*Id.*, FIGS. 11(a), 11(b).)

FIG. 12

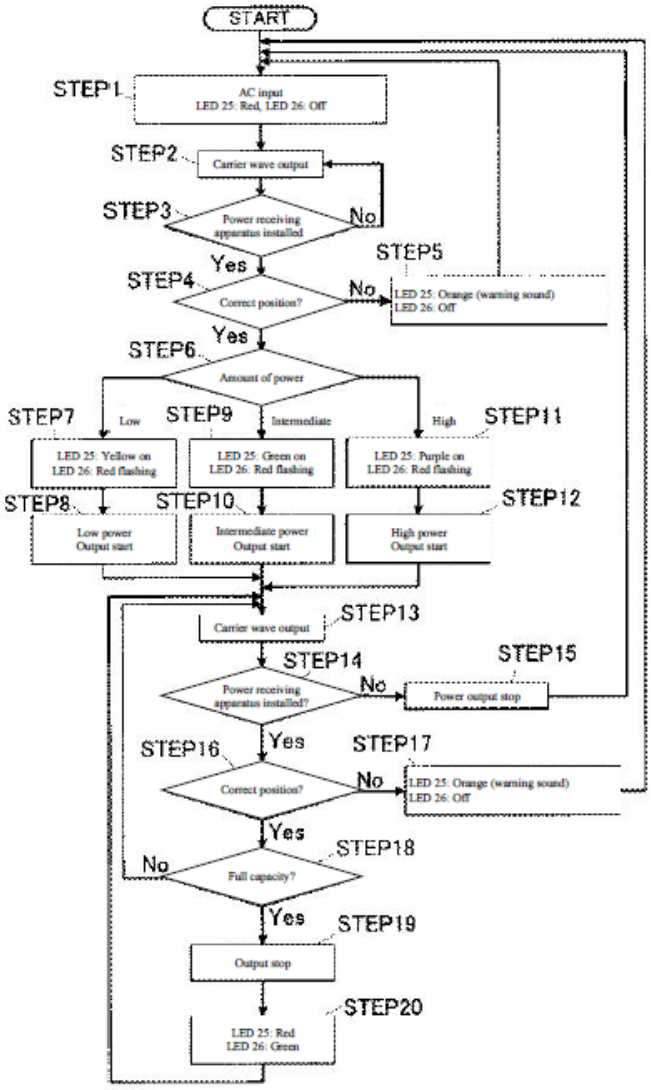


(*Id.*, FIGS. 12(a), 12(b).)



(*Id.*, FIGS. 13(a), 13(b).)

76. *Okada*'s FIG. 3 (below) shows "power supply operations carried out between [PTM10 and PRM40]," applicable to the configurations (such as those I explained above and below) disclosed by *Okada*. (Ex. 1005, FIG. 3, ¶¶0059, 0060-0090, 0094-0115.)



(Ex. 1005, FIG. 3.)

77. In *Okada*, PTM10 (e.g., of cradle 4) transmits a carrier wave signal to PRM40 (e.g., of a portable device such as PDA 3), resulting in a portable device

such as PDA 3 to generate and send a modulated signal/wave[4] including device information relating to the portable device (e.g., **"the code indicating that a device is capable of receiving power," "power consumption information," "full capacity information"**) back to PTM10 via magnetically coupled secondary-side coil 41 and primary-side coil(s) 19. Demodulating circuit 35 of PTM10 "demodulates modulated signals included with the voltage from" primary coil 19 (Ex. 1005, ¶0042), and the information is evaluated by power transmission capability evaluating circuit 36, power amount evaluating circuit 37, and full capacity evaluating circuit 38 (which "perform various decision-making processes based on information included in the signal demodulated by the demodulating circuit 35" (*id.*, FIG. 2, ¶0042, FIG. 3, ¶¶0060-0077)) and also used by other components for *Okada*'s power transfer operations. (*Id.*, FIGS. 2-3, ¶¶0056-0077.) For example, *Okada* explains:

> **A carrier wave** output from the carrier wave oscillating circuit 33 is applied to the tap c of the primary-side coil

[4] *Okada* explains that such a modulation method may be based on "periodic intensity modulation of a carrier wave and may use a phase modulation method to express 0/1 information via phase change information of a signal." (Ex. 1005, ¶0058.)

19, which, when the PDA 3 is mounted on the common cradle 4, **is transmitted to the magnetically coupled secondary-side coil 41**. This carrier wave transmitted to the secondary-side coil 41 is rectified, smoothed, and converted to a DC voltage via the smoothing capacitor 42, the rectifying circuit 43, and the smoothing circuit 44 as described above. Furthermore, the power-on reset circuit 48 detects the DC voltage converted from this carrier wave and recognizes that the carrier wave has been transmitted. Furthermore, the clock extracting circuit 46 connected to the secondary-side coil 41 extracts a clock signal necessary for **modulation from the carrier wave**, and a **modulating circuit 47 applies to the secondary-side coil 41 a modulated wave in which the carrier wave is modulated based on information on the PDA 3: such as "the code indicating that a device is capable of receiving power," "power consumption information," and "full capacity information."** . . .

The modulated wave provided to the secondary-side coil 41 from the modulating circuit 47 is transmitted to the magnetically coupled primary-side coil 19. Furthermore, a demodulating circuit 35 connected to the tap c of the primary-side coil 19 receives and demodulates the

> transmitted modulated wave, and provides the "code indicating that a device is capable of receiving power," "power consumption information," and "full capacity information" included in the demodulated information signal to the power transmission capability evaluating circuit 36, the power amount evaluating circuit 37, and full capacity evaluating circuit 38. . . .

(Ex. 1005, ¶¶0063-0064.)

78. *Okada* explains that such device information (e.g., "code indicating that a device is capable of receiving power," "power consumption information," "full capacity information") received from PRM40 is used in *Okada*'s inductive power transfer operations (e.g., for providing power from an inductive power source such as cradle 4 to a portable device such as PDA 3). (*See, e.g.*, Ex. 1005, FIGS. 2-3, ¶¶0057, 0060-0077.) For example, *Okada* explains:

> . . . the clock extracting circuit 46 connected to the secondary-side coil 41 extracts a clock signal from the carrier wave necessary for modulation, and the modulating circuit 47 uses the clock signal provided by the clock extraction circuit 46 to modulate the carrier wave based on information on a PDA 3: such as "a code indicating that a device is capable of receiving power," "power

consumption information," and "full capacity information." A modulated wave generated by this modulation is applied to the secondary-side coil 41. **When a device (PDA 3) is mounted on the common cradle 4, this "code indicating that a device is capable of receiving power" is used by the power transmission capability evaluating circuit 36 of the power transmitting module 10 to evaluate whether supplying power to the device via the common cradle 4 is feasible (whether the device is equipped with the power receiving module 40)**, as described below. Note that a device where supplying power via the common cradle 4 is feasible (common cradle 4 compatible device) is referred to as a "device capable of receiving power" hereinafter. Also, as described below, **the "power consumption information" is used by the power amount evaluating circuit 37 of the power transmitting module 10 to determine the amount of power to supply to the device (PDA 3) placed on the common cradle 4, and for instructing providing of the signal thereof to the power switching circuit 24 to change the turn ratio of the transformer 30.** Furthermore, the **"full capacity information" is used by the full capacity evaluating circuit 38 to determine whether charging of the**

> **compatible device (PDA 3) is completed**, as described below.

(Ex. 1005, ¶0057; *see also id.*, FIGS. 2-3, ¶¶0060-0077.)

79. *Okada* explains that the "code indicating that a device is capable of receiving power" is used to determine/verify that a portable device / power receiving apparatus (e.g., PDA 3) is a "device capable of receiving power" from (e.g., also referred to as a "compatible" device (*id.*, ¶¶0057, 0064, 0073) with) an inductive power source / power transmitting device (e.g., cradle 4) and that the portable device and its secondary/receiver coil 41 are present and properly aligned with the inductive power source (e.g., cradle 4) and its primary coil(s), where there is appropriate magnetic coupling for high power transmission efficiency between the primary and secondary coils (before transmitting power inductively from the source to the portable device). (*See, e.g.*, Ex. 1005, ¶¶0064-0069, 0074-0076, FIGS. 2-3, 4(a)-(b).) For example, *Okada* explains:

> . . . Here, the power transmission capability evaluating circuit 36 determines whether a power receiving apparatus is mounted onto a power transmitting device 1 based on the "code indicating that a device is capable of receiving power" (STEP 3). If a prescribed "code indicating that a

device is capable of receiving power" is received (STEP 3: Yes), it is recognized that a device capable of receiving power is mounted onto the common module 4 [sic - common cradle 4]. Next it is determined whether the device capable of receiving power (compatible device) is correctly mounted onto the common cradle 4 (STEP 4). Meanwhile, if no prescribed "code indicating that a device is capable of receiving power" is received (STEP 3: No), it is determined that no device capable of receiving power is mounted onto the common cradle 4, and a carrier wave is output again (STEP 2).

Next, the determination as to whether a device capable of receiving power is correctly mounted onto the common cradle 4 is described. **Determining whether a device capable of receiving power is correctly mounted onto the common cradle 4 determines whether the primary-side coil 19 in the power transmitting module 10 and the secondary-side coil 41 in the power receiving module 40 are arranged at positions having high power transmission efficiency, and providing this determination step allows for the selection not to carry out power transmission when the mount position has significantly poor power transmission efficiency.**

FIG. 4 illustrates the relationship between relative positions of the common cradle 4 and the PDA 3, transmission efficiency of power and an information signal. Here, the information signal is the modulated wave described above, returned by the power receiving module 40 in response to a carrier wave transmitted by the power transmitting module 10. In FIG. 4, (a) illustrates an absolute value of a transmission efficiency of power (solid line) and an information signal (dashed line), and (b) illustrates a relative value of the power (solid line) and the information signal (dashed line). In both (a) and (b), the horizontal axis represents an amount of offset of the common cradle 4 and the PDA 3, with 0 being a case where the common cradle 4 and the PDA 3 are positioned at positions at which magnetic coupling of the primary-side coil 19 of the common cradle 4 and the secondary-side coil 41 of the PDA 3 is highest, illustrating the amount of offset of the PDA 3 from this position either left to right or front to back in units of mm.

As illustrated in FIG. 4(a), the greater the amount of offset of the positions of the common cradle 4 and the PDA 3, the worse the power transmission efficiency and information signal transmission efficiency. As illustrated

in FIG. 4(b), this power transmission efficiency and information signal transmission efficiency decrease by the same percentage as the amount of positional offset of the common cradle 4 and the PDA 3, so even when the common cradle 4 is in a state where power is not being transmitted, by measuring a signal intensity of the information signal, the amount of positional offset of the common cradle 4 and the PDA 3 can be recognized.

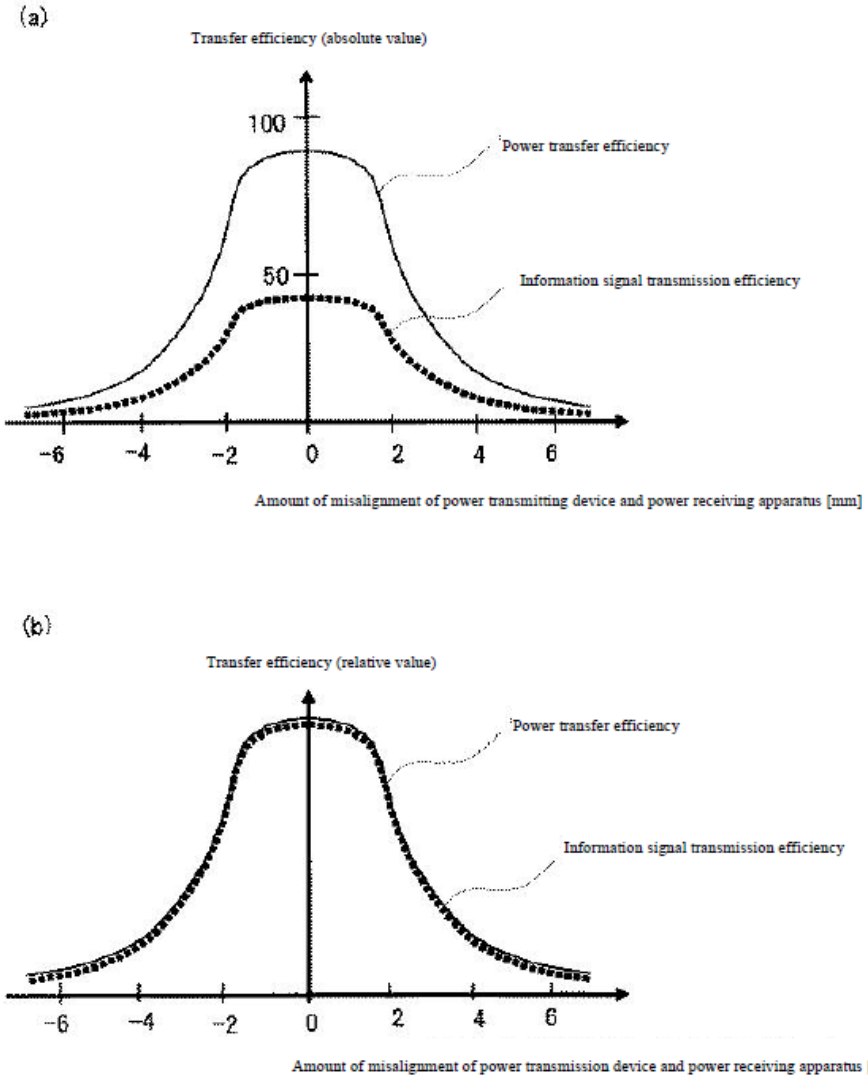
The greater the amount of positional offset of the common cradle 4 and the PDA 3, the worse the power transmission efficiency, so when power transmission efficiency is significantly low, the PDA 3 cannot receive power even if power is transmitted from the common cradle 4, which defeats the purpose of transmitting power. Therefore, after evaluating whether an amount of positional offset of the common cradle 4 and the PDA 3 exceeds a prescribed amount of offset (STEP 4), when exceeded (STEP 4: No), power is not transmitted from the power transmitting device 1 . . .

Meanwhile, when the amount of positional offset of the common cradle 4 and the PDA 3 does not exceed the prescribed amount of offset (STEP 4: Yes), processing

proceeds to evaluating an amount of power to transmit (STEP 6). . . .

(Ex. 1005, ¶¶0064-0069; *see also id.*, FIGS. 3, 4(a)-(b), ¶¶0074-0076.)

FIG. 4



(Ex. 1005, FIGS. 4(a) and (b) ("Amount of ***misalignment*** of power transmission device and power receiving apparatus [mm]").) Thus, *Okada* discloses that power is delivered (e.g., from the inductive power source / power transmission device (e.g., cradle 4 with PTM10) to portable device / power receiving apparatus (e.g., PDA 3 with PRM40)) only when such a "compatible" portable device (and its secondary/receiver coil) is present and properly placed/aligned with the source (e.g., cradle 4) and its primary coil(s). (Ex. 1005, ¶¶0057, 0064-0069, 0074-0076, FIGS. 2-3, 4(a)-(b).)

80. In the multi-coil system configuration (e.g., FIG. 7 (with primary coil group 19x and secondary coil group 41x)) I discussed above, *Okada* explains how switching controller circuitry (e.g., 73) in PTM10 can select a coil from primary coils group 19x based on detected voltage values so that a pair of primary and secondary coils "having a highest power transmission efficiency" (e.g., least misalignment) is used for power transfer. (Ex. 1005, ¶0105; *see also id.*, ¶¶0017, 0094-0115, Claims 9-10.)

81. *Okada* also discloses verifying portable device / PDA 3's presence by measuring intensity of the signal(s) communicated via primary coil(s) 19 and secondary coil 41. (Ex. 1005, FIGS. 4(a)-4(b), ¶¶0066 ("transmission efficiency of

power and the information signal"), 0067-0068, 0074-0076, FIG. 8 (current sensor 91), ¶¶0110 ("current measuring sensor" measuring current "through the primary-side coil 19" when PDA 3 "is in proximity" of cradle 4), 0111.)

82. *Okada* explains that selection/adjustment of the power level (e.g., high, intermediate, low) of power transmitted (e.g., from cradle 4 to a portable device such as PDA 3) may be determined based on the device's "power consumption information" provided by PRM40 to PTM10. (*Id.*, ¶¶0057, 0063-0064, 0069-0073, 0090, FIGS. 2-3.) For example, *Okada* explains:

> when the amount of positional offset of the common cradle 4 and the PDA 3 does not exceed the prescribed amount of offset (STEP 4: Yes), **processing proceeds to evaluating an amount of power to transmit (STEP 6). This evaluation process is conducted using the power amount evaluating circuit 37 based on the "power consumption information" included in the information signal demodulated by the demodulating circuit 35, recognizes the PDA 3 power based on the "power consumption information," and depending on this power, adjusts power transmission output in three levels: high, intermediate, and low.** An evaluation result from the power amount evaluating circuit 37 is relayed to

the LED display circuit 32 and the power switching circuit 24, and depending on the determination result of high, intermediate, and low, a process such as described below is conducted.

First, when the evaluation result is low (STEP 6: Low), the LED display circuit 32 turns ON the light emitting diode 25 yellow and turns ON the light emitting diode 26 red (STEP 7). By changing a combination of colors of light emitted by the light emitting diode 27 and the light emitting diode 28 depending on a magnitude of the power transmission output, a user can visually recognize the magnitude of the power transmission output currently being conducted by the common cradle. **The power switching circuit 24 controls the transistor 21 into an ON state. When the transistor 21 is in the ON state, a pulse voltage from the switching circuit 15 is applied to an entire winding wire of the primary-side coil 19, and power transmission is started (STEP 8).**

Next, when the evaluation result is intermediate (STEP 6: Intermediate), it means that intermediate power transmission will be conducted, and the LED display circuit 32 turns ON the light emitting diode 25 green and turns ON the light emitting diode 26 red (STEP 9). The

power switching circuit 24 controls the transistor 22 into an ON state. When the transistor 22 is in the ON state, a pulse voltage from the switching circuit 15 is applied to a tap a of the primary-side coil 19, and power transmission is started (STEP 10).

Also, **when the evaluation result is high (STEP 6: High), it means that high power transmission will be conducted**, and the LED display circuit 32 turns ON the light emitting diode 25 purple and turns ON the light emitting diode 26 red (STEP 11). **The power switching circuit 24 controls the transistor 23 into an ON state. When the transistor 23 is in the ON state, a pulse voltage from the switching circuit 15 is applied to a tap b of the primary-side coil 19, and power transmission is started (STEP 12).**

Switching the transistor 21, the transistor 22, or the transistor 23 changes the position at which pulse voltage from the switching circuit is applied on winding wire of the primary-side coil 19. That is, because the effective number of actual turns of the primary-side coil 19 changes, the turn ratio of the primary-side coil 19 and the secondary-side coil 41 changes. As such, power can be transmitted depending on the power of a compatible

> device. Note that the present example switches between three levels: high, intermediate, and low, however, the number of switches may be further increased.

(Ex. 1005, ¶¶0069-0073; *see also id.*, ¶0057, FIG. 3.)

83. *Okada* explains that "[e]ven after power transmission has begun," the carrier wave is "periodically transmitted" from PTM10 to PRM40 (e.g., to receive the above-discussed device information in return from PRM40) to determine whether the portable device/PDA 3 (and its coil) remains present and properly positioned/aligned with cradle 4 (and its coil(s)) (e.g., as I explained above, using the above-mentioned "code indicating that a device is capable of receiving power") and whether the portable device/PDA 3 (e.g., its battery) is fully charged (e.g., using the above-mentioned "full capacity information"). (Ex. 1005, ¶¶0074-0076, FIG. 3.) For example, *Okada* explains:

> Even after power transmission has begun, a carrier wave is periodically transmitted (STEP 13), and first, based on information included in a modulated wave returned in response to this carrier wave, it is verified whether the PDA 3 has been removed from the common cradle 4 (STEP 14). As in STEP 3, for this verification, the power transmission capability evaluating circuit 36 determines

whether a device capable of receiving power is mounted onto the common cradle 4 based on the "code indicating that a device is capable of receiving power." Furthermore, if no prescribed "code indicating that a device is capable of receiving power" is received (STEP 14: No), it is determined that the device capable of receiving power has been removed from off of the common cradle 4, the power switching circuit 24 controls all of the transistors including the transistor 21, the transistor 22, and the transistor 23 into an OFF state and stops power transmission (STEP 15).

Meanwhile, if a prescribed "code indicating that a device is capable of receiving power" is received (STEP 14: Yes), it is recognized that a device capable of receiving power is mounted on the common cradle 4. Next it is determined whether the device capable of receiving power is correctly mounted onto the common cradle 4 (STEP 16). As in STEP 4, this determination is conducted by evaluating whether an amount of positional offset of the common cradle 4 and the PDA 3 exceeds a prescribed amount of offset. Furthermore, if this amount of offset exceeds the prescribed amount of offset (STEP 16: No), no power is transmitted from the common cradle 4, the light emitting

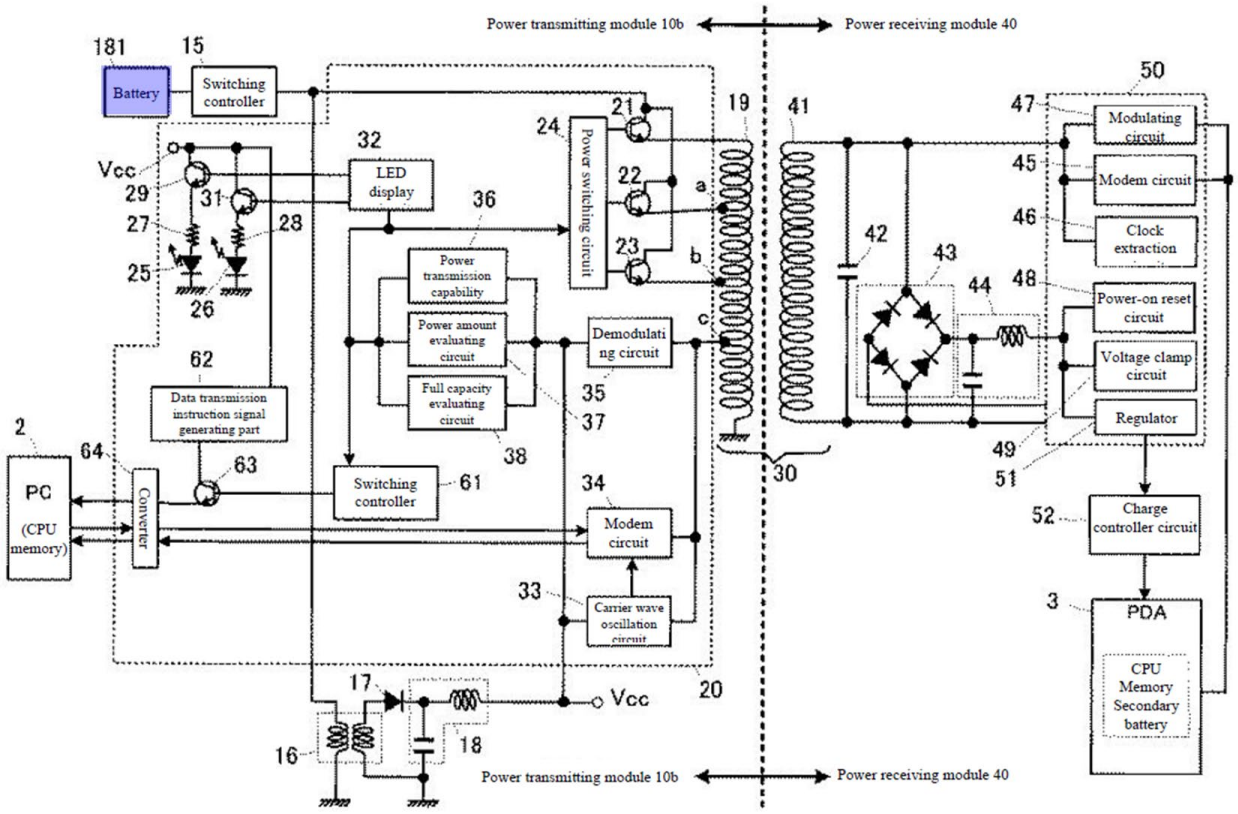
diode 25 is turned ON orange and the light emitting diode 26 is turned OFF as a warning display similar to STEP 5 (STEP 17). A warning sound may also be generated at this time.

Meanwhile, when the amount of positional offset of the common cradle 4 and the PDA 3 does not exceed the prescribed amount of offset, processing proceeds to evaluating whether a charged state of the PDA 3 is at full capacity (STEP 18). This evaluation process is conducted by the full capacity evaluating circuit 38 evaluating whether the PDA 3 is at full capacity based on "full capacity information" included in the information signal demodulated by the demodulating circuit 35. Furthermore, if at full capacity (STEP 18: Yes), the power switching circuit 24 controls all of the transistors including the transistor 21, the transistor 22, and the transistor 23 into an OFF state, ends power output (STEP 19), meaning that the power transmission is stopped because the power receiving apparatus is a full capacity state, turns ON the light emitting diode 25 red, turns ON the light emitting diode 26 green (STEP 20), and continues to confirm the state of the power receiving apparatus by outputting carrier waves (STEP 13). On the other hand, if not at full

> capacity (STEP 18: No), the state of the power receiving apparatus continues to be verified while power is transmitted (STEP 13). As described above, power is supplied from the common cradle 4 to the PDA 3.

(Ex. 1005, ¶¶0074-0076; *see also id.*, FIGS. 2-3.)

84. *Okada* (in addition to that I explained above) also discloses a system, which instead of using AC power, uses an internal battery to power/charge a portable device such as PDA 3. For example, *Okada* discloses configurations where PTM10 can be powered by an internal rechargeable battery that provides power to switching circuit 15. (Ex. 1005, ¶¶0148 ("these devices may be provided with an internal battery and may supply power from this battery"), 0149 (FIG. 17 configuration "is identical to that in FIG. 2, except that DC power is supplied from the battery 181"), 0150-0151, FIG. 17 (annotated below highlighting the battery in purple).)



(Ex. 1005, FIG. 17 (annotated).) Additionally, *Okada* explains that "each of the examples described above, the common cradle 4 [Figure 1], power supply pad 100 [Figure 9], side panel 121 [Figure 11], side panel 131 [Figure 12], [and] mouse pad 141 [Figure 13]" may be provided with an internal battery and "may supply power from this battery." (*Id.*, ¶0148, FIGS. 1, 9, 11(a), 12-13 (*see* these figures above in this section).)

B. *Odendaal* (Ex. 1008)

85. I understand that *Odendaal* is an issued United States patent. (Ex. 1008, Cover.) My understanding is that *Odendaal* was filed June 26, 2002 and issued November 1, 2005. (*Id.*) I rely on the disclosures and analysis thereof of *Odendaal* discussed in this section VIII for my opinions regarding *Odendaal*'s teachings and suggestions as applied to the challenged claims of the '371 patent below in Section IX.

86. *Odendaal* discloses a contactless inductive power/charging system (e.g., "contactless power transfer system[]") that uses inductive coupling (e.g., "coupling between battery charging circuit and the battery [that] may comprise capacitive coupling and/or **magnetic coupling, and wherein power is transferred by the coupling of** an electric field and/or **magnetic flux** across the IOET [interface-of-energy-transfer]") between primary and secondary coils (e.g., thin, planar-type coils) to provide power to a mobile device (e.g., cellphone, computer, etc.) through its secondary coil placed on or near primary coils in the surface of a powering device (e.g., charger for cellphones, powering pad, or charger embedded in a thin surface, including fabrics, etc.). (Ex. 1008, 1:5-3:57; *see also id.*, Title, Abstract, FIGS. 1A-4, 11-12, 4:50-5:8, 5:24-28, 6:59-64.)

87. *Odendaal* discloses the known use of thin, planar-type inductor coils for use in a contactless power/data transfer system that transfers power/data via magnetic coupling for, e.g., charging a battery of a cellphone, computer, wearable items, etc. (*Id.*, FIGS. 1A-1B, 2A, 2C, 8E, 1:58-2:43.) For example, *Odendaal* explains:

> The spiral-shaped conductor may comprise pcb spiral-wound conductors. In addition, a battery charging circuit can be coupled to one of the first and second spiral-shaped conductors, and a load can be coupled to the other of the first and second spiral-shaped conductors. The coupling between battery charging circuit and the battery may comprise capacitive coupling and/or magnetic coupling, and wherein power is transferred by the coupling of an electric field and/or magnetic flux across the IOET [interface-of-energy-transfer].
>
> According to an aspect of the present invention, a signal applied to the first spiral-shaped conductor can be transferred to the second spiral-shaped conductor by coupling of magnetic flux of the first and second spiral-shaped conductors across the IOET.

> The first and second spiral-shaped conductors and the IOET are preferably integrated into a planar (flat/thin) structure.

(*Id.*, 2:55-3:5.) *Odendaal* also explains:

> According to another aspect of the invention, an isolating coupling interface and a resonant tank are functionally integrated into a planar configuration for transferring power with isolation properties. **The device may comprise two separable structures on either side of the IOET, such as, for example, a cellphone and its charger**. . . .
>
> An advantage of the present invention is that it facilitates the use of **wearable electronics**. For example, **flex circuits may be used so as to cause the surface of the coils to be flexible.** In addition to the flexibility, the coils may be formed in any arbitrary shape to facilitate woven wire arranged in **a fabric, or pads with embedded conductors that can be attached to clothes**. In this way, for example, **one could charge a radio, cellphone, and/or computer (just to name a few of the many wearable items) by bringing the device in close proximity to the fabric.** Thus, implementation of the invention with wearable electronics could provide an

> **interface between the wearable device(s) and external power sources. Digital or analog signals may also be transmitted across such interfaces to, for instance, up- or download digital information.**

(*Id.*, 2:16-43; *see also id.*, 2:44-54 (explaining that the "interface-of-energy-transfer" (IOET) of the planar power resonator "may have a **thin and/or relatively flat top coil surface**" and may have coils arranged in upper and lower configurations "with an air gap"); *see also id.*, 2:1-15 (transferring power across IOET "in **either** an electric **or magnetic form**, or both" and "**transformer action** with or **without** capacitive energy transfer"), 4:44-5:8, 6:1-18 (air coil transformer).)

88. As noted in the quote above, *Odendaal* explains that in addition to charging "a radio, cellphone, and/or computer," etc. (Ex. 1008, 2:30-41), its system can also transmit "**digital**" signals through the IOET (e.g., between the primary side and the secondary side) for uploading/downloading "**digital information**" (*id.*, 2:41-44). (Ex. 1008, 2:30-44; *see also id.*, 2:65-3:2 ("According to an aspect of the present invention, a signal applied to the first spiral-shaped conductor can be transferred to the second spiral-shaped conductor by coupling of magnetic flux of the first and second spiral-shaped conductors across the IOET.").)

C. *Shima* (Ex. 1032)

89. I understand that *Shima* is an issued United States patent. (Ex. 1032, Cover.) My understanding is that *Shima* was filed March 21, 1997 and issued September 15, 1998. (*Id.*) I rely on the disclosures and analysis thereof of *Shima* that I discuss in this section VIII for my opinions regarding *Shima*'s teachings and suggestions as applied to the challenged claims of the '371 patent below in Section IX.

90. *Shima* discloses an inductive power/signal transfer system using primary and secondary coils. (Ex. 1032, Abstract, 1:42-50, 2:12-4:10, 5:62-6:53, 7:17-8:38.)

91. *Shima* discloses connecting different coil patterns residing on different layers of PCBs by using through-holes (vias). For example, FIG. 3A (below) is described having "a plurality of thin printed-circuit substrates 30-1 to 30-n" with similar "coil patterns 32-1 to 32-n." (Ex. 1032, 5:62-6:1, FIGS. 3D-3E (below), 6:13-35.) *Shima* explains that starting and terminating ends of the coil patterns are connected using through-holes 33 and 34, respectively. (*Id.*, 6:4-21.) *Shima* also explains that layers of loop patterns (e.g., 37-1 to 37-n (FIG. 5A (below)) may also "have the respective through-holes [39] connected in such a way that a spiral coil is

formed in the direction in which the printed-circuit substrates 30-1 to 30-n are stacked." (*Id.*, 7:17-35.)

FIG. 3A

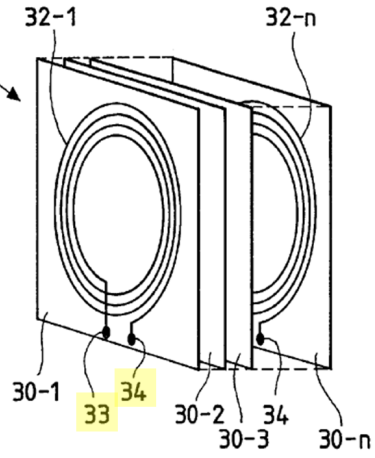
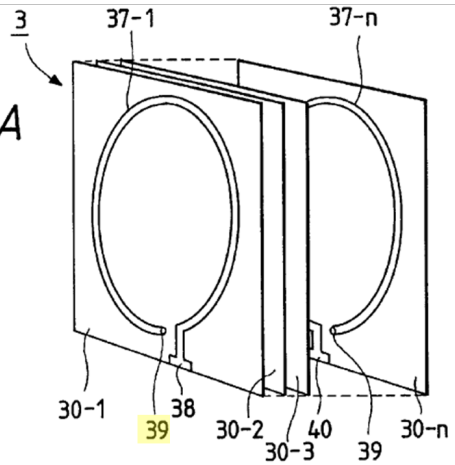


FIG. 5A



(Ex. 1032, FIGS. 3A, 5A (annotated).)

FIG. 3D

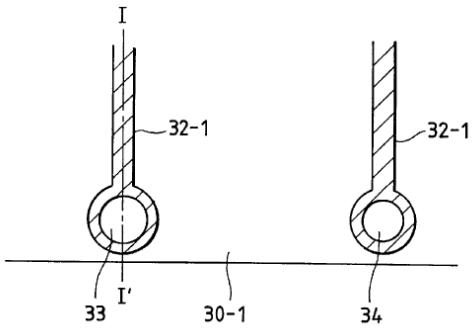
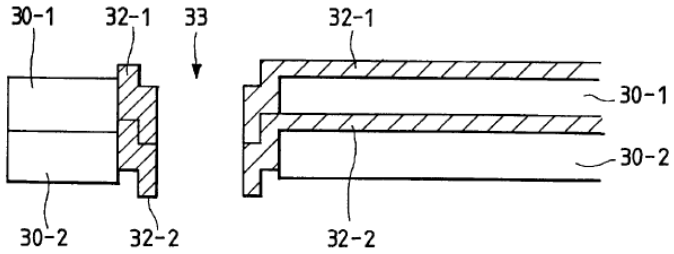


FIG. 3E



(*Id.*, FIGS. 3D, 3E.)

D. *Hui-027* (Ex. 1068)

92. I understand that *Hui-027* is a published United States patent application. (Ex. 1068, Cover.) My understanding is that *Hui-027* was filed October

28, 2002 and issued May 22, 2003. (*Id.*) I rely on the disclosures and analysis thereof of *Hui-027* I discuss in this section VIII for my opinions regarding *Hui-027*'s teachings and suggestions as applied to the challenged claims of the '371 patent below in Section IX.

93. *Hui-027* discloses an inductive power/signal transfer system using primary and secondary coils (Ex. 1068, Abstract, ¶¶0001-0004, 0030-0033, 0039-0042, 0065, 0067, Table I, FIGS. 1, 2, 3a, and 3b). For example, *Hui-027* discloses:

> It has been shown that the use of coreless PCB transformer in signal and low-power applications does not cause a serious EMC problem. In power transfer applications however, the PCB transformers have to be shielded to comply with EMC regulations. Investigations of planar transformer shielded with ferrite sheets have been reported and the energy efficiency of a PCB transformer shielded with ferrite sheets can be higher than 90% in Megahertz operating frequency range. However, as will be discussed below, the present inventors have found that using only thin ferrite materials for EMI shielding is not effective and the EM fields can penetrate the thin ferrite sheets easily.

(Ex. 1068, ¶0003.)

94. *Hui-027* discloses PCB coils made of copper of certain thickness. For example, Table I (below) shows that the PCB coils of FIGS. 3a and 3b (below) have a "Copper Track Thickness" of "70 µm (**2 Oz/ft²**)" and FIG. 3b illustrates that the "Conductor **Thickness**" corresponds to that of the primary winding. (Ex. 1068, ¶¶0004, 0030, FIGS. 3a and 3b (below).)

TABLE I

Geometric Parameters of the PCB Transformer

Geometric Parameter	Dimension
Copper Track Width	0.25 mm
Copper Track Separation	1 mm
Copper Track Thickness	70 μm (2 Oz/ft^2)
Number of Primary Turns	10
Number of Secondary Turns	10
Dimensions of Ferrite Plates	25 mm × 25 mm × 0.4 mm
PCB Laminate Thickness	0.4 mm
Insulating Layer Thickness	0.228 mm
Transformer Radius	23.5 mm

(Ex. 1068, Table I (annotated).)

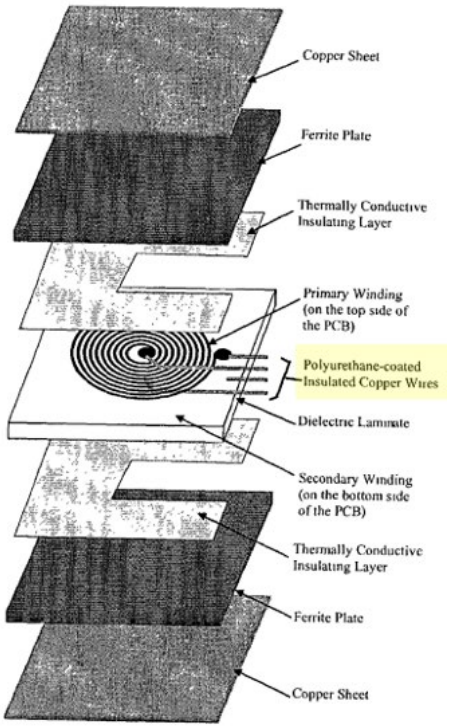


Fig. 3a.

(Ex. 1068, FIG. 3a (annotated).)

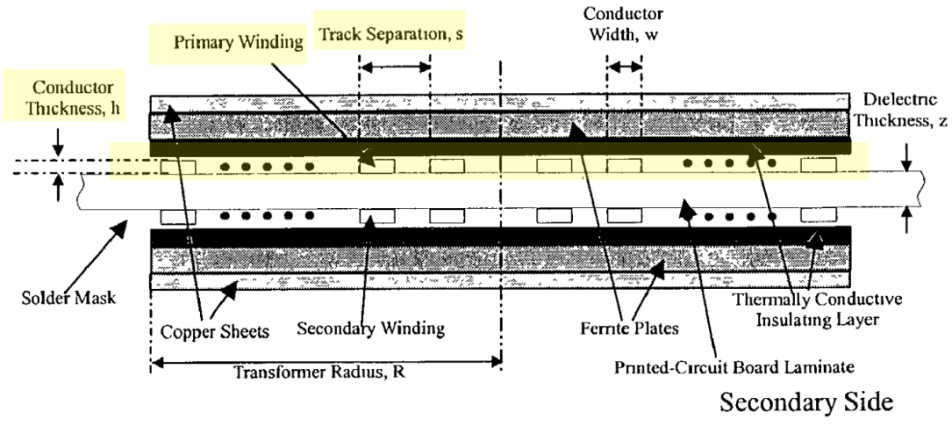


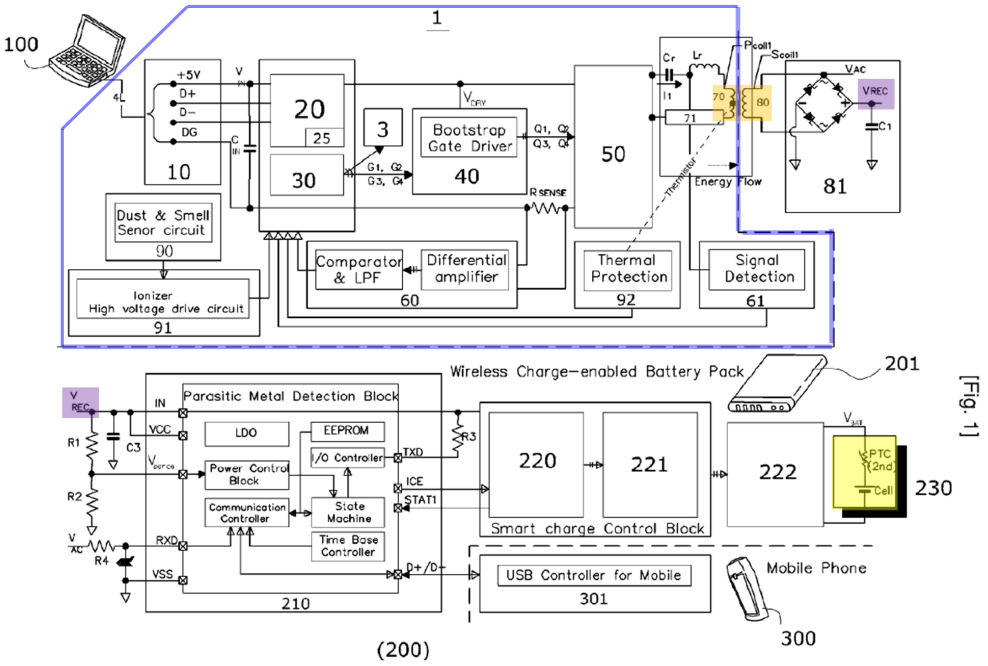
Fig. 3b.

(Ex. 1068, FIG. 3b (annotated).)

E. *Kook* (Ex. 1059)

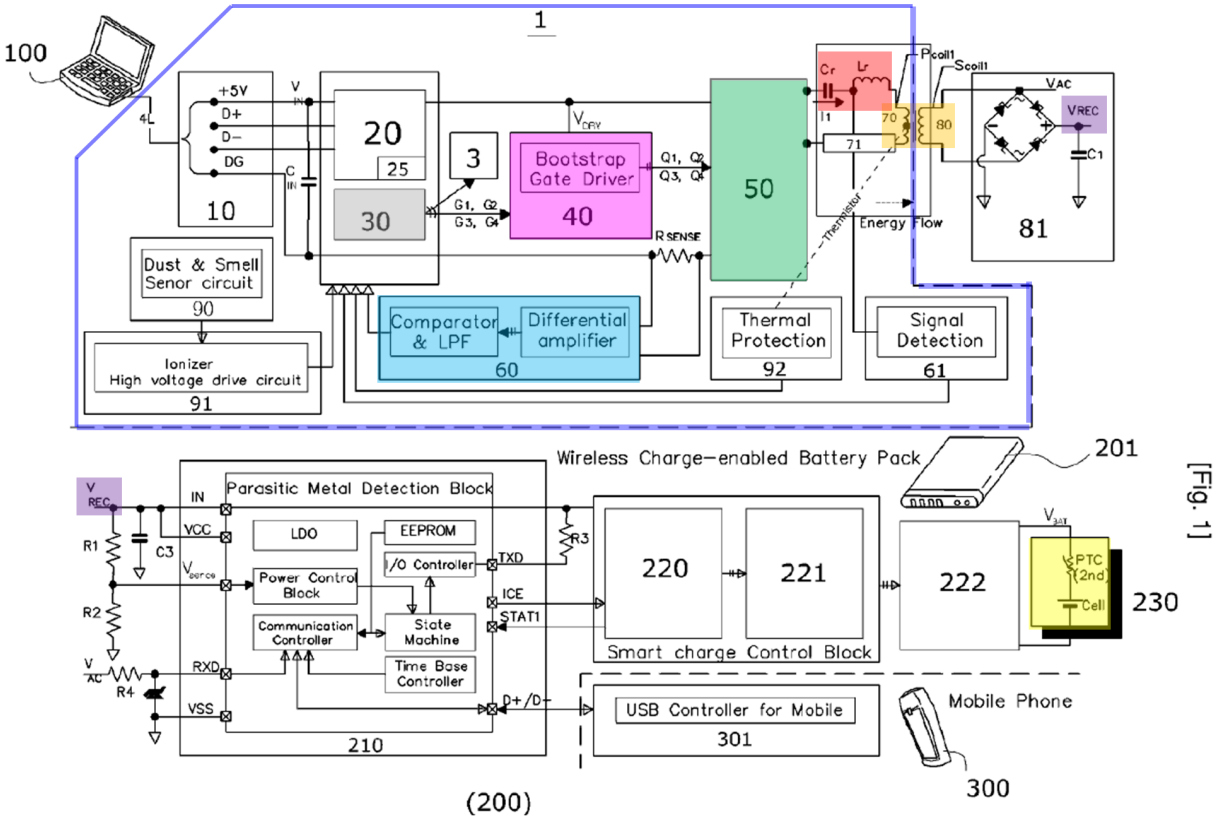
95. I understand that *Kook* is an International Application Published under the Patent Cooperation Treaty. (Ex. 1059, Cover.) My understanding is that *Kook* was filed October 25, 2006 and issued October 22, 2009. (*Id.*) I rely on the disclosures and analysis thereof of *Kook* that I discuss in this section VIII for my opinions regarding *Kook's* teachings and suggestions as applied to the challenged claims of the '371 patent below in Section IX.

96. *Kook* discloses "a non-contact charger capable of wireless data communication and…charging battery-pack of a mobile device." (Ex. 1059, Abstract, ¶¶0001, 0006, 0037-0042.) *Kook* explains that charger 1 (blue below) receives power from computer 100 to power/charge mobile device 300 having a battery pack 200 (containing battery 230 (yellow)), via primary coil 70 and secondary coil 80 (both orange). (Ex. 1059, ¶¶0015 (mobile device has battery-pack 200), 0032, 0036-0037, FIG. 1 (below (rectification block 81 of battery pack 200 providing VREC (purple) to charger controller 210 of the same).)



[Fig. 1]

(Ex. 1059, FIG. 1 (annotated).) *Kook* explains that charger 1 includes an MPU 30 "for controlling internal elements" of charger 1. (Ex. 1059, ¶0041.) *Kook* further explains that charger 1 also includes gate drive block 40 (magenta below) and serial resonator converter 50 (*e.g.*, a LLC full/half wave type serial resonator converter, green), a "C-**L resonator**" (red (**Cr**/Lr), coupled to primary coil 70, and current sensing block 60 (blue). (*Id.*, ¶¶0032-0035, 0041.)



[Fig. 1]

(Ex. 1059, FIG. 1 (annotated).)

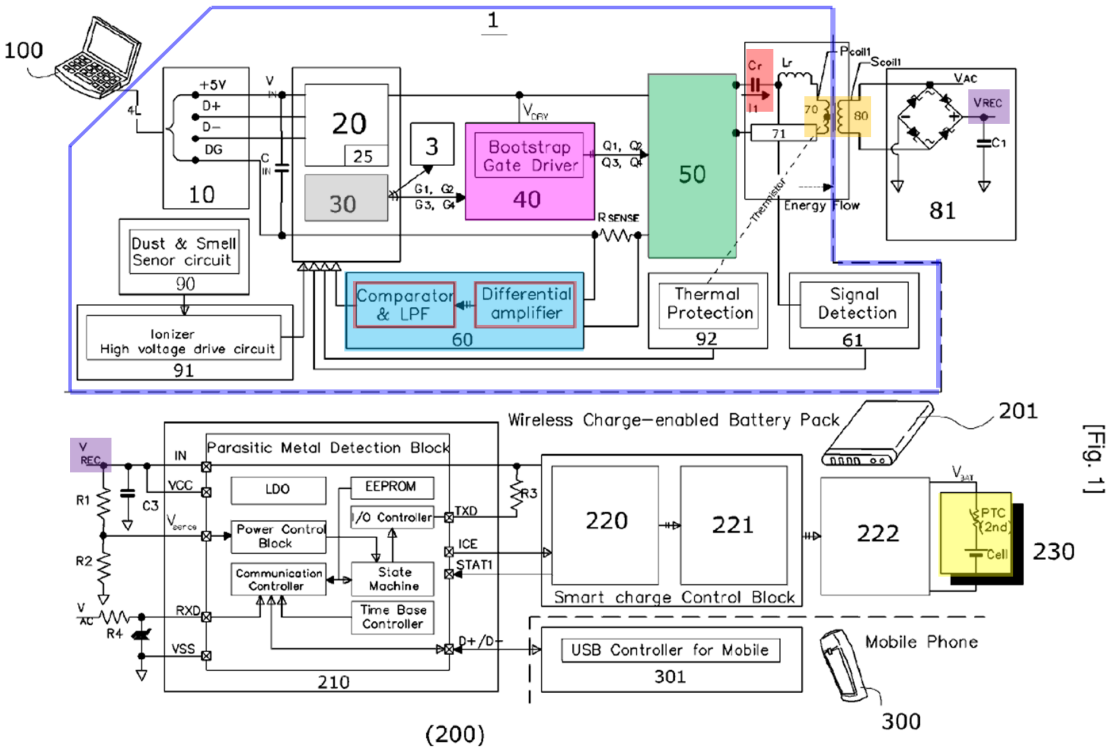
97. *Kook* explains that the "C-L resonator" coupled to primary coil 70, including capacitor Cr. (Ex. 1059, FIG. 1, ¶0041.) *Kook* further explains that by using a "resonator converter to induce LC resonance," it "make[s] an electric current into a sine wave and transmit[s] an electric power to the secondary side by means of the inductive coupling." (*Id.*, ¶0049.) *Kook* describes bootstrap ***gate*** drive block 40" providing four signals Q1-Q4 to serial resonator converter 50. (Ex. 1059, FIG. 1, ¶¶0009, 0032-0035, 0041.)

98. In addition to that described above, *Kook* describes feedback controlled type functionalities that allow the charger to adjust the operating frequency of the charger circuit, to control charging power/voltage to the portable device **during** charge/power transfer operations. For example, in connection with FIG. 1 (annotated above) *Kook* explains that current sensing block 60 "stably control[s] an electric power through a current **feedback** using an automatic variation algorithm of **primary** frequency so as…to control a voltage of a **secondary** rectification terminal in the charging battery-pack 200." (Ex. 1059, ¶¶0041.) *Kook* also explains that current sensing block 60 analyzes "a signal of the secondary coil 80 to recognize the mobile device 300, monitor the primary coil 70 and the secondary coil 80 to control a charge voltage to a stable voltage." (*Id*., ¶0033; *see also id.*, ¶0047 ("voltage of the secondary rectification terminal…is controlled to a constant voltage" via coils 70/80, which "may control the secondary charging power…using an automatic variation algorithm of primary frequency of the non-contact charger 1"), ¶0083 ("adjusting a voltage of the secondary side to the stable voltage…using a parameter (frequency).").)

99. Further, *Kook* discloses that "a voltage of the secondary rectification terminal in [the battery/device] is controlled to a **constant voltage**" via coils 70/80

by "using an automatic variation algorithm of primary frequency of the non-contact charger 1." (Ex. 1059, ¶0047; *id.*, ¶0041 (current sensing block 60 "**stably controlling**" power "through a current feedback using an automatic variation algorithm of primary frequency").)

100. In addition to what I explained above, *Kook* discloses that charger 1 includes **current sensing block 60** (blue in FIG. 1 below) that **monitors primary coil 70** to receive signals and associated information. (Ex. 1059, ¶¶0008, 0010, 0032-0033, 0041 ("a current sensing block 60 for stably controlling an electric power through a current feedback"), 0045 ("current sensing block 60 receives a signal").) *Kook* explains that current sensing block 60 includes a differential "**amplifier**" and a "LPF" ("**Low Pass Filter**" (red below)).



(Ex. 1059, FIG. 1 (annotated).)

F. *Kazutoshi* (Ex. 1034)

101. I understand that *Kazutoshi* is a published United States patent application. (Ex. 1034, Cover.) My understanding is that *Kazutoshi* was filed December 3, 2004 and published June 23, 2005. (*Id.*) I rely on the disclosures and analysis thereof of *Kazutoshi* that I discuss in this section VIII for my opinions regarding *Kazutoshi*'s teachings and suggestions as applied to the challenged claims of the '371 patent below in Section IX.

102. *Kazutoshi* discloses a "contactless power supply system" with a power supply device 21 providing power to portable object (cart 3). (Ex. 1034, Abstract, FIG. 1, ¶¶0001, 0005-0014, 0024-0030.) *Kazutoshi* explains that power supply device 21 provides power through inductive wires 19, where power is induced on a signal pickup coil 20A used to operate a load (motor 15) in the portable object. (Ex. 1034, FIG. 3, ¶0029.)

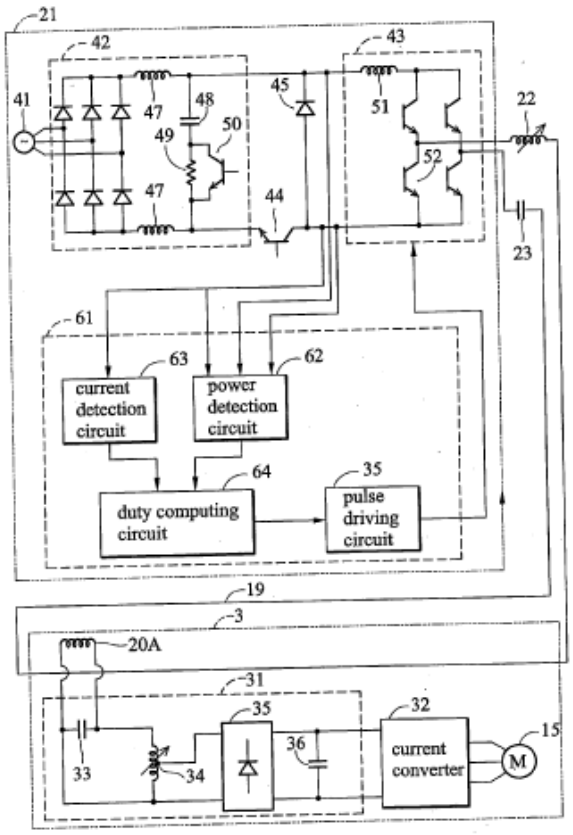


FIG. 3

(Ex. 1034, FIG. 3.)

103. Power supply device 21 includes a controller 61, which comprises power detection circuit 62, current detection circuit 63, duty computing circuit 64, and pulse driving circuit 65. (*Id.*, ¶¶0037-0038.) Duty computing circuit 64 receives signals (associated with the output of current converter 42 and current alternator 43, and output power of power supplying inductive wires 19) from power detection circuit 62 and current detection circuit 63. (*Id.*) Duty computing circuit 64 "employs the output current of the current detection circuit 63 as a reference, [] evaluates the duty of the square wave driving the transistor 52 in the current alternator 43," and provides an output signal to pulse generating circuit 65 to drive transistor 52 and inductive wires 19 in order to power cart 3. (*Id.*, ¶¶0038, 0043.)

104. *Kazutoshi* discloses that duty computing circuit 64 (e.g., shown in FIG. 5 below) "comprises a subtractor 71, a multiplier 72, an integrator 73, a differentiator 74, an adder 75, and a gain configurator 76," where "[t]he multiplier 72, the integrator 73, and the differentiator 74 make up a proportional integral derivative (PID) controller." (Ex. 1034, ¶0039.) A person of ordinary skill in the art would have understood that the controller uses the difference between the output current (current detection circuit 63) and a reference value to determine an output signal to pulse generating circuit 65 for driving transistor 52 and inductive wires 19 to

inductively power cart 3. (*Id.*; *id.*, ¶¶0040-0043.) A person of ordinary skill in the art would have understood that the proportional integral derivative (PID) controller provides "an output voltage for load resistance R and an output current within the range of the reference current." (*Id.*, ¶0043; *see also id.*, ¶0044.)

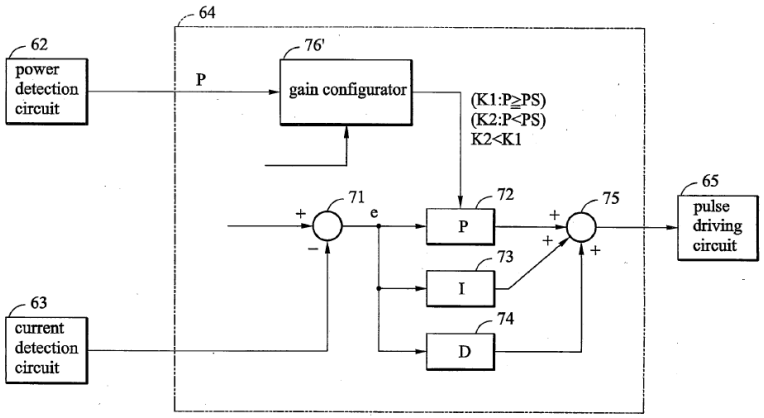


FIG. 5

(Ex. 1034, FIG. 5.)

IX. THE PRIOR ART DISCLOSES OR SUGGESTS ALL RECITED FEATURES OF CLAIMS 28 AND 29 OF THE '371 PATENT[5]

A. Ground 1: *Okada* in view of *Odendaal*, *Shima*, *Hui-027*, and *Kook* Discloses and/or Suggests the Features of Claim 28

105. In my opinion, *Okada* in view of *Odendaal, Shima, Hui-027, and Kook* discloses and/or suggests all of the features of claim 28 of the '371 patent.

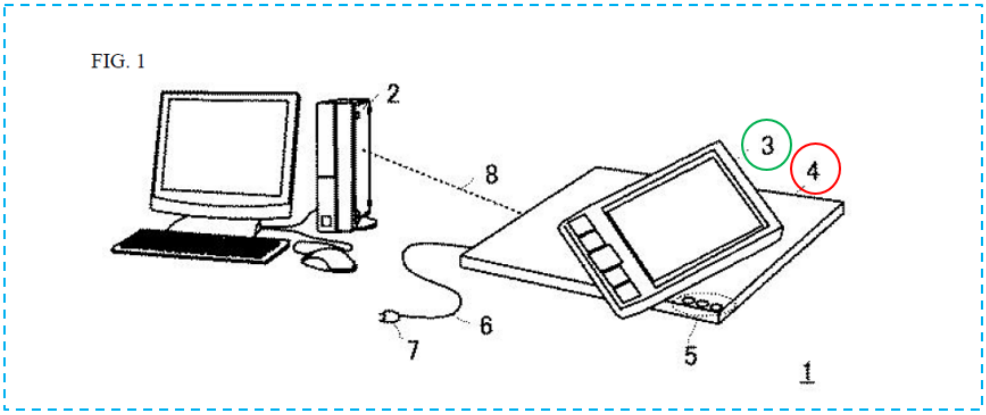
1. Claim 28

a) A system for providing power inductively to a portable device comprising a battery and an inductive receiver unit including a receiver coil and a receiver circuit, the system comprising:

106. I understand that this phrase is the preamble of claim 28, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Okada* discloses the limitation(s) in the preamble. (*See* my analysis and discussions below for this section; *see also* my analysis and discussions below for Sections IX.A.1(b)-(k).) *Okada* discloses a "**system**" for inductively

[5] In this section (Section IX), I refer to exhibits other than those identified prior art reference(s) that disclose and/or suggest the claimed limitations. Such exhibits reflect the state of the art known to a person of ordinary skill in the art at the time of the alleged invention. (*See also* my discussions above in Section V.)

powering/charging portable devices, *e.g.*, mobile phones. (Ex. 1005, Abstract, ¶¶0001, 0047.) FIG. 1 (annotated below) shows power supply system 1 (blue) including PC2, PDA3 (green) ("**portable device**"), and cradle 4 (red) including LEDs 5, cable/plug 6/7 ("**system**"). (Ex. 1005, ¶¶0034-0036.)



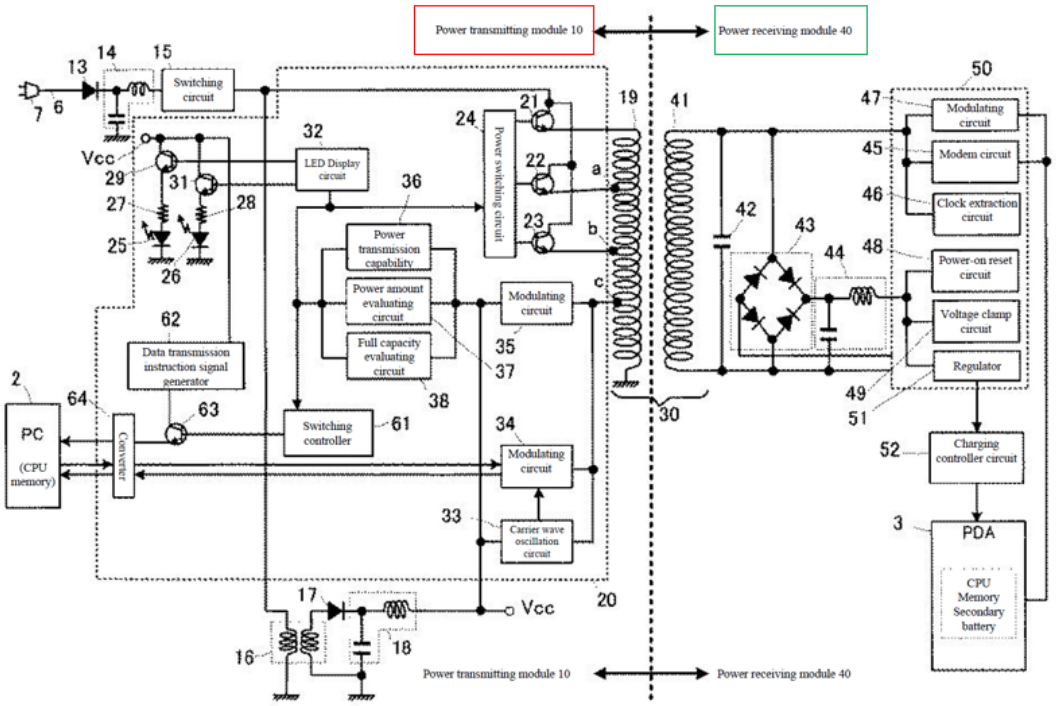
(Ex. 1005, FIG. 1 (annotated).) *Okada* explains that "magnetic coupling" occurs between cradle coil and PDA3 coil, which "induces voltage at both ends of the coil in the PDA" to "suppl[y] power to the PDA." (Id., ¶0035.) *Okada* explains:

> In FIG. 1, when the AC plug 7 is inserted into an AC outlet (not shown) and the PDA 3 is placed in a prescribed position on the common cradle 4, commercial voltage is supplied to the common cradle 4 via the cord 6. In addition, as described below, if the PDA 3 and the common cradle 4 each have an internal coil, when commercial voltage is applied to the common cradle 4,

> ***magnetic coupling occurs between the coil in the common cradle 4 and the coil in the PDA 3, which induces voltage at both ends of the coil in the PDA, and this induced voltage supplies power to the PDA***. *Note that* ***the internal circuit of the common cradle 4, which is the power supply side, is referred to as the power transmitting module 10, and the internal circuit of the PDA 3, which is the side power is supplied to, is referred to as the power receiving module 40***. At this time, the power transmitting module 10 and the power receiving module 40 are respectively configured including the aforementioned coils.

(*Id.*, ¶0035.)

107. *Okada's* FIG. 2 (annotated below) also describes an exemplary embodiment where cradle 4/PDA3 each includes circuitry/components and at least one coil. (Ex. 1005, ¶¶0035, 0037.) Cradle 4 includes a **power transmitting module 10** ("PTM10") (also an example of a "**system**" (alone or collectively with cradle 4)), and PDA3 includes a **power receiving module 40** ("PRM40"). (*Id.*, ¶¶0035-0037, 0038-0058, FIG. 8, 0110-0111.)



(Ex. 1005, FIG. 2 (annotated).)

108. *Okada* explains that PTM10 converts received power to a DC signal via circuits 13-14. (Ex. 1005, ¶¶0038, 0049.) Switching circuit 15 generates a switching pulse signal using the DC signal (*id.*), which is converted to a DC signal (V_{CC}) powering PTM10 components (via circuits 16-18). (*Id.*, ¶0039.) *Okada* also discloses that the pulse signal is also supplied to primary coil 19 via switches 21/22/23. (*Id.*, ¶¶0040, 0049-0051.) Power switching circuit 24 selects a switch 21/22/23 to allow the pulse signal to traverse selected turns of coil 19, enabling the system to select/adjust the power level transmitted to PRM40 (PDA3). (*Id.*, ¶¶0040,

0051, 0057, 0069-0073.) The transmitted power level may be determined based on the device's "power consumption information" provided by PRM40 to PTM10. (*Id.*, ¶¶0057, 0063-0064, 0069-0073.) *Okada* explains:

> The pulse voltage switched by the switching circuit 15 is applied to both ends of the primary-side coil 19 through one of the transistors, namely transistor 21, transistor 22, or transistor 23, controlled by the power switching circuit 24. ***The primary-side coil 19 together with the secondary-side coil 41 constitute the transformer 30 and magnetic coupling induces a voltage on both ends of the secondary-side coil 41.*** A magnitude of the voltage generated at this time is affected by a transformation ratio of the primary-side coil 19 and secondary-side coil 41. This transformation ratio can be changed because the number of turns of the primary-side coil 19 changes depending on which transistor among transistor 21, transistor 22, and transistor 23 that a power switching circuit 24 brings into an ON state, as described above.

(Ex. 1005, ¶0051; *see also id.*, ¶¶0040, 0057, 0069-0073.)

109. *Okada* discloses various configurations of such a "system" providing similar functionalities associated with PTM10 and PRM40, in connection with, *e.g.,*

FIGS. 2, 7-17. (Ex. 1005, ¶¶0009-0032, ¶¶0094-0096 (PTM10 and PRM40 including multiple coils), 0097-0154). For example, *Okada* states:

> The voltage induced at both ends of the secondary-side coil 41 by the signal from the carrier wave oscillating circuit 33 is converted to a DC voltage after being rectified and smoothed by a smoothing capacitor 42, a rectifying circuit 43, and a smoothing circuit 44. When this DC voltage is applied to the power-on reset circuit 48, the power receiving module 40 (power receiving control IC 50) recognizes that a carrier wave is sent from the carrier wave oscillating circuit 33.
>
> Furthermore, the clock extracting circuit 46 connected to the secondary-side coil 41 extracts a clock signal from the carrier wave necessary for modulation, and the modulating circuit 47 uses the clock signal provided by the clock extraction circuit 46 to ***modulate the carrier wave based on information on a PDA 3: such as "a code indicating that a device is capable of receiving power," "power consumption information," and "full capacity information." A modulated wave generated by this modulation is applied to the secondary-side coil 41.***

> When a device (PDA 3) is mounted on the common cradle 4, this "code indicating that a device is capable of receiving power" is used by the power transmission capability evaluating circuit 36 of the power transmitting module 10 to evaluate whether supplying power to the device via the common cradle 4 is feasible (whether the device is equipped with the power receiving module 40), as described below. Note that a device where supplying power via the common cradle 4 is feasible (common cradle 4 compatible device) is referred to as a "device capable of receiving power" hereinafter.
>
> Also, as described below, ***the "power consumption information" is used by the power amount evaluating circuit 37 of the power transmitting module 10 to determine the amount of power to supply to the device (PDA 3) placed on the common cradle 4, and for instructing providing of the signal thereof to the power switching circuit 24 to change the turn ratio of the transformer 30***. Furthermore, the "full capacity information" is used by the full capacity evaluating circuit 38 to determine whether charging of the compatible device (PDA 3) is completed, as described below.

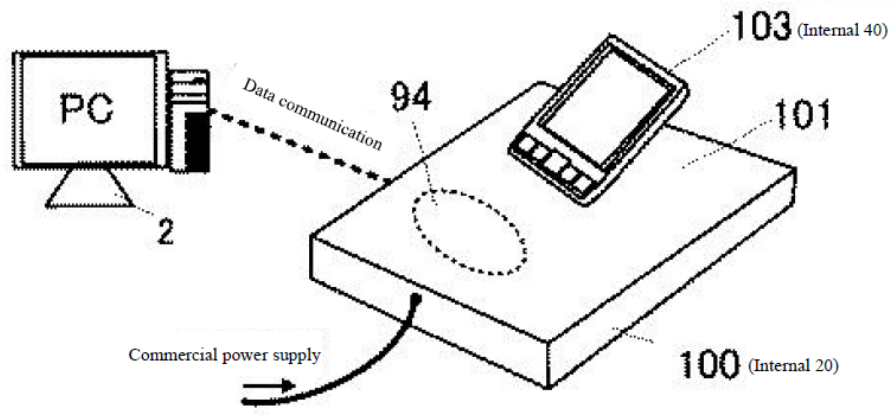
(Ex. 1005, ¶0057; *see also id.*, ¶0069 (below).)

> [W]hen the amount of positional offset of the common cradle 4 and the PDA 3 does not exceed the prescribed amount of offset (STEP 4: Yes), processing proceeds to **evaluating an amount of power to transmit (STEP 6)**. ***This evaluation process is conducted using the power amount evaluating circuit 37 based on the "power consumption information" included in the information signal demodulated by the demodulating circuit 35***, recognizes the PDA 3 power based on the "power consumption information," and depending on this power, adjusts power transmission output in three levels: high, intermediate, and low. An evaluation result from the power amount evaluating circuit 37 is relayed to the LED display circuit 32 and the power switching circuit 24, and depending on the determination result of high, intermediate, and low, a process such as described below is conducted"), FIG. 3.)

110. In my opinion, a person of ordinary skill in the art would have understood that applications of these features are described with respect to other exemplary "system[s]." (Ex. 1005, ¶0107 ("one of these [modules] consists of [multiple] coils and the other consists of one coil"), FIG. 9 (below), ¶¶0116-0118,

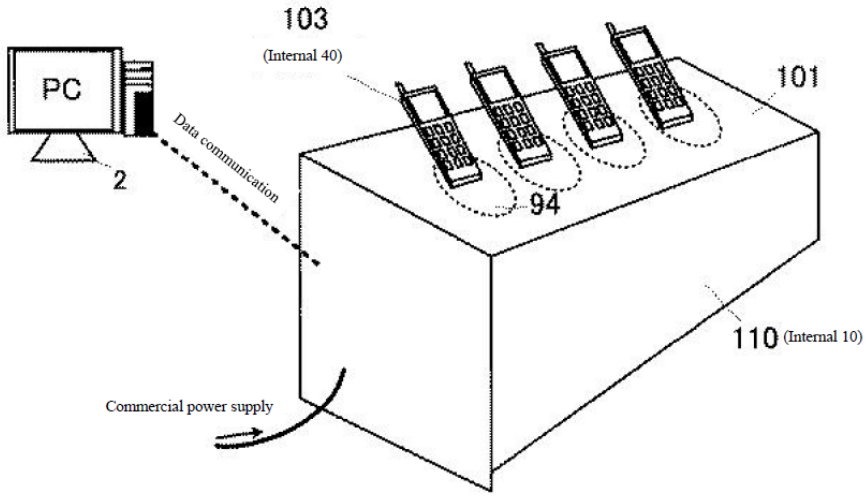
FIG. 10, ¶0119, FIGS. 11(a)-(b) (below), ¶¶0120-0122, FIGS. 12(a)-(b) (below) ¶¶0123-0126, FIGS. 13(a)-(b) (below), ¶¶127-132.)

FIG. 9

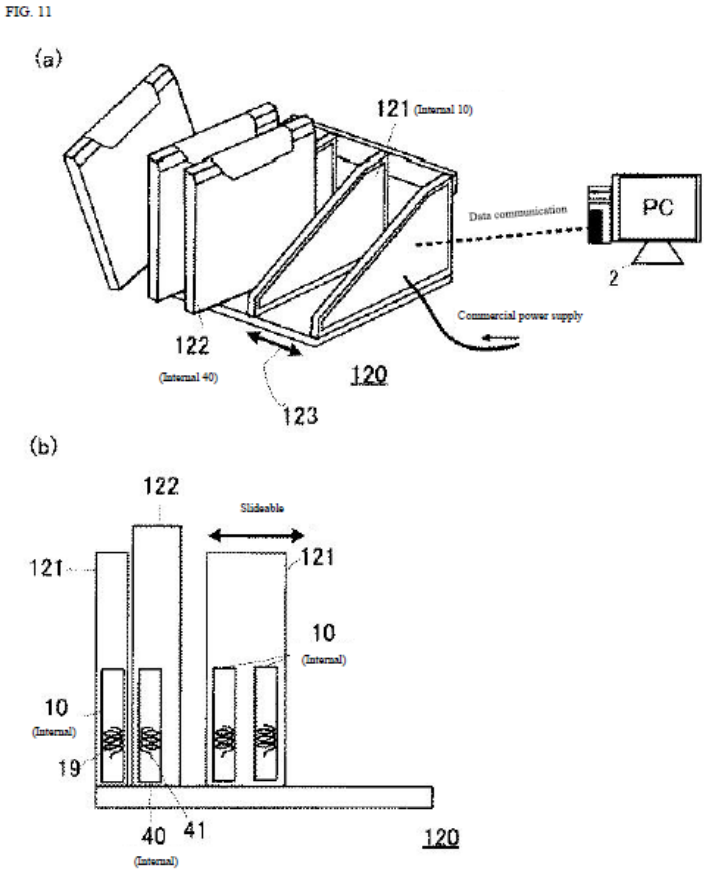


(Ex. 1005, FIG. 9.)

FIG. 10

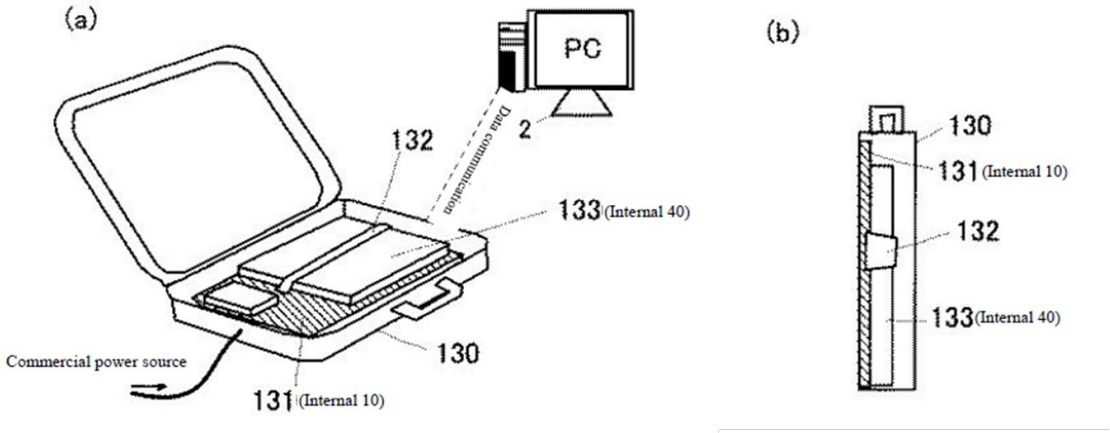


(*Id.*, FIG. 10.)



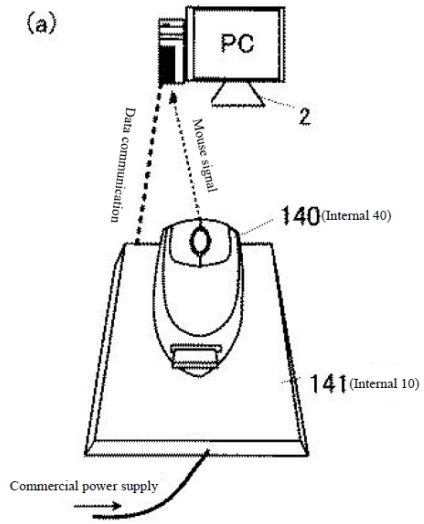
(*Id.*, FIGS. 11(a), 11(b).)

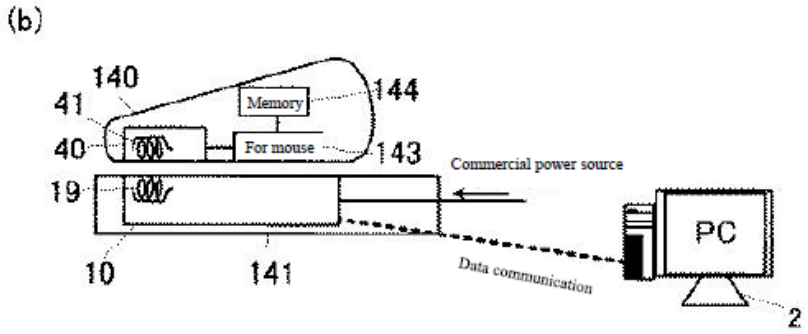
FIG. 12



(*Id.*, FIGS. 12(a), 12(b).)

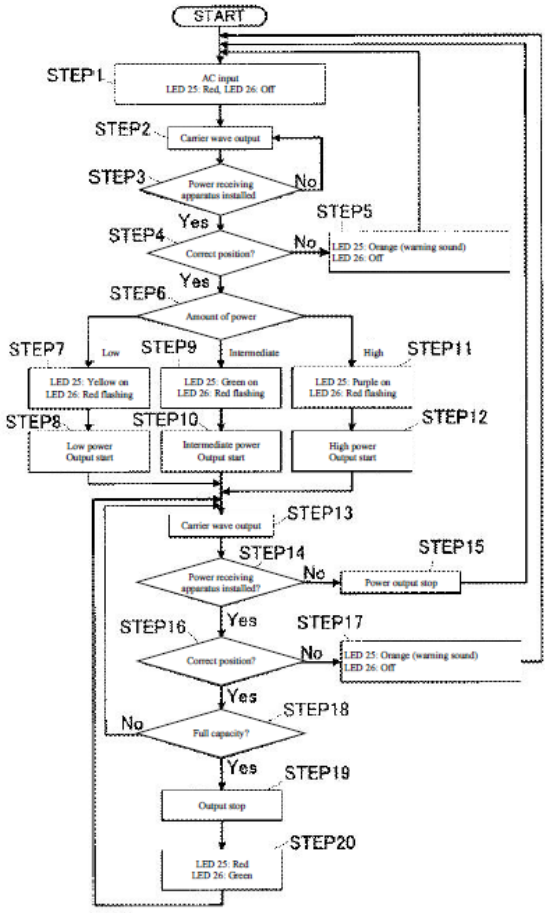
FIG. 13





(*Id.*, FIGS. 13(a), 13(b).)

111. In my opinion, a person of ordinary skill in the art would have understood that *Okada*'s FIG. 3 (below) shows "power supply operations carried out between [PTM10 and PRM40]," applicable to the configurations (such as those I explained above and below) disclosed by *Okada.* (Ex. 1005, FIG. 3, ¶0059; ¶¶0060-0090; 0094-0115; *see also* my analysis and discussions above in this section and in Section VIII.A; *see also* my analysis and discussions in Sections IX.A.1(b)-(n).)



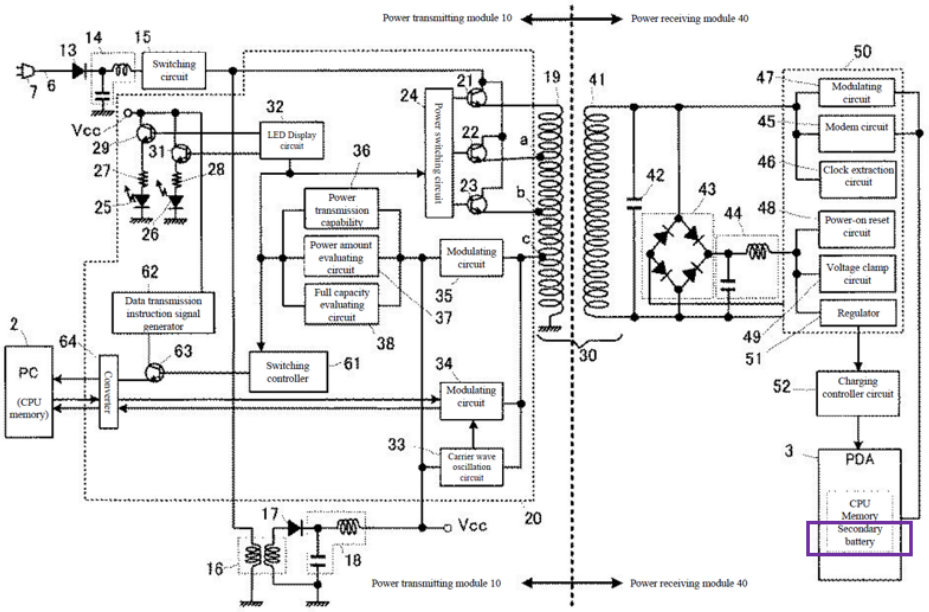
(Ex. 1005, FIG. 3.)

112. Thus, and for reasons I explained above and below, in my opinion, a person of ordinary skill in the art would have understood that any disclosed configurations of *Okada* including features as recited in the limitations of claim 28 (including as modified) I explained above and below is a "**system**" ("**system for inductive powering or charging of portable devices**") (*see, e.g.*, *Okada*'s FIGS 1, 2, 7, 9-13, etc.). *Okada* further explains:

> With the power supply system of the present invention, electric power is supplied by placing an electronic device such as a PDA, mobile phone, or the like, equipped with the power receiving device of the present invention on a common cradle or the like equipped with the power transmitting device of the present invention . . . Furthermore, *the power transmitting device of the present invention can be incorporated into all types of products, not just a common cradle, but also showcases, mouse pads, and the like, and therefore* ***the device is highly versatile***, because an electronic device incorporating the power receiving device of the present invention can receive power supplied from the product.

(Ex. 1005, ¶0030; *see also* my analysis and discussions above in this section and in Section VIII.A; *see also* my analysis and discussions in Sections IX.A.1(b)-(l).)

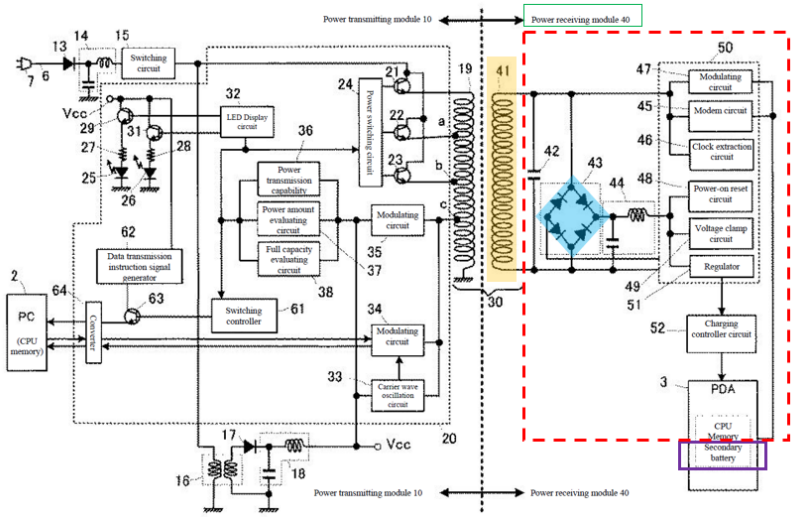
113. In my opinion, a person of ordinary skill in the art would have understood that *Okada's* "**portable device**" includes "**a battery and an inductive receiver unit**." For example, *Okada* explains that an exemplary PDA3 includes a "secondary battery" and PRM40. (Ex. 1005, ¶¶0012, 0015, 0037, FIG. 14, ¶¶0134-0136, FIG. 15, ¶¶0138-0140, FIG. 16, ¶¶0142-0144, claim 4, FIG. 2 (**purple** below)).)



(Ex. 1005, FIG. 2 (annotated).)

114. In my opinion, a person of ordinary skill in the art would have understood that PRM40 in the portable device exemplifies an "**inductive receiver unit**" including "**a receiver coil and a receiver circuit**." (*See* my analysis and discussions in this section; *see also* my analysis and discussions in Sections VIII.A, IX.A.1(b)-(l).) For example, a person of ordinary skill in the art would have understood that FIG. 2 (annotated below) exemplifies a PRM40 ("**inductive receiver unit**") including coil 41 (**orange**) ("**receiver coil**") (Ex. 1005, ¶0040), and a "**receiver circuit**" (e.g., **red** below), which includes at least rectifier 43 (**blue**), clock and modulating circuits 46-47, and may further include one or more other

PRM40 components (other than the **battery**) (e.g., circuits 42, 44-45, 48-49, 51, and/or 52). (Ex. 1005, ¶0047.)[6]



(Ex. 1005, FIG. 2 (annotated).)

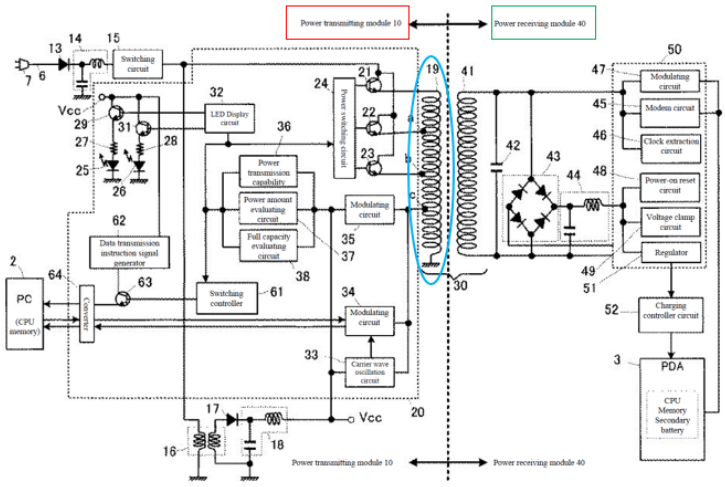
b) a primary coil that is substantially planar and parallel

[6] The annotated figures I provide here (and below) are exemplary visual aids and are not intended to describe or define precise boundaries, schematics or limit/constrain the mappings/analysis that I provide of the prior art to the claim language (alone or as modified). A person of ordinary skill in the art would have understood that variations of components, or other components/circuitry, etc. not shown but described or suggested by *Okada* (alone or as modified as applicable below) are or would have been contemplated portions of such mappings.

to a surface of the system for providing power inductively to the portable device, wherein the primary coil comprises a flexible Printed Circuit Board (PCB), multi-turn coil having multiple layers of substantially similar patterns of substantially spiral-shaped conductors of 1 to 4 ounce copper thickness for each layer and having coil patterns electrically connected with vias between the layers;

115. In my opinion, *Okada* in view of *Odendaal*, *Shima*, and *Hui-027* discloses and/or suggests this limitation. (*See* my analysis and discussions below in this section.)

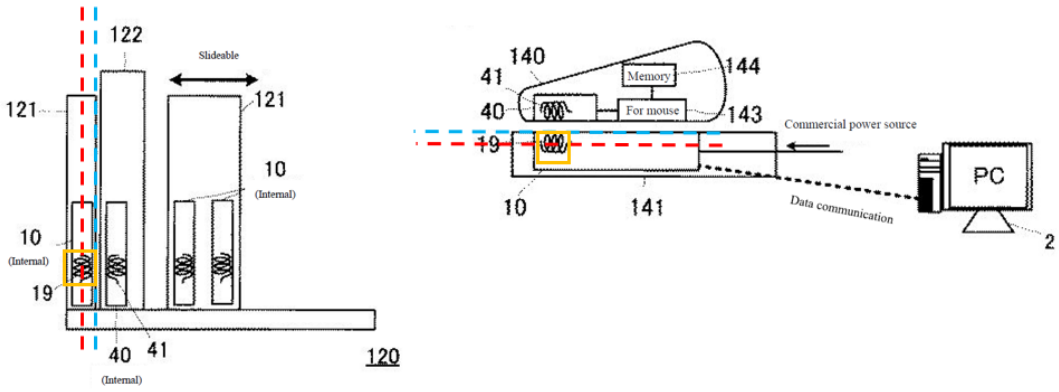
116. For example, *Okada*'s "**system**" includes "**a primary coil**." (*e.g.*, Ex. 1005, FIG. 2 (**blue** below), ¶¶0040, 0050, FIG. 7, 0095-0107, FIGS. 9-10, ¶¶0116-119, FIGS. 11(a)-(b), ¶0121, FIGS. 12(a)-(b), ¶¶0123-0125, FIG. 13, ¶0132; *see also* my analysis and discussions in Sections VIII.A, IX.A.1(a).)



(Ex. 1005, FIG. 2 (annotated).)

117. In my opinion, a person of ordinary skill in the art would have understood that the "primary coil" is used for "providing power inductively to the portable device." For example, Okada explains that switches 21/22/23 are selected to provide selected power level(s) transmitted to PRM40 of "portable device" via coils 19/41 through induction. (Ex. 1005, FIG. 3, ¶¶0035, 0040, 0051, 0057, 0069-0073; see also my analysis and discussions in Section IX.A.1(a).)

118. In my opinion, a person of ordinary skill in the art would have understood that Figures 11(b) and 13(b) show examples of "**primary coil**" 19 positioned "**substantially…parallel to a surface of the system**" (**blue** parallel (**red**) to coil 19 (**orange**) below). (Ex. 1005, FIGS. 11(b) (below left), 13(b) (right); *See* my analysis and discussions in Section IX.A.1(a).) In my opinion, a person of ordinary skill in the art would have understood a similar arrangement exists with the other exemplary system configurations that I discussed above.



(Ex. 1005, FIG. 11(b) (left), FIG. 13(b) (right) (annotated).)

119. In my opinion, while *Okada* does not expressly state that the "**primary coil…is *substantially planar* and parallel to a surface of the system**," a person of ordinary skill in the art would have been motivated to configure the *Okada* system to implement or use a planar primary coil (and secondary coil) in light of *Odendaal*. (*See* my analysis and discussions in this section and in Sections IX.A.1(a), (c)-(k); *see also* my analysis and discussions in Sections V.B.3, VIII.A-B.)

120. In my opinion, a person of ordinary skill in the art would have appreciated that inductive power/data transfer (consistent with that disclosed by *Okada*) uses inductive coils to wirelessly transfer power/data to another electronic device. (*Id.*) In my opinion, a person of ordinary skill in the art was aware of and appreciated that different types of coil designs were available to achieve desired applications of inductive power/data transfer. (*Id.*) For example, planar coils placed

in parallel to a power transfer system's surface were known by a person of ordinary skill in the art, as were their characteristics and design techniques for implementing circuits/systems/devices that use them to achieve desired contactless/inductive power/data transfer. (*Id.*) In my opinion, several state of the art references describe features consistent with such a skilled person's knowledge at the time. (*Id.*)

121. For one example, *Lee* (Ex. 1027)[7] discusses the known use of a planar spiral inductor.

> Since the arrival of the silicon-based RF IC era, much effort has been put into the spiral inductor designs. The main focus of the endeavor was to improve the quality factor. The major concern for the silicon-based spiral inductors has been the resistivities of the metal and the silicon substrate. Numerous techniques have been proposed to reduce the resistivities of the interconnect

[7] As I noted previously, I reference and cite Ex. 1027 and other references/exhibits below/herein to support my opinions regarding the state of art knowledge of a person of ordinary skill in the art at the relevant time (like other extraneous references I may refer to throughout this Declaration when discussing what such a skilled person would have understood/appreciated, etc.). (*See* my discussions in Section V.)

> lines and the silicon substrates [1,2]. Yet, many planar spiral inductor structures have been designed and evaluated without a clear understanding for the layout dependences of the quality factor. Simple and clear guidelines of inductor layout rules for optimum quality factor are presented for the required inductance and process information. . . . Figure 1 shows the top view of a square spiral inductor layout. Mohan [3] reported a simple and very accurate expression for the planar spiral inductor inductances. Modifying the Mohan's work, for the inductor dimensions shown in Fig. 1, the inductance can be expressed as . . .

(Ex. 1027, 1; *see also id.*, 1-3.)

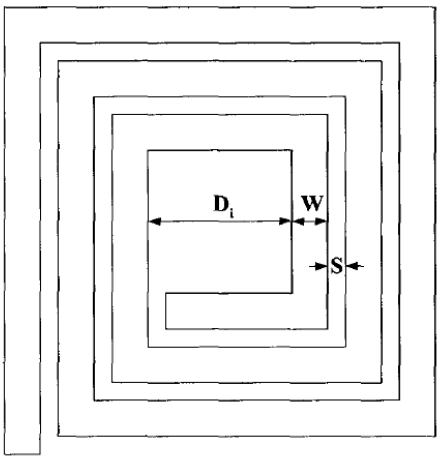


Fig. 1. A planar square spiral inductor structure.

(*Id.*, FIG. 1 (showing a "**planar square spiral inductor** structure").)

122. Also, references such as *Sano* (Ex. 1015) (which also disclose features consistent with the state of art knowledge of a person of ordinary skill in the art at the time) discuss a thin coil and a flat disk-like core.

> Currently, the preferred form of the power receiving coil 54 is a **thin coil** which facilitates efficient interlinkage of the magnetic flux developed from the power supplying coil 18 with the power receiving coil 54. More particularly, the currently preferred power receiving **coil** 54 is a **flat disc-like core** on which is formed a single layer or several layers of wire-like electrical conductors. Such conductors can be formed, for example, by depositing conductive material on a side of the disc-like core that faces the power supplying apparatus 10. FIG. 3 is a front view of such a **sheet coil** and FIG. 4 is a vertical sectional view taken along its middle plane.

(Ex. 1015, 3:39-51; *see also id.*, FIGS. 1-2, 3-4, 7-12, Abstract, 1:5-2:29, 2:64-3:27, 5:5-47, 5:48-9:5.)

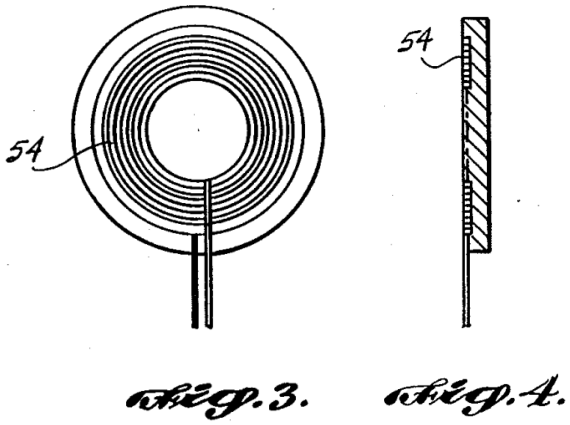


Fig. 3. Fig. 4.

(*Id.*, FIGS. 3-4.)

123. References such as *ChengII* (Ex. 1026) (which also disclose features consistent with the state of art knowledge of a person of ordinary skill in the art at the time) also show the known use of thin, planar-type coils in an inductive power source/charger and an inductive power receiver (device).

> Figure 9 extends these two means of generating a rotational degree of freedom by adding universality. A charger 901 consists of a number of such coils, arranged concentrically, each of which can be driven independently. The charger behaves differently depending on which type of device is present 902.
>
> • In Figure 9a no device is present, and so no charger coils are driven.

> • In Figure 9b a physically small device with correspondingly small power requirements is present, and so only a few of the inner coils are driven.
>
> • In Figure 9c a physically large device with correspondingly large power requirements is present, and so many of the coils are driven.

(Ex. 1026, 11:4-12; *see also id.*, Abstract.)

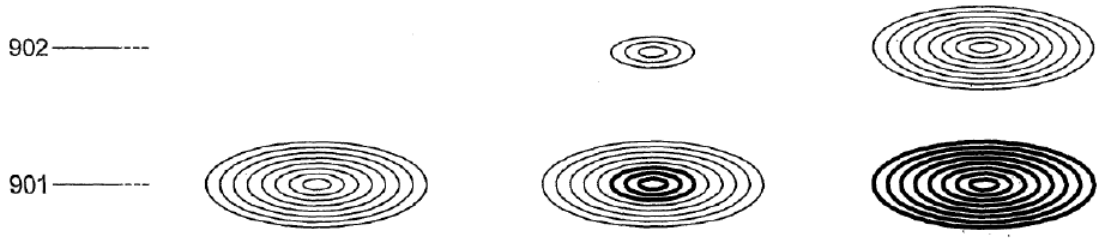


Figure 9a Figure 9b Figure 9c

(*Id.*, FIGS. 9a-9c.)

124. There are other state of art references that demonstrate and exemplify the above-discussed knowledge of a person of ordinary skill in the art. (*See, e.g.*, Ex. 1027, 1-3 (planar spiral inductor); Ex. 1015, FIGS. 1-2, 3-4, 7-12, Abstract, 1:5-2:29, 2:64-3:27, 3:39-51 (thin coil, flat disc-like core), 5:5-47, 5:48-9:5; Ex. 1047, FIGS. 1-3, 6, 8A-9, ¶¶0002, 0006-0007, 0018-0025-0034; Ex. 1025, FIGS. 1, 3, 8-9, 13, 1:10-2:3, 2:5-12 (reasons to consider thin coil designs), 2:14-3:2, 4:19-32,

7:25-9:28, 12:27-32, 14:4-17; Ex. 1026, FIGS. 1-2, 5, 9A-9C, Abstract, 1:3-4:4, 4:6-9:4, 11:4-15 (flat coils); Ex. 1009, Abstract, FIGS. 1-3, 1:4-51, 1:54-2:26, 2:47-3:8 (flat configurations), 3:9-39 (thin flat coil), 4:18-60; Ex. 1024, FIGS. 3, 8-9, 1:12-15, 1:39-2:29, 9:41-53, 10:45-57, 11:60-13:4; Ex. 1028, Abstract, FIGS. 2-7, ¶¶0001, 0004-0007, 0025-0032, 0041; Ex. 1029, 1-4, 9-19 (planar, spiral coils); Ex. 1030, FIGS. 3-7B, 1:5-9, 1:59-61, 3:19-56, 4:62-567, 5:25-44; Ex. 1036, Abstract, 2:22-3:6 ("primary winding…***substantially parallel*** to [] planar charging surface" and "formed on a ***planar printed circuit board***"), 5:22, 11:18, 23:20-24:8 ("Each secondary charging module 200 is provided with a housing 203," where "[t]he housing 203 should have at least one preferably flat surface" and "**[t]his flat surface is preferably parallel to the plane of the secondary winding** within the housing such that when the secondary module is placed in a slot of the primary extension system the secondary winding is substantially parallel to the primary winding beneath the surface of the slot."), 24:19-22 ("The secondary coil or PCB winding **should be placed close to the (preferably flat) 20 surface of the housing of the secondary charging module so as to pick up maximum changing AC magnetic flux** from the primary inductive charging extension system or platform."); *see also* my discussions above in Section V.)

125. Therefore, in my opinion, a person of ordinary skill in the art would have been aware of available designs and options for implementing inductor coils to facilitate contactless inductive power/data transfer, including the related circuitry, and the tradeoffs, benefits, advantages, etc. associated with their use. (*Id.*; *see also* my analysis, discussions, and citations in this section; *see also* Section V.) In my opinion, a person of ordinary skill in the art would have relied on such knowledge when considering design and implementation options for the *Okada* system/device, and would have appreciated how various coil designs (including planar coils) would have improved the system/device based on given applications taking into account factors, such as size, weight, form factors, cost, efficiencies, performance, design constraints, etc. (*Id.*; *see e.g.*, Ex. 1047, ¶0033 (describing size/shape attributes of coils and known characteristics in a contactless inductive power/charge system).) In my opinion, a person of ordinary skill in the art would have considered the tradeoffs and potential benefits provided by planar coils when contemplating ways to design, configure, and implement an inductive power transfer system similar to *Okada*. (*Id.*) In my opinion, one source of such relevant guidance and knowledge is *Odendaal*.

126. In my opinion, a person of ordinary skill in the art would have had reasons to consider the teachings/suggestions of *Odendaal* in context of *Okada* since

Odendaal describes a contactless inductive power/charging system including techniques/technologies similar and related to those of *Okada*. (*See* my analysis and discussions in Section IX.A.1(a); *see, e.g.*, Ex. 1008, Title, Abstract, Figs. 1A-4, 11-12, 1:5-3:57, 4:50-5:8, 5:24-28, 6:59-64; *see also* my analysis and discussions in Sections VIII.A-B, IX.A.1(c)-(k).) For example, *Odendaal* (like *Okada*) discloses a contactless inductive power/charging system that uses inductive coupling to provide power to a mobile device (e.g., cellphone, computer, etc.) having a secondary coil placed on or near the primary coils in the surface of a powering device (e.g., charger for cellphones, powering pad, or charger embedded in a thin surface, including fabrics, etc.). (Ex. 1008, Title, Abstract, 1:5-3:57.) For example, *Odendaal* explains that "[t]he present invention is related to **contactless power transfer systems**" (Ex. 1008, 1:6-7) and discloses configurations of its invention, including one where:

> a battery charging circuit can be coupled to one of the first and second spiral-shaped conductors, and a load can be coupled to the other of the first and second spiral-shaped conductors. **The coupling between battery charging circuit and the battery may comprise** capacitive coupling and/or **magnetic coupling, and wherein power is transferred by the coupling of an electric field and/or**

> **magnetic flux** across the IOET [interface-of-energy-transfer].

(*Id.*, 2:56-64; *see also id.*, Title, Abstract, FIGS. 1A-4, 11-12, 1:5-3:57 (1:6-67 (known use of planar coils)), 4:50-5:8, 5:24-28, 6:59-64; *see also* my analysis, discussions, and citations regarding *Okada* above in this section and in Section IX.A.1(a); *see also* my analysis and discussions in Sections VIII.A-B.)

127. Thus, in my opinion, a person of ordinary skill in the art would have understood that *Odendaal* is in the same technical field as the '371 patent and *Okada* because *Odendaal* also describes a system and processes for powering/charging a mobile device/battery using inductive contactless power transfer techniques/technologies. (*Id.*; Ex. 1008, Title, Abstract, FIGS. 1A-4, 11-12, 1:5-3:57, 4:50-5:8, 5:24-28, 6:59-64; Ex. 1001, Abstract, 4:13-14; *see also* my analysis and discussions in Section IX.A.1(a).) In my opinion, a person of ordinary skill in the art would have appreciated that *Odendaal* (like *Okada*) also discloses features that were reasonably pertinent to one or more particular problems the '371 patent discusses. (*See, e.g.*, Ex. 1001, 4:13-29; Ex. 1008, Abstract, 1:5-3:57, 4:50-5:8, 5:24-28, 6:59-64; Ex. 1005, FIGS. 1, 2, 7, 9-12, ¶¶0037-0048, 0049-0058, 0094-0109, 0116-0126; *see also* my analysis and discussions in Sections VIII.A-B,

IX.A.1(a)-(b).) As I explained above and do so further below, *Odendaal* also discloses techniques and technologies for addressing the need to power mobile devices using contactless inductive coupling. Therefore, in my opinion, a person of ordinary skill in the art contemplating designing and configuring a system like that described by *Okada* would have considered teachings/suggestions like those provided in *Odendaal* and thus would have been motivated to modify *Okada*'s system to include planar primary coils that are parallel to a surface of the system to provide features like those discussed herein and claimed (and complemented such a design with corresponding planar secondary/receiver coil(s) in an inductive power receiver / portable device). (*Id.*)

128. *Odendaal* discloses known use of **planar-type inductor coils** in an inductive power transfer system, for, *e.g.*, charging a cellphone battery. (Ex. 1008, FIGS. 1A-1B, 2A, 2C, 8E, 1:58-2:43.) For example, *Odendaal* explains:

> ***The spiral-shaped conductor may comprise pcb spiral-wound conductors.*** In addition, a battery charging circuit can be coupled to one of the first and second spiral-shaped conductors, and a load can be coupled to the other of the first and second ***spiral-shaped conductors***. The coupling between battery charging circuit and the battery may comprise capacitive coupling and/or ***magnetic coupling,***

> ***and wherein power is transferred by the coupling of an electric field and/or magnetic flux across the IOET*** [interface-of-energy-transfer].
>
> According to an aspect of the present invention, a signal applied to the first spiral-shaped conductor can be transferred to the second spiral-shaped conductor by coupling of magnetic flux of the first and second spiral-shaped conductors across the IOET.
>
> ***The first and second spiral-shaped conductors*** and the IOET are preferably integrated into ***a planar (flat/thin) structure***.

(Ex. 1008, 2:55-3:5.) *Odendaal* also explains:

> According to another aspect of the invention, an isolating coupling interface and a resonant tank are functionally integrated into a planar configuration for transferring power with isolation properties. ***The device may comprise two separable structures on either side of the IOET, such as, for example, a cellphone and its charger***. . . .
>
> An advantage of the present invention is that it facilitates the use of ***wearable electronics***. For example, ***flex circuits may be used so as to cause the surface of the coils to be flexible.*** In addition to the flexibility, the coils may be

> formed in any arbitrary shape to facilitate woven wire arranged in ***a fabric, or pads with embedded conductors that can be attached to clothes***. In this way, for example, ***one could charge a radio, cellphone, and/or computer (just to name a few of the many wearable items) by bringing the device in close proximity to the fabric.*** Thus, implementation of the invention with wearable electronics could provide an ***interface between the wearable device(s) and external power sources.*** Digital or analog signals may also be transmitted across such interfaces to, for instance, up- or download digital information.

(Ex. 1008, 2:16-43; *see also id.*, 2:1-15, 2:44-3:5, 4:44-5:8, 6:1-18.)

129. *Odendaal* explains that it would be advantageous to provide a planar resonator for wireless power transfer that exhibits characteristics of an integrated inductor-capacitor transformer. (*Id.*, 1:53-57.) The planar resonator includes a coil arrangement where spirals arranged on opposite sides of each other can be used for energy transfer "so that a battery of a cellphone could be charged without physical wires connecting the cellphone to a charger." (*Id.*, 1:60-67.) Depending on the physical arrangement and/or material used, the planar resonator "transfer[s] power across the "interface-of-energy-transfer" (IOET) in either an electric or **magnetic**

form, or both." (*Id.*, 2:1-7.) Thus, while *Odendaal* discusses capacitive-type energy transfer, *Odendaal*'s configurations / "[t]he physical arrangement and/or material can *permit transformer action with or* ***without*** [such] capacitive energy transfer." (*Id.*, 2:7-10; *id.*, 2:65-3:5 (signal transfer between spiral coils "***by coupling of magnetic flux***"), 4:44-5:8, 6:1-18 (air coil transformer).)

130. Additionally, *Odendaal* explains that the planar coils of the planar power resonator "may have a thin and/or relatively flat top coil surface" and may be arranged in upper and lower configurations "with an air gap." (*Id.*, 2:44-54.) Also, as I explained above, *Odendaal* explains that "[t]he spiral-shaped conductor may comprise ***pcb spiral-wound conductors***" and "***a battery charging circuit can be coupled to one of the first and second spiral shaped conductors, and load can be coupled to the other*** . . ." where "coupling between the battery charging circuit and the battery may comprise . . . ***magnetic coupling***, wherein power is transferred by the ***coupling of . . . and/or magnetic flux*** across the IOET." (*Id*., 2:55-64.) Therefore, in my opinion, *Odendaal*'s known use of "**planar**" coils in an inductive charging system (*id.*, 1:60-67; *see also* my analysis and discussions above) is consistent with that known in the art. (Ex. 1008, 1:23-31 (conventional road embedded coils), 1:60-67, 2:19-21, 2:29-44 (coils embedded in fabric or pads), 3:65-

67 (spirals arranged within substrate material); *see also* my analysis and discussions regarding state of art knowledge of a person of ordinary skill in the art above in this section; *see also* my analysis and discussions in Sections V, VIII.B.)

131. Additionally, in my opinion, a person of ordinary skill in the art would have understood that consistent with the thin form factor configurations of *Okada* (e.g., charging pads, case, etc.), *Odendaal* discloses that "[t]he ***first and second spiral-shaped conductors*** and the IOET are preferably integrated into a ***planar (flat/thin) structure***" (Ex. 1008, 3:3-5) and may conform to the housing surface to facilitate charging a device "in close proximity" (*id.*, 2:29-44). A person of ordinary skill in the art would have understood that such arrangements disclose coils that are parallel to a system's surface. (*Id.*; *see also* my analysis and discussions above in this section; *see also* my analysis and discussions in Sections VIII.A-B, IX.A.1(a).)

132. In my opinion, in light of such above-discussed teachings, and state of art knowledge, a person of ordinary skill in the art would have been motivated to modify the *Okada* system to use "**primary coils that are substantially planar and parallel to a surface of the system** . . ." (and complemented such a design with corresponding planar secondary/receiver coil(s) in the portable device) to expand/complement applications compatible with those contemplated by *Okada* to

use thin(ner) primary-side and secondary-side units/devices. (*See* my analysis and discussions in Section IX.A.1(a); *see also* my analysis and discussions in Sections VIII.A-B, IX.A.1(c)-(k).) In my opinion, such a modification would have provided options to reduce the volume the coil(s) occupy, reduce the device size/weight, and expand/enhance applications of systems/devices contemplated by *Okada* (e.g., charge pads, tables/objects/surfaces with inductive powering/charging capabilities, portable devices such as PDAs, cellphones, etc.). (*Id.*; *see* my analysis and discussions in Sections VIII.A, IX.A.1(a), IX.A.1(c)-(k); Ex. 1005, FIGS. 1, 9, 10-16, ¶¶0033-0034, 0116-0146.) Additionally, in my opinion, a person of ordinary skill in the art would have understood that planar coils provided options to reduce the distance between primary and secondary coils (promoting close proximity coupling (*see, e.g.*, Ex. 1008, 2:29-44)) for improving power transmission efficiency, reducing energy waste, and shortening charging time. (Ex. 1005, ¶¶0066-0068, 0112, FIGS. 4(a)-4(b); Ex. 1036, 24:19-22 ("The . . . winding **should be placed close to the (preferably flat) 20 surface of the housing . . . so as to pick up maximum changing AC magnetic flux** . . ."); *see* my analysis and discussions in Section IX.A.1(a); *see also* my analysis and discussions in Sections V, VIII.A-B, IX.A.1(c)-(k).)

133. Further, as I explained above (*see* Section V.B.3), a person of ordinary skill in the art would have understood complementing a primary/secondary-side planar coil with a secondary/primary-side planar coil would provide for efficient transmission of energy between the two planar coils in an inductive charging/power systems, especially where the coils were aligned to face each other to allow the perpendicular magnetic field generated from the transmitting planar coil to be received by the receiving planar coil. (*See* my discussions above in Section V.B.1.) Thus, in my opinion, where design applications in an inductive power transfer system called for planar transmitting or receiving coil designs (e.g., to provide for thin, compact, versatile devices), such a skilled person would have had reasons to likewise consider design options where the receiving or transmitting coil likewise incorporated planar-type coil(s). Such knowledge (supported by the state of art references I discuss above) in context of the teachings of *Okada* and *Odendaal* would have motivated a person of ordinary skill in the art to consider and implement the use of planar coil(s) for the charger (e.g., cradle 4) in *Okada*'s system, and also to complement its inductive power transmission features, via use of a planar coil for a portable device (e.g., PDA 3, cellphone). (*See also* my analysis and discussions in Section IX.A.1(c)(2).)

134. In my opinion, a person of ordinary skill in the art would have understood that *Odendaal* discloses the primary coil may be "a set of **spiral coils**…with each spiral being a conductor trace **on a separate substrate**, such as **flex** or **printed circuit board**" (Ex. 1008, 2:19-28, 3:41-48 (multi-layer coils)) and that "number of turns of spirals" may be adjusted (*id.*, 6:59-64) ("**a flexible Printed Circuit Board (PCB), multi-turn coil having multiple layers…of substantially spiral-shaped conductors**"). In addition to reasons that I explained above for modifying *Okada* in view of *Odendaal* (*see* my analysis and discussions above in this section), in my opinion, a person of ordinary skill in the art would have been motivated to include these features, *e.g.*, a primary coil made of a flexible PCB having a set of multi-layer spiral-shaped coils, when implementing the *Okada-Odendaal* system. In my opinion, a person of ordinary skill in the art would have understood that implementing the *Okada-Odendaal* system to include a flexible PCB having a set of multi-layer spiral-shaped coils would have allowed forming flexible coils/substrate to be used in charger systems having different surfaces (*e.g.,* either rigid or flexible). (Ex. 1008, 2:30-44 (disclosing a charger surface being a fabric).) Additionally, multi-layer spiral-shaped coils were known to increase the generated magnetic field. (Ex. 1008, 3:41-48.)

135. In my opinion, a person of ordinary skill in the art would have had the skills and rationale in light of the teachings/suggestions of *Okada-Odendaal*, and a person of ordinary skill in the art's state of art knowledge, to implement the above-modification while considering design tradeoffs and techniques/technologies with a reasonable expectation of success. Especially given such modification would have involved known technologies/techniques (*e.g.*, flexible PCB having a set of multi-layer spiral-shaped coils) to yield the foreseeable result of expanding/complementing applications of an inductive powering/charging system, like that contemplated by *Okada-Odendaal*. (*See* my analysis and discussions in Section IX.A.1(a); *see also* my analysis and discussions above in this section.) In my opinion, a person of ordinary skill would have been further motivated to implement in the *Okada* system a primary coil comprising a flexible PCB, multi-turn coil having multiple layers of substantially similar patterns of substantially spiral-shaped conductors in light of the teachings of *Shima*, as explained below.

136. To the extent the *Okada-Odendaal* combination does not expressly disclose a primary coil comprising multi-layer spiral-shaped flexible PCB coils having "**multiple layers of substantially similar patterns**" of spiral-shaped conductors and "**having coil patterns electrically connected with vias between**

the layers." Under that scenario, a person of ordinary skill would have found been motivated to do so given that was a common design for interconnecting multi-layer PCB circuit arrangements, as exemplified by *Shima*. (*See* my analysis and discussions below in this section.)

137. In my opinion, a person of ordinary skill in the art would have understood that *Shima*, like *Okada-Odendaal*, discloses an inductive power/signal transfer system using primary and secondary coils (Ex. 1032, Abstract, 1:42-50, 2:12-4:10, 5:62-6:53, 7:17-8:38), and thus such a skilled person would have understood that *Shima* similarly in the same technical field as the '371 patent. (*Id.; see also* my analysis and discussions in Sections IX.A.1, VIII.A-C.) In my opinion, a person of ordinary skill in the art would have understood that *Shima* discloses features reasonably pertinent to particular problem(s) the '371 patent discusses and a person of ordinary skill in the art was trying to solve. (*Id*.) Therefore, such a skilled person had reasons to consider/consult *Shima* when looking to design/implement the above-discussed *Okada-Odendaal* system I discussed above. (*Id.*)

138. In my opinion, a person of ordinary skill in the art would have understood that *Shima* discloses coils having similar spiral patterns that reside on

different layers of PCBs ("coil having multiple layers of substantially similar patterns of substantially spiral-shaped conductors"), where the coil patterns are connected by through-holes (a person of ordinary skill in the art would have understood that the through-holes taught by *Shima* are "vias," as known in the art). For example, FIG. 3A (below) is described having "a plurality of thin printed-circuit substrates 30-1 to 30-n having similar coil patterns 32-1 to 32-n." (Ex. 1032, 5:62-6:1, FIGS. 3D-3E (below), 6:13-35.) *Shima* explains that starting and terminating ends of the coil patterns are connected using through-holes 33 and 34, respectively. (*Id.*, 6:4-21.) *Shima* also explains that layers of loop patterns (*e.g.*, 37-1 to 37-n (FIG. 5A (below)) may also "have the respective through-holes [39] connected in such a way that a spiral coil is formed in the direction in which the printed-circuit substrates 30-1 to 30-n are stacked." (*Id.*, 7:17-35.)

FIG. 3A

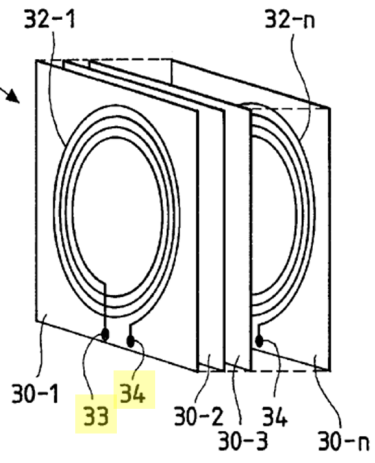
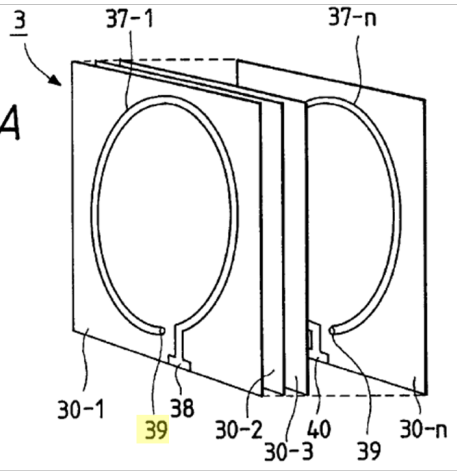
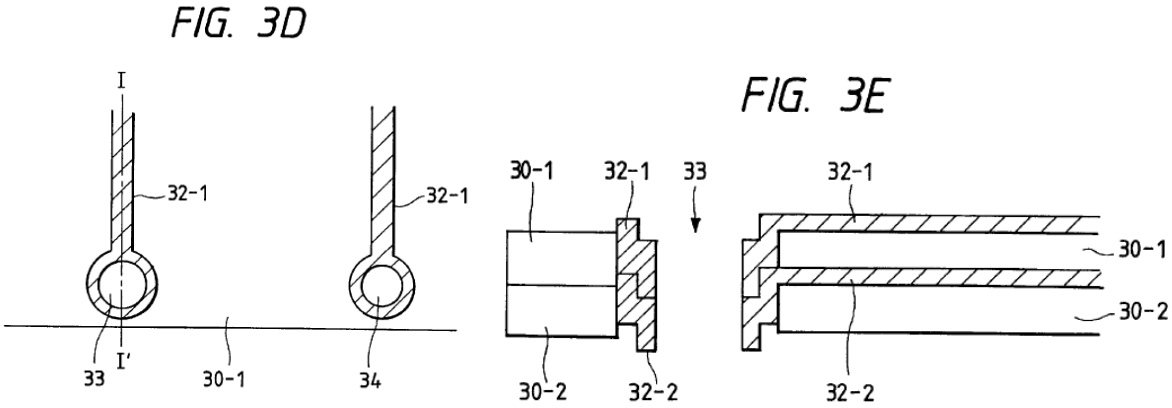


FIG. 5A



(Ex. 1032, FIGS. 3A, 5A (annotated).)



(Ex. 1032, FIGS. 3D-3E (annotated).)

139. In my opinion, in view of *Shima* and *Odendaal*, such a skilled person would have been motivated to configure/implement the primary coils in the *Okada-Odendaal* system (*see* my analysis and discussions in Section IX.A.1) as a flexible PCB multi-turn coil having layers of substantially similar patterns of substantially spiral-shaped conductors with coil patterns electrically connected with vias between the layer to maintain continuity while providing a compact coil configuration with enhanced efficiency and reduced conductor resistance as suggested by *Shima*. (Ex. 1032, 6:47-53, 7:41-44, 8:28-33; *see also* my analysis and discussions above in this section.) In my opinion, a person of ordinary skill in the art would have appreciated the versatility in applications taught by *Okada* (*see* my analysis and discussions in Section IX.A.1(a)) and known stacked PCB coil designs and ways to interconnect

them (vias) (*Shima/Odendaal*), and thus been motivated to design/implement various system designs that were consistent with such applications, including thin form factor configurations (as I explained above for claim 28). (*See, e.g.*, my analysis and discussions in Section IX.A.1(a); *see also* my analysis and discussions in Sections VIII.A-B.) In my opinion, such a skilled person would have also understood that implementing a coil with layers having substantially similar patterns would have reduced the complexity of designing and manufacturing comparing to a multi-layer coil having different patterns. (*Id.*)

140. In my opinion, a person of ordinary skill in the art would have had the skill and rationale in implementing, and reasonable expectation of success in achieving, such a modification, especially since it was known to use vias to connect multi-layered flexible PCBs. (*See* my analysis and discussions above in this section; *see also* my analysis, discussions, and citations regarding *Shima* in this section; Ex. 1045, ¶0026, FIGS. 3A-C.) Therefore, in my opinion, such modification would have involved applying known technologies/techniques to yield the foreseeable result of providing a charger with multi-layer flexible PCB primary coils that would have performed power/signal communications consistent with what I discussed above for the *Okada-Odendaal* system. (*See* my analysis and discussions in section IX.A.1.)

141. While the *Okada-Odendaal-Shima* combination does not expressly disclose that the multi-layer coil has "1 to 4 ounce copper thickness for each layer," in my opinion, a person of ordinary skill in the art would have been motivated to implement such a feature given that copper PCB-coils were well-known and thickness thereof was commonly designed within that range, as exemplified by *Hui-027*. (*See* my analysis and discussions below in this section.)

142. *Hui-027*, like *Okada-Odendaal-Shima*, discloses an inductive power/signal transfer system using primary and secondary coils (Ex. 1068, Abstract, ¶¶0001-0004, 0030-0033, 0039-0042, 0065, 0067, Table I, FIGS. 1, 2, 3a, and 3b), and thus a person of ordinary skill in the art would have understood that *Hui-027* is similarly in the same technical field as the '371 patent. (*Id*.; Ex. 1001, Abstract, 11:5-10; *see also* my analysis and discussions in Section VIII.A-D, IX.A.1; Ex. 1001, Abstract.) In my opinion, a person of ordinary skill in the art would have understood that *Hui-027* discloses features reasonably pertinent to particular problem(s) the '371 patent discusses and a person of ordinary skill in the art was trying to solve. (*Id*.) Thus, in my opinion, such a skilled person would have had reasons to consider/consult *Hui-027* when looking to design/implement the *Okada-Odendaal-Shima* inductive charging system I discussed above. (*Id*.)

143. *Hui-027* discloses PCB coils made of copper of certain thickness. For example, Table I (below) shows that the PCB coils of FIGS. 3a and 3b (below) have a "Copper Track Thickness" of "70 µm (**2 Oz/ft^2**)" and FIG. 3b illustrates that the "Conductor **Thickness**" corresponds to that of the primary winding. (Ex. 1068, ¶¶0004, 0030, FIGS. 3a and 3b (below).)

TABLE I

Geometric Parameters of the PCB Transformer

Geometric Parameter	Dimension
Copper Track Width	0.25 mm
Copper Track Separation	1 mm
Copper Track Thickness	70 μm (2 Oz/ft^2)
Number of Primary Turns	10
Number of Secondary Turns	10
Dimensions of Ferrite Plates	25 mm × 25 mm × 0.4 mm
PCB Laminate Thickness	0.4 mm
Insulating Layer Thickness	0.228 mm
Transformer Radius	23.5 mm

(Ex. 1068, Table I (annotated).)

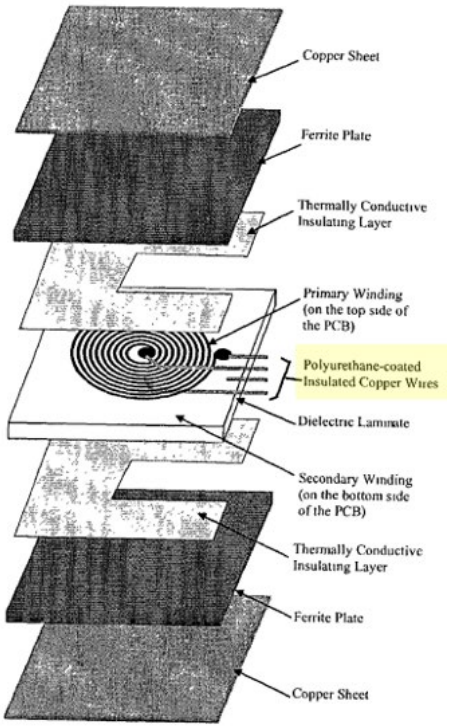


Fig. 3a.

(Ex. 1068, FIG. 3a (annotated).)

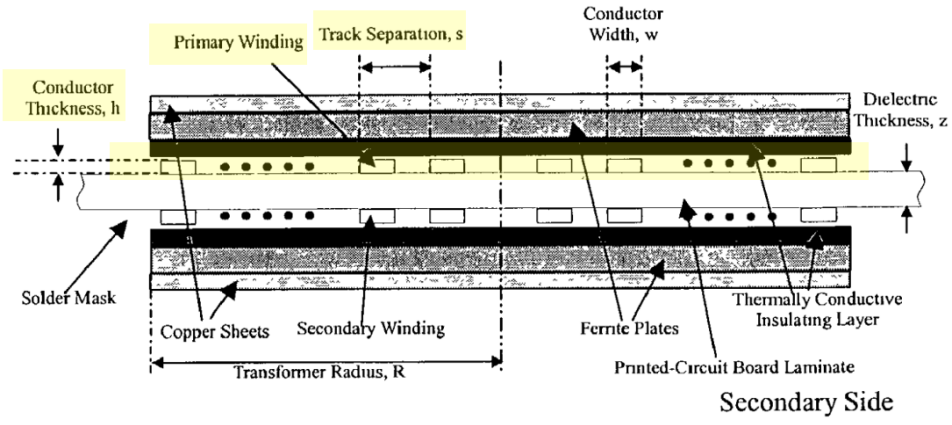


Fig. 3b.

(Ex. 1068, FIG. 3b (annotated).)

144. In view of *Hui-027*, a person of ordinary skill in the art would have been motivated to configure/implement the above-modified primary coil in the *Okada-Odendaal-Shima* system (*see also* my analysis and discussions in Section IX.A.1(a) and above in this section) with spiral-shaped copper conductors having a thickness of a few ounces (*e.g.*, 1 to 4 ounces) for each layer, as suggested by *Hui-027*, especially when the *Okada-Odendaal*, while disclosing use of PCB coils, does not provide specifics regarding type of coil material and its thickness. (*Id*.) In my opinion, such a skilled person would have also been motivated to combine implement the primary coil in the *Okada-Odendaal-Shima* system using the thickness suggested by *Hui-027* by looking to the patent specification, which explains that "[m]ost common PCBs use 1-2 oz copper PCBs." (Ex. 1001, 22:1-2.)

145. It is my further opinion that a person of ordinary skill in the art would have understood that using a multi-layer coil having "1 to 4 ounce copper thickness for each layer" would have been a matter of routine optimization of the thickness of copper, which may affect electrical conductivity/weight of the coil, well within the grasp and technical ability of a person of ordinary skill in the art, as acknowledged by the '371 patent. (*Id.*)

146. Additionally, it is my opinion that a person of ordinary skill in the art would have had the skill and rationale in implementing, and reasonable expectation of success in achieving, such a modification. Especially since it was known to use a multi-layer coil having a thickness of a few ounces, *e.g.*, 2 oz. (Ex. 1068, Table 1; Ex. 1001, 22:1-2; *see also* my analysis and discussions above in this section.) Therefore, in my opinion, such a modification would have involved applying known technologies/techniques to yield the foreseeable result of providing a charger with a (primary) copper coil having a certain thickness, *e.g.*, 2 oz, which would have performed power/signal communications consistent with what I discussed above regarding the *Okada-Odendaal-Shima-Hui-027* system. (*Id.*; *see also* my analysis and discussions in Sections VIII.A-E, IX.A.1.)

c) Limitation 28(c)

147. In my opinion, *Okada-Odendaal-Shima-Hui-027* in view of *Kook* discloses/suggests this limitation, which I address below in two parts (28(c)(1) and 28(c)(2). (*See* my analysis and discussions below in this section; *see also* my analysis and discussions in Sections IX.A.1(a)-(b), IX.A.1(d)-(l); *see also* my analysis and discussions in Sections VIII.A-E.)

(1) a drive circuit, including a FET driver, a capacitor and a FET switch, coupled to a DC voltage input and coupled to the primary coil,

148. *Okada* explains that the switching circuit 15 in PTM10 generates a switching pulse signal supplied to primary coil 19 via a switch 21/22/23 selected by power switching circuit 24. Namely in paragraph 40, *Okada* states:

> The ***power transmitting module 10 has the switching pulse voltage output from the switching circuit 15*** input thereto and also includes a primary-side coil 19 that together with the secondary-side coil 41 equipped in the power receiving module 40, described below, constitutes a transformer. ***The primary-side coil 19 is configured to have the switching pulse voltage supplied via one of switching element 21, switching element 22, or switching element 23.*** Therefore, the transformation ratio of the transformer 30 constituting the selected switching element and the secondary-side coil 41 changes. In addition, ***the power transmitting module 10 is provided with a power switching circuit 24 that controls ON/OFF switching of the switching element 21, switching element 22, and switching element 23 based on a control signal from the power switching circuit 24.*** Note that the number of switching elements that determine the transformation ratio

> of the transformer 30 constituted by the primary-side coil 19 and the secondary-side coil 41 is configured by three elements, switching element 21, switching element 22, and switching element 23 in FIG. 2 but this number is not limited to three.

(Ex. 1005, ¶0040.) *Okada* discloses that switches 21/22/23 can be MOSFETs ("**FET switch**"). (Ex. 1005, ¶0049.)

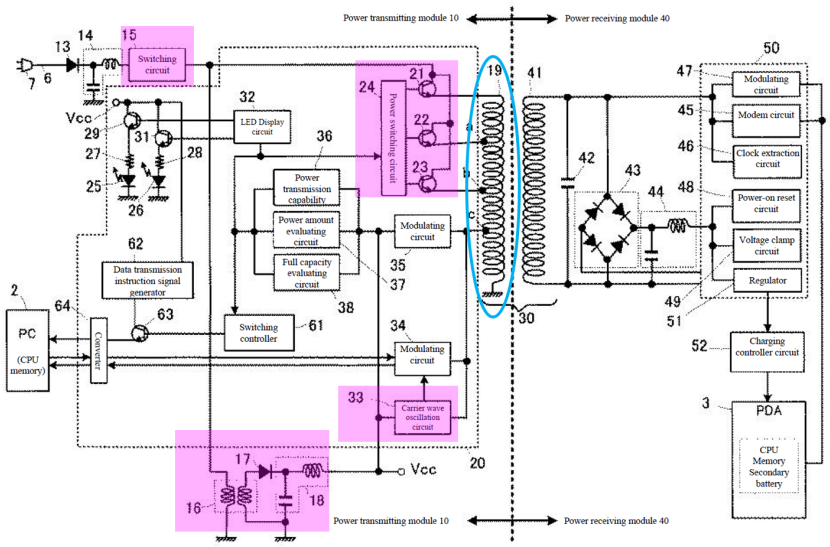
149. *Okada* also explains that the switching pulse signal is also converted (via circuits 16-18) to V_{CC} for powering PTM10 components. (*See* my analysis and discussions in Section IX.A.1(a); Ex. 1005, ¶¶0038-0040, 0046, 0049-0051, FIG. 2.) In my opinion, such PTM10 components are (directly/indirectly) coupled/configured to drive/power primary coil 19. (*Id.*) For example, circuits 16-18 provide power to other components, *e.g.*, circuit 33, which outputs signals driving coil 19 to send a carrier wave signal to PRM40. (Ex. 1005, ¶¶0062-0063, ¶¶0010-0014, 0042-0046, 0055-0058, Claims 2-3, 6; *see* my analysis and discussions in Sections IX.A.1(d)-(g).) Switching circuit 15 also provides the switching pulsed signal to (FET) switch 21/22/23, and together with circuit 24, provides signals that drive coil 19 to transfer power. (*Id.*; Ex. 1005, ¶¶0040, 0049-0051, 0070-0073.)

150. Accordingly, in my opinion, a person of ordinary skill in the art would have understood that *Okada*'s examples of a "**drive circuit**" include:

> **(1)** switching circuit 15 (including as modified below) and circuits 21-24;
>
> **(2)** same with circuits 16-18 (providing Vcc for IC 20, including circuit 24 (controlling (FET) switches 21/22/23));
>
> **(3)** same with circuit 33 (driving coil 19 to send carrier wave to PRM40); or
>
> **(4)** a combination of such components (with/without other circuitry in IC 20).

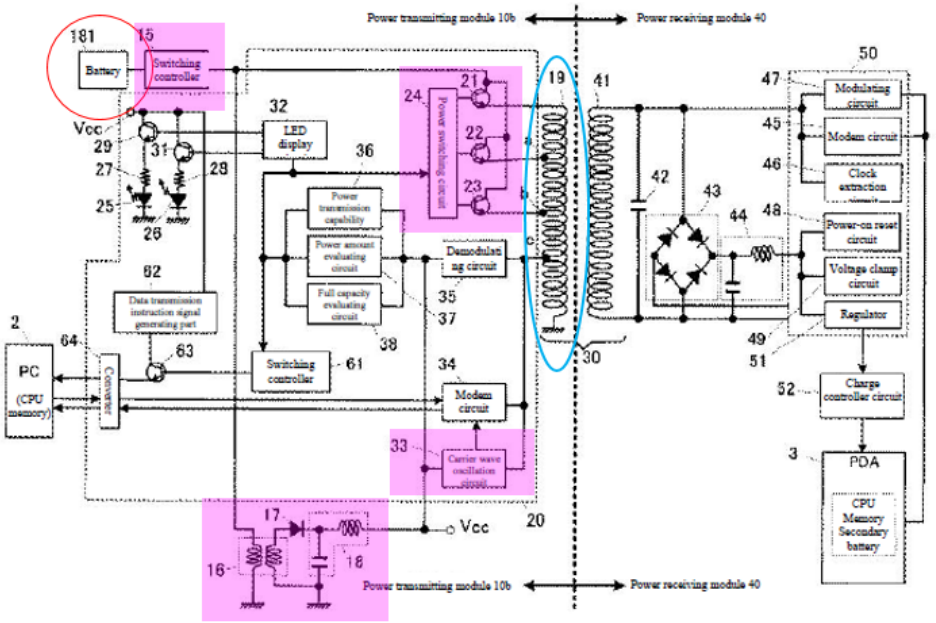
(*See* FIG. 2, annotated below in **pink**; *see also* my analysis, citations, and discussions above.) In my opinion, such a skilled person would have understood that the "**drive circuit**" includes an "**FET driver**" (*e.g.,* switch 15, circuit 24, and/or one or more of circuits 16-18, or a combination of such components) and "**a FET**

switch" (*e.g.*, switch 21/22/23).[8] In my opinion, these components forming the "**drive circuit**" are (directly/indirectly) coupled to rectifier/smoothing circuits 13/14 (providing a "DC voltage") (Ex. 1005, FIG. 2, ¶0038, FIG. 17, 0148-0149 (battery 181 input)) thus having a "**DC voltage input**" and also (directly/indirectly) coupled to coil 19 ("**primary coil**") (Ex. 1005, FIG. 2, ¶¶0039-0049).



(Ex. 1005, FIG. 2 (annotated).)

[8] In my opinion, a person of ordinary skill in the art would have understood that *Okada*'s circuitry that provides a switching signal to power primary coil 19 is similar to drive circuitry discussed in the '371 patent. (*See* my analysis and discussions in Section IX.A.1(a); Ex. 1001, 22:45-49, 24:3-4, 41:38-47, 44:5-6.)

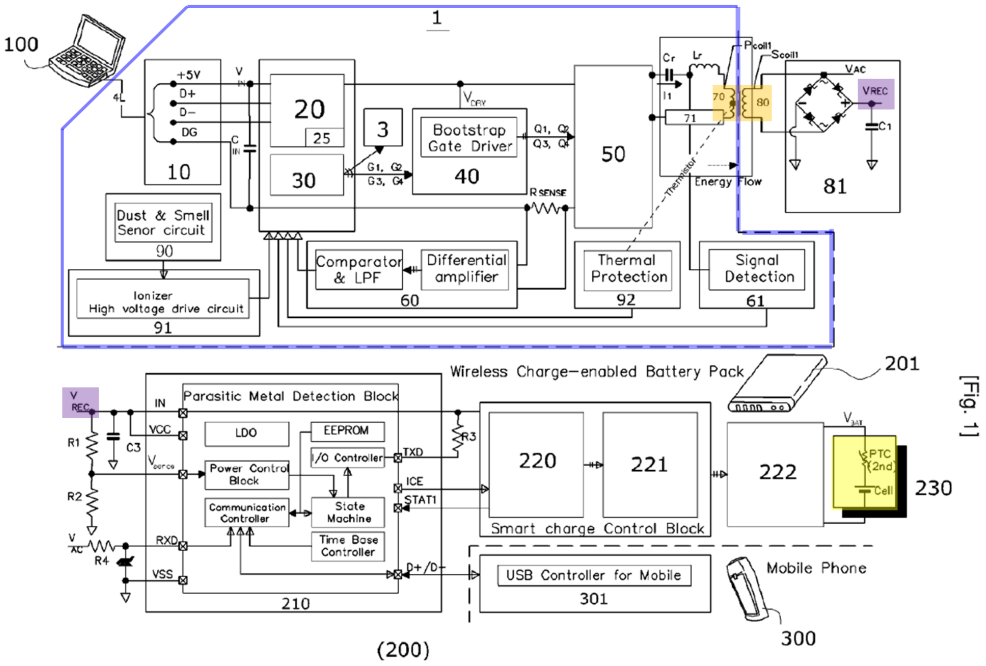


(Ex. 1005, FIG. 2 (annotated).)

151. *Okada* does not expressly disclose the drive circuit(s) having a "**capacitor.**" Nevertheless, in my opinion, a person of ordinary skill in the art would have been motivated to modify the *Okada-Odendaal* system to include such features in light of *Kook*. (*See* my analysis and discussions below; *see also* my analysis and discussions in Section VIII.E.) Thus, in my opinion, such a skilled person would have understood *Kook* is in the same technical field as the '371 patent and *Okada* and discloses features reasonably pertinent to particular problem(s) the '371 patent discusses and the person of ordinary skill in the art was trying to solve. (Ex. 1001, Abstract, 1:54-5:16; *see also* my analysis and discussions in Sections IX.A.1(a)-(b);

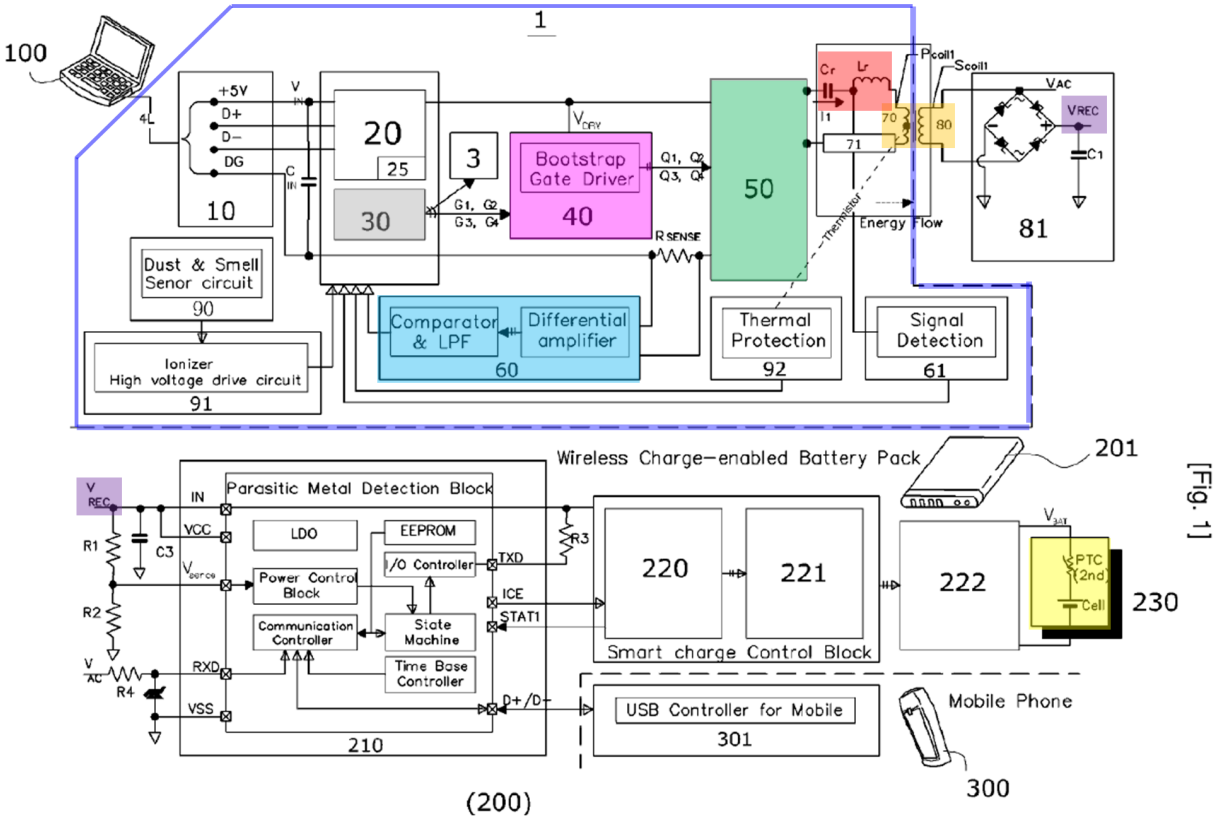
Ex. 1059, Abstract, ¶¶0009, 0035, 0041, 0049; *see also* my analysis and discussions in Sections VIII.A-E.) Thus, such a skilled person would have consulted *Kook* in context of configuring and implementing a system consistent with that described by *Okada-Odendaal*.

152. *Kook* discloses "a non-contact charger capable of wireless data communication and…charging battery-pack of a mobile device." (Ex. 1059, Abstract, ¶¶0001, 0006, 0037-0042.) *Kook* explains that charger 1 (blue below) receives power from computer 100 to power/charge mobile device 300 having a battery pack 200 (containing battery 230 (yellow)), via primary coil 70 and secondary coil 80 (both orange). (Ex. 1059, ¶¶0015 (mobile device has battery-pack 200), 0032, 0036-0037, FIG. 1 (below (rectification block 81 of battery pack 200 providing VREC (purple) to charger controller 210 of the same).)



[Fig. 1]

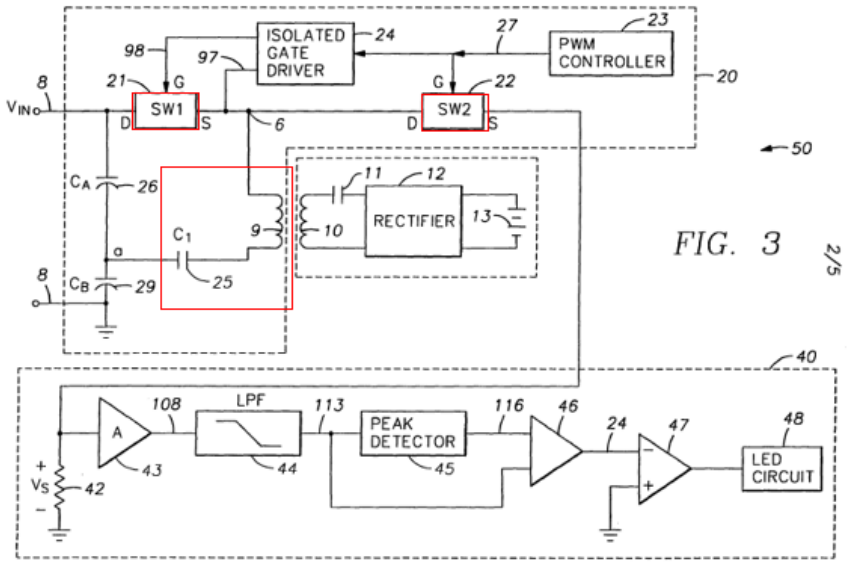
(Ex. 1059, FIG. 1 (annotated).) *Kook* explains that charger 1 includes an MPU 30 "for controlling internal elements" of charger 1. (Ex. 1059, ¶0041.) *Kook* further explains that charger 1 also includes gate drive block 40 (magenta below) and serial resonator converter 50 (*e.g.*, a LLC full/half wave type serial resonator converter, green), a "C-**L resonator**" (red (**Cr**/Lr), coupled to primary coil 70, and current sensing block 60 (blue). (*Id.*, ¶¶0032-0035, 0041.)



(Ex. 1059, FIG. 1 (annotated).)

153. *Kook* also discloses that the "C-L resonator" is coupled to primary coil 70, including capacitor Cr, which, in my opinion, a person of ordinary skill in the art would have understood also discloses a "**capacitor**." (Ex. 1059, FIG. 1, ¶0041.) *Kook* further explains that by using a "resonator converter to induce LC resonance," it "make[s] an electric current into a sine wave and transmit[s] an electric power to the secondary side by means of the inductive coupling." (*Id.*, ¶0049.) Consistent with that known in the art and *Kook*, a person of ordinary skill in the art would have

understood such a capacitor-based circuit would have allowed the coil to transmit less-distorted and efficient signals (*e.g.,* sine wave) with reduced harmonics. (*See* my analysis and discussions in Section V.C.) In my opinion, a person of ordinary skill in the art was aware that capacitor-based circuits (similar to that taught by *Kook*) improved signal transmissions in inductive-based systems, like *Okada-Kook* (*e.g*., minimizing/reducing unwanted radiations and heat issues caused by harmonics, etc.) as exemplified by several state-of-art references. (Ex. 1016, 631 ("Resonant circuits…useful for constructing filters"), 641, 798, ("**blocks out all higher harmonics**"); Ex. 1013, (capacitor/switches reducing harmonics from primary coil), FIGS. 3 (annotated below), 6, 3:29-4:5, 4:19-5:7, 7:24-8:14, 8:17-23, 24-31, 9:26-12:27); Ex. 1008, 2:16-19 (resonant tank); Ex. 1001, 22:13-30 (acknowledging harmonics are "undesirable"); *see also* my analysis and discussions in Section V.C.)



(Ex. 1013, FIG. 3 (annotated).)

154. Other state-of-art references also describes similar features consistent with the knowledge of a person of ordinary skill in the art at the time. (Ex. 1012, FIGS. 2, 5 (C1 25, inductor 9), 8, 3:30-62, 8:47-9:51; Ex. 1014, 67-68 ("filter…for ***reduction of harmonic output***"); *id.*, 62-68; Ex. 1015, FIGS. 1-2, 5-12, Abstract, 1:55-2:10, 3:28-51, 4:22-44, 5:45-6:4); Ex. 1020, Abstract, (harmonic reducing tuning capacitor); Ex. 1021, ¶¶00164-0165; Ex. 1029, 22-25.)

155. In my opinion, in light of *Kook* in context of the knowledge of a person of ordinary skill in the art, such a skilled person would have been motivated to consider/implement a capacitor with the above-discussed "drive circuit" and primary coil arrangement in PTM10 of the modified *Okada-Odendaal* system to improve

power transmission and reduce harmonics, consistent with that known in the art. (*See* my analysis, discussions, and citations regarding *Kook* and *Okada* above and below in this section; *see also* my analysis and discussions in Sections VIII.A, VIII.E, IX.A.1(a).) In my opinion, a person of ordinary skill in the art would have had the skill and rationale in implementing, and expectation of success in achieving, the above-modification, especially given the known benefits of capacitor-based filter circuits and use of capacitor(s) to enhance the transmission efficiency in inductive power transfer systems, and that the modification would have involved implementation of known technologies/techniques (capacitor-based filter design). For example, a person of ordinary skill in the art would have known, and been motivated to consider/implement, an appropriately designed capacitor-based circuit/filter positioned between switches 21/22/23 and primary coil 19, or between switching circuit 15 and the switches, (each as part of the "**drive circuit**" discussed above), which would have achieved the above-noted filtering benefits (*e.g.*, reduced harmonics). (*See* my analysis and discussions in Section V.C.)

156. In my opinion, beyond the capacitor-based disclosures noted above, a person of ordinary skill in the art would have also recognized other advantages/benefits from *Kook*'s teachings in context of *Okada* (which are relevant

to features recited in other limitations). For example, although *Okada*'s configurations were capable of adjusting power levels based on device power requirements and selective switching at the **onset** of a charging process, *Okada* does not expressly indicate controlling power levels **during** the charging process. (Ex. 1005, ¶¶0069-0076, FIG. 3.) Nevertheless, in my opinion, based on *Kook*'s other teachings, a person of ordinary skill in the art would have found it beneficial to modify the *Okada-Odendaal* system to include such features.

157. For example, in addition to that described above, *Kook* describes feedback controlled type functionalities that allow the charger to adjust the operating frequency of the charger circuit, to control charging power/voltage to the portable device **during** charge/power transfer operations. (*See* my analysis and discussions in Section VIII.E.) Regarding FIG. 1 (annotated above), *Kook* explains that current sensing block 60 "stably control[s] an electric power through a current **feedback** using an automatic variation algorithm of **primary** frequency so as…to control a voltage of a **secondary** rectification terminal in the charging battery-pack 200." (Ex. 1059, ¶¶0041.) *Kook* also discloses that current sensing block 60 analyzes "a signal of the secondary coil 80 to recognize the mobile device 300, monitor the primary coil 70 and the secondary coil 80 to control a charge voltage to a stable voltage."

(*Id*., ¶0033; *see also id.*, ¶0047 ("voltage of the secondary rectification terminal…is controlled to a constant voltage" via coils 70/80, which "may control the secondary charging power…using an automatic variation algorithm of primary frequency of the non-contact charger 1"), ¶0083 ("adjusting a voltage of the secondary side to the stable voltage…using a parameter (frequency).").)

158. In my opinion, a person of ordinary skill in the art would have understood that resonator converter 50 includes switching FETs and a capacitor. *Kook* describes bootstrap ***gate*** drive block 40" providing four signals Q1-Q4 to serial resonator converter 50. (Ex. 1059, FIG. 1, ¶¶0009, 0032-0035, 0041; *see also* my analysis and discussions in Section VIII.E.) A person of ordinary skill in the art would have understood such signals necessarily control corresponding "gates" of associated **FET** switches in converter 50 since it was understood that only FET switches have "gate(s)" (unlike a BJT) and *Kook* discusses "switching" in relation to converter 50. (Ex. 1059, ¶¶0049, 0075.) As I explained, and as would have been recognized by a person of ordinary skill in the art, *Kook* describes converter 50 as including an "LLC" serial resonator converter (Ex. 1059, ¶¶0009, 0041, 0033, 0064), which a person of ordinary skill in the art would have understood to reflect a

capacitor ("C") with inductors ("LL"). (*See* my analysis and discussions above in this section; *see also* my analysis and discussions in Section VIII.E.)

159. In my opinion, such teachings/suggestions of *Kook* would have further motivated a person of ordinary skill in the art to configure the above modified *Okada* system such that the switching circuit 15 (part of the "**drive circuit**" (as modified above to implement an **FET driver**, **FET switch**, and a **capacitor** coupled to the primary coil, similar to the features described/suggested by *Kook*, of the "**system**") to improve/enhance power transmission control during charging operations, by adjusting the switching/operating frequency of the primary circuitry in response to current feedback information, while providing a more efficient power transfer via capacitive filtering as discussed above. A person of ordinary skill in the art would have appreciated the guidance of *Kook*, which describes a closed-loop feedback arrangement, where powering/charging is controlled through a current feedback by varying the primary-side circuit operating frequency using FET driver/switch/capacitor-based circuitry.[9] (Ex. 1059, ¶¶0033, 0041, 0047, 0083.)

[9] A person of ordinary skill in the art would have appreciated configuring the "drive circuit" in the modified *Okada* system to use "FET switches/FET driver"-circuitry

160. Such a configuration would have improved/complemented the *Okada-Odendaal* system, which also uses device information to control/adjust power delivery in a closed-loop feedback fashion, but does so at the onset of charging, not during charging. (Ex. 1005, ¶¶0069-0076, FIG. 3; *see also* my analysis and discussions in Sections IX.A.1(a), (e).) A person of ordinary skill in the art, in my opinion, would have appreciated that implementing features similar to those described above would have improved the power transmission control in the modified *Okada* system, providing a stabilized voltage for the battery of the mobile device, for efficient power transfer/consumption during charging operations. (*See* my analysis and discussions in Section VIII.E.) Such improvements would have led such a skilled person to the modifications that I discussed above.

161. In my opinion, consistent with that explained above, a person of ordinary skill in the art would have had the skill and rationale in implementing, and expectation of success in achieving, the above-modifications, especially given the

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with the modified switching circuit 15 to accommodate the frequency adjustment features that I discussed above. (*See* my analysis and discussions above in this section and Sections IX.1.A(a)-(c)(1), VIII.A, and VIII.E.)

use of capacitor(s) and closed-loop feedback control technologies/techniques for adjusting power delivery was known. (*See* my analysis and discussions above in this section and Sections IX.1.A(a)-(b) and VIII.A, and VIII.E.) This is so, in my opinion, because a person of ordinary skill in the art would have recognized such a modification would have involved applying known technologies/techniques (*e.g.*, FET-based drive circuitry in closed-loop feedback power transfer system with capacitive filtering to adjust power delivery (*Okada* and *Kook*, state-of-art knowledge)) to yield the foreseeable result of an inductive power/charging system that ensures sufficient power is available to portable device during power delivery that achieves energy-efficient continuous power transfer with reduced heat waste and signal distortion. (*Id.*; *see also* my analysis and discussions in Sections V.)

162. It is my opinion that there were various ways for a person of ordinary skill in the art to implement such modifications. For example, in addition to implementing an appropriately designed/positioned capacitor-based circuit/filter (*see* my analysis and discussions above in this section), a person of ordinary skill in the art would have been motivated to configure/leverage features/components in *Okada*'s system that are used to receive/pass/process device information for power transfer control (*e.g.*, demodulator 35, circuits 36-38 (Ex. 1005, ¶0064; *see also* my

analysis and discussions in Sections IX.A.1(d)-(k)) to achieve the noted foreseeable and beneficial power delivery features during charging/powering operations. For example, a person of ordinary skill in the art would have recognized/appreciate the benefits of configuring the system to receive current feedback information/signals (*e.g.,* via demodulator 35, processed by one/more circuits (*e.g.*, 36-38), provided to the modified switching circuit 15) to vary the operating frequency of the primary side "drive circuit" to control a voltage of output by the rectifier circuitry 43 used to charge/power the battery in the portable device. (*See* my analysis and discussions in Sections IX.A.1(e)-(k).) In my opinion, such exemplary configurations do not limit the possible modifications/implementations of the modified system. Other successful designs/configurations within the capabilities/knowledge of a person of ordinary skill in the art would have been contemplated to achieve the same functionalities.

(2) wherein during operation the drive circuit is configured to apply an alternating electrical current to the primary coil at an operating frequency within a range of 100 kHz to 1 MHz and duty cycle to generate an alternating magnetic field in a direction substantially perpendicular to the surface of the primary coil to provide power inductively to the portable device;

163. In my opinion, the *Okada-Odendaal-Shima-Hui-027-Kook* combination discloses and/or suggests this limitation. (*See* my analysis and discussions below in this section; *see also* my analysis and discussions in Sections IX.A.1(a)-(c)(1); *see also* my analysis and discussions in Sections VIII.A-E.)

164. As I discussed, a person of ordinary skill in the art would have been motivated to configure the modified *Okada* system to include a drive circuit (with FET driver, FET switch, capacitor) having current-based closed-loop feedback control to adjust the power/voltage used to charge the portable device battery by adjusting the operating frequency on the primary side. (*See* my analysis and discussions in Section IX.A.1(c)(1).) Based on the teachings and suggestions offered by *Kook-Okada,* a person of ordinary skill in the art would have understood that the configured drive circuit in the modified *Okada* system, during operation, would have provided **an alternating electrical current** to the primary coil 19 at an "**operating frequency and duty cycle**," consistent with the features taught and/or suggested by *Kook*. (Ex. 1059, ¶¶0041 ("stably controlling an electric power through a current feedback using an automatic variation algorithm of primary frequency"), 0047, 0083 ("receives AC current from the secondary coil 80"); *see*

also my analysis and discussions in Sections IX.A.1(c)(1) and VIII.E; Ex. 1005, ¶¶0110-0111.)

165. It is my opinion that a person of ordinary skill in the art would have understood that *Shima* discloses that it was known to drive a primary coil at "the operating frequency…typically on the **low order of several hundred kHz**." (Ex. 1032, 1:33-48; *see also id.*, 1:63 ("antenna coils").) In view of *Shima*, such a skilled person would have been motivated to configure the disclosed "drive circuit" in the above-modified *Okada* system to operate in the hundreds of kHz range.

166. It is my opinion that a person of ordinary skill in the art would have understood that operating a drive circuit at "a range of 100 kHz to 1 MHz" would have been a matter of routine optimization of the operating frequency of the drive circuit (which may affect power transmission efficiency, harmonics/noise/EMI reduction/generation, skin effects), well within the grasp and technical ability of a person of ordinary skill in the art, as acknowledged by the '371 patent. (Ex. 1001, 53:1-7 (disclosing that "the radiation at the fundamental operating frequency (100's of kHz to several MHz), can be self-contained within the coil area. However, noise at higher frequencies (such as the test range of 30 MHz to 1 GHz) must be reduced to avoid interference with other nearby electronic devices."); Ex. 1032, 2:50 ("skin

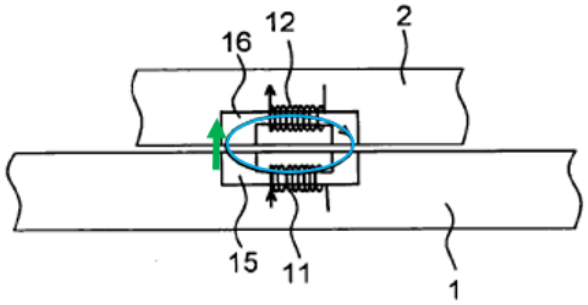
effect of high-frequency currents substantially increases the conductor resistance R.").)

167. It is my opinion that a person of ordinary skill in the art would have had the skill and rationale in implementing, and reasonable expectation of success in achieving, such a modification. Especially since it was known to operate a drive circuit of a wireless power transfer system at the range of hundreds of kHz. (Ex. 1032, 1:33-48.) Therefore, it is my opinion that such a modification would have involved applying known technologies/techniques (*e.g.*, operating a drive circuit in a frequency range of hundreds of kHz (*Shima*)) to yield the foreseeable result of an inductive power/charging system that effectively transfers power at a given operating frequency range.

168. Additionally, a person of ordinary skill in the art would have also understood that the ac signal applied to the primary coils in the modified *Okada* system (employing a planar coil) would have generated a "**substantially perpendicular**" "**alternating magnetic field**" as claimed, given such a field would have been the natural result of activating the planar primary coil to inductively transfer power to the portable device as described by *Okada*, *Odendaal,* and *Kook*. (Ex. 1005, ¶¶0035, 0051, 0056, 0063, 0066, 0121, ¶¶0127-0132, FIGS. 11(b) and

13(b); Ex. 1059, ¶¶0032, 0037-0042; *see also* my analysis and discussions in Section IX.A.1(c); Ex. 1011, 557-562, 593-594, 601; Ex. 1009, 2:62-3:8 ("current is inducted into" receiving device "when magnetic field lines are approximately 90 degrees to the first part of the transformer"), 1:54-2:18, 3:20-4:11, FIGS. 1-3; Ex. 1010, FIGS. 1-5B, 8:55-9:52, FIGS. 6A-10, 7:21-8:54, 9:53-10:22, 11:27-14:67; Ex. 1029, 3-4, 27-50); Ex. 1019, FIG. 2B (showing magnetic field (blue below) perpendicular (green) to charger surface 1), ¶¶0027, 0064.)

FIG. 2B



(Ex. 1019, FIG. 2B (annotated).)

169. It is my opinion that a person of ordinary skill in the art would have understood the planar primary coils in the *Okada-Odendaal-Shima-Hui-027-Kook* system, when providing power inductively to the coil of the portable device (which also may be planar in the modified system), would have likewise generated a

magnetic field that was substantially perpendicular to the surface of primary coil 19, as known in the art. (*See* my analysis and discussions in Section IX.A.1(c); Ex. 1011, 558, 559 ("magnetic field at the center of [a wire] loop is perpendicular to the plane of the loop"), 562-564, 592; Ex. 1048, Abstract, FIGS. 1-6, 1:28-2:4, 2:27-3:14, 4:11-24, 5:23-6:15, claims 1-88; Ex. 1049, Abstract, FIGS. 1, 5-6, 9, 11-12, 24-26, ¶¶0008-0010, 0044-0051, 0065-0066; Ex. 1050, Abstract, FIGS. 1-5, 9A-9C, 5:22-6:45, 11:22-33, 12:28-38, 16:25-17:23, 17:61-18:3 ("**substantially perpendicular**" magnetic field from planar coils).)

d) a sense circuit to monitor current flow through the primary coil during operation of the drive circuit to sense a current modulation in the primary coil from a modulation of a current in the receiver coil; and

170. It is my opinion that the *Okada-Odendaal-Shima-Hui-027-Kook* combination discloses and/or suggests this limitation. (*See* my analysis and discussions below in this section; *see also* my analysis and discussions in Sections IX.A.1(a)-(c), IX.A.1(e)-(l); *see also* my analysis and discussions in Sections VIII.A-E.)

171. As I discussed below, limitation 28(d) recites "a sense circuit…to **sense a current modulation** in the primary coil from a modulation of a current in the receiver coil." (*See* my analysis and discussions in Section IX.A.1(f) (reciting

"detect, through the **sense circuit**, a received communication of information in the **current modulation** in the primary coil").) A person of ordinary skill in the art would have recognized that PTM10 in *Okada*'s system transmits a carrier wave signal to PRM40, resulting in PDA3 to generate/send a modulated signal including device information back to PTM10 via coils 41 and 19. Circuit 35 "**demodulates modulated** signals included with the voltage from" primary coil 19 (Ex. 1005, ¶0042), and the information is evaluated by circuits 36-38 as part of power transfer operations. (Ex. 1005, FIG. 3, ¶¶0060-0077).) Thus, demodulating circuit 35 is an example of "**a sense circuit**" given it senses/receives/demodulates a modulated response signal from PRM40 via coil 19. (Ex. 1005, FIG. 2, ¶¶0050, 0064, 0069, 0076.) For example, *Okada* explains:

> A carrier wave output from the carrier wave oscillating circuit 33 is applied to the tap c of the primary-side coil 19, which, when the PDA 3 is mounted on the common cradle 4, is transmitted to the magnetically coupled secondary-side coil 41. This carrier wave transmitted to the secondary-side coil 41 is rectified, smoothed, and converted to a DC voltage via the smoothing capacitor 42, the rectifying circuit 43, and the smoothing circuit 44 as described above. Furthermore, the power-on reset circuit

48 detects the DC voltage converted from this carrier wave and recognizes that the carrier wave has been transmitted. Furthermore, the clock extracting circuit 46 connected to the secondary-side coil 41 extracts a clock signal necessary for ***modulation from the carrier wave***, and a ***modulating circuit 47 applies to the secondary-side coil 41 a modulated wave in which the carrier wave is modulated based on information on the PDA 3: such as "the code indicating that a device is capable of receiving power," "power consumption information," and "full capacity information."*** . . .

The modulated wave provided to the secondary-side coil 41 from the modulating circuit 47 is transmitted to the magnetically coupled primary-side coil 19.

Furthermore, a demodulating circuit 35 connected to the tap c of the primary-side coil 19 receives and demodulates the transmitted modulated wave, and provides the "code indicating that a device is capable of receiving power," "power consumption information," and "full capacity information" included in the demodulated information signal to the power transmission capability evaluating circuit 36, the power amount evaluating circuit 37, and full capacity evaluating circuit 38. . . .

(Ex. 1005, ¶¶0063-0064.) Thus, in my opinion, demodulating circuit 35 is an example of "**one or more sense circuits**" given it receives and demodulates (e.g., "**monitor[s] the current through the one or more primary coils to sense**") a modulated response signal containing device information (e.g., "code indicating that a device is capable of receiving power," "power consumption information," "full capacity information") ("**communication**") from PRM40's secondary-side coil 41 ("**one or more receiver coils**") received via primary-side coil 19 ("**one or more primary coils**"). (*Id.*; Ex. 1005, FIG. 2, ¶¶0050, 0064, 0069, 0076; *see also* my analysis and discussions in Sections VIII.A, IX.A.1(a).)

172. *Okada* explains that the modulation method may be based on "periodic intensity modulation of a carrier wave and may use a phase modulation method to express 0/1 information via phase change information of a signal." (Ex. 1005, ¶0058.) However, to the extent *Okada-Odendaal-Kook* does not disclose "a sense circuit to **monitor current flow** through the primary coil during operation of the drive circuit to sense **a current modulation in the primary coil from a modulation of a current in the receiver coil**," it is my opinion that a person of ordinary skill in the art would have been motivated to implement such features.

173. In my opinion, a person of ordinary skill in the art would have understood that modulating/demodulating a waveform (as discussed in *Okada*) and sensing communications based on monitoring an inherent property of the waveform (e.g., current) in order to detect/sense/process information contained therein during charging operations (operation of the drive circuit) would have been a known and available option for including/encoding/decoding information from the portable device in the modified system, such as information used to confirm power reception equipment, full charge, and/or power level used to verify presence/alignment of coils, consistent with that disclosed by *Okada*. (Ex. 1005, ¶¶0056-0057, 0062-0064.) Thus, a person of ordinary skill in the art would have been motivated to configure the modified *Okada* system to provide current modulation/demodulation-type techniques/technologies (including current sense circuit(s) that monitor current flow in the primary coil 19) to facilitate the communication of information from the secondary side coil, consistent with that known in the art. (Ex. 1056, Abstract, 2:7-9, 2:38-44, 4:21-34, 5:12-14, 6:12-33; Ex. 1057, 9:20-24, 15:16-21, 21:21-22:3, FIGS. 1-3, 11-13; Ex. 1058, Abstract, FIGS. 1, 3A-8, 3:25-4:35, 5:27-7:23, 10:22-24, 10:25-12:17; *see also* my analysis and discussions in Section IX.A.1(g).) (*See also* Ex. 1001, 24:32-45) (discussing "current modulation" in context of

conventional technologies, which supports that such features were known); Ex. 1063.)

174. For example, *Okada* describes verifying PDA3's presence by measuring intensity of the signal(s) communicated via primary coil 19 and secondary coil 12. (Ex. 1005, FIGS. 4(a)-4(b), ¶¶0066-0068, 0074-0076, FIG. 8 (current sensor 91), 0110 ("**current measuring sensor**" measuring current "through the primary-side coil 19" when PDA3 "is in proximity" of cradle 4), 0111.) Thus, for reasons I explained, in my opinion, a person of ordinary skill in the art would have been motivated and found it beneficial to configure/implement such current sensing/detecting/modulation/demodulation features in the modified *Okada* system/device for detecting communications of the modulated information signal (*e.g.*, device capability code) when received via coil 19 (detected as current corresponding to current modulation in coil 19 induced from the current modulation via coil 41) so that it is timely/properly detected, demodulated, and used to verify that PDA3 is "placed in a correct position" and "capable of data transmission and reception." (*Id.*, ¶0080, FIGS. 3, 8, 4(a)-4(b), ¶¶0081-0082.) A person of ordinary skill in the art would have been motivated to implement such a modification in light of *Okada*'s teachings, *e.g.*, using signal intensity and sensed current in coil 19 for

determining/verifying PDA3 presence, and state-of-art knowledge relating to current modulation/demodulation techniques/technologies, as I explained above. (*Id.*; *see also* my analysis, discussions, and citations above in this section; *see also* my analysis and discussions in Sections VIII.A, IX.A.1(a).) A person of ordinary skill in the art would have considered various ways of configuring the modification, such as configuring the "sense circuit" associated with current sensor 91, demodulation circuit 35, and/or other components to allow PTM10 to monitor the current flow through coil(s) 19 to sense/detect communications from PRM40 via coil 41, consistent with known current modulation/demodulation techniques as explained. (*Id.*)

175. In my opinion, a person of ordinary skill in the art would have had the requisite skills and rationale to design/implement such "**sense circuit…**" and related current modulation/demodulation-type features in the modified *Okada* system/device, and done so with a reasonable expectation of success given the teachings of *Okada* and the knowledge of such a person of ordinary skill in the art at the time. Especially since such modification would have involved applying known technologies/techniques (as discussed above) to foreseeably result in an inductive power transfer system that senses/detects communications received by coil

19 via known current modulation/demodulation techniques in the *Okada-Odendaal-Kook* system. (*See* my analysis and discussions above in this section; *see also* my analysis and discussions in Sections VIII.A-E, IX.A.1(a)-(c), IX.A.1(e)-(k).)

e) a communication and control circuit, including a microcontroller coupled to the drive circuit and the sense circuit, configured to:

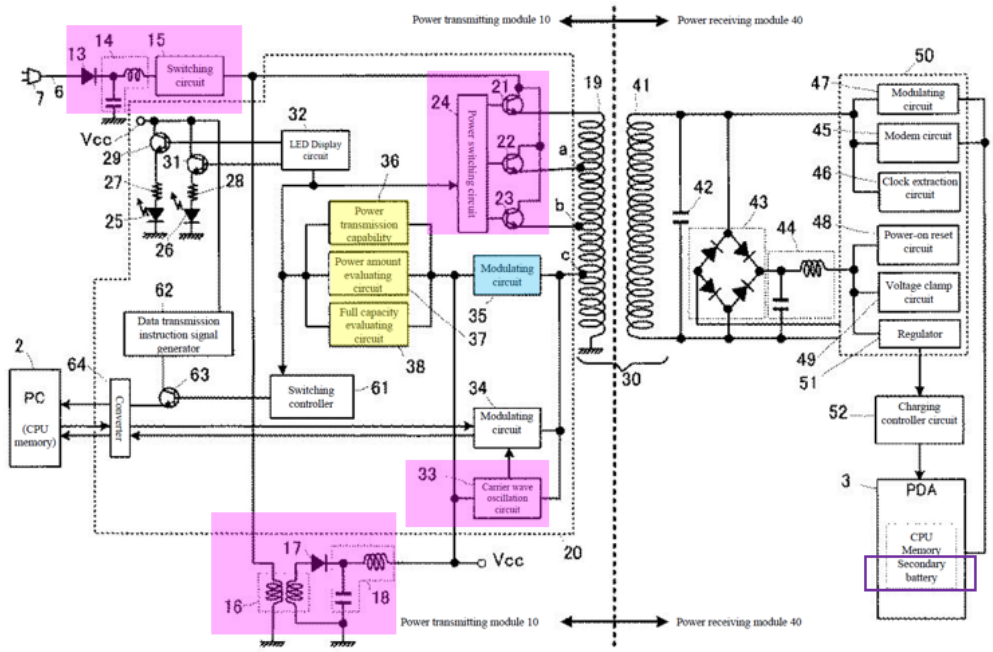
176. In my opinion, the *Okada-Odendaal-Shima-Hui-027-Kook* combination discloses and/or suggests this limitation. (*See* my analysis and discussions below in this section; *see also* my analysis and discussions in Sections IX.A.1(a)-(d), IX.A.1(f)-(k); *see also* my analysis and discussions in Sections VIII.A-E.)

177. For example, as I explained above, carrier wave oscillating circuit 33 provides a carrier wave to PRM40 that causes responsive device information from circuit 47 of PRM40 via coils 41-19 to be received/processed by demodulator 35. (*See* my analysis and discussions in Section IX.A.1(c)(1)); Ex. 1005, ¶¶56-57, 0062-0064.) Evaluation circuits 36-38 "perform various decision-making processes based on information included in the signal demodulated by the demodulating circuit 35." (Ex. 1005, FIG. 2, ¶0042, FIG. 3, ¶¶0060-0077.) *Okada* explains that the circuits control power transmission processes (FIG. 3) by providing signals to circuit 24 that

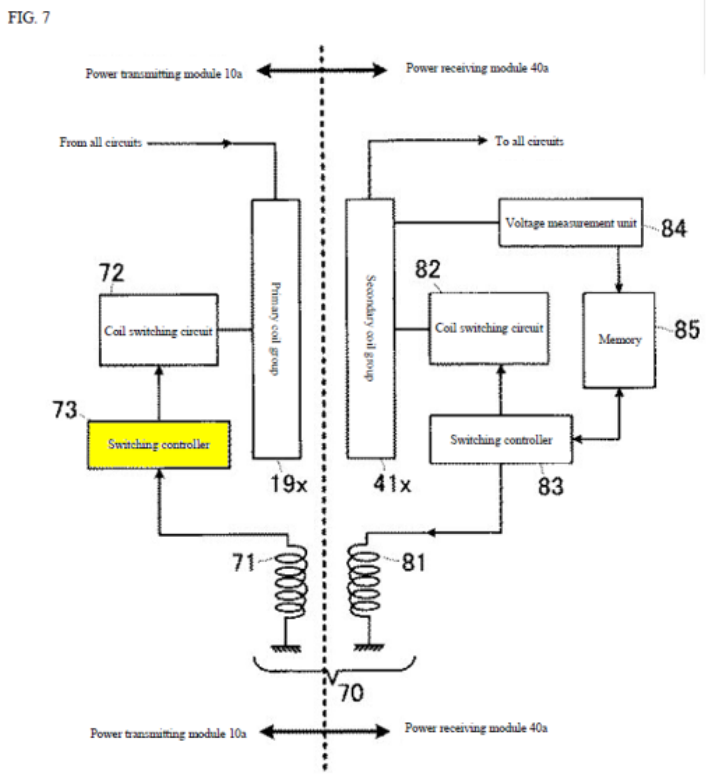
controls/selects switches 21/22/23 (part of "**drive circuit**"). (Ex. 1005, FIG. 3, ¶¶0057-0076; *see also* my analysis and discussions in Sections IX.A.1(a), (c)(1).) *Okada* also explains that the Circuits 36-38 provide a signal to switching control 61 (Ex. 1005, ¶0045) that determines whether "data can be **transmitted and received**" (*id.*, ¶0081, ¶¶0082-0085) and whether PDA3's charge capacity exceeds a "minimum capacity" for it to transmit/receive data (*id.*, ¶¶0082-0089, FIG. 6). Circuits 36-38 additionally control LEDs 25-26 that communicates charging status to a user. (*Id.*, ¶¶0041, 0053-0055, 0061, 0069-0072, 0077, FIG. 5.)

178. Thus, in my opinion, a person of ordinary skill in the art would have understood that one or more circuits 36/37/38 disclose one example of "**a communication and control circuit** [FIG. 2, **yellow** below]…**coupled to the drive circuit** [*e.g.*, *see* my analysis and discussions in Section IX.A.1(c)(1) pink] **and the sense circuit** [*see* my analysis and discussions in Section IX.A.1(d), 35 blue]" as claimed. (*See* my analysis and discussions above and below in this section; *see also* my analysis and discussions in Sections IX.A.1(f)-(k); Ex. 1005, FIG. 2 (annotated below).) Other components may also be included in such claimed "**communication and control circuit**," *e.g.*, switching controller 61, signal generator 62, controller

64, and/or "switching controller 73" in the multi-coil arrangement of FIG. 7 "system," (Ex. 1005, FIG. 7 (**yellow** below), ¶¶0094-0115.)



(Ex. 1005, FIG. 2 (annotated))



(Ex. 1005, FIG. 7 (annotated))

179. In my opinion, a person of ordinary skill in the art would have understood that such inter-relationships would have enabled the "**communication and control circuit**" implemented in the modified *Okada* system to perform various processes/functions discussed in limitations (g)-(k) discussed below. (*See* my analysis and discussions in Sections IX.A.1(f)-(k).) In my opinion, such a skilled person would have been motivated to configure the above-identified "**communication and control circuit**" in the modified *Okada* system to, *e.g.*, process the current feedback information received from demodulator 35 (including

as modified in view of *Kook*) for controlling the operating frequency of the modified "**drive circuit**" to control the voltage output of secondary rectification terminal during charging/powering operations, as explained. (*See, e.g.*, Section IX.A.1(c)(1).)

180. In my opinion, a person of ordinary skill in the art would have understood, based on *Okada*'s disclosures, that circuits 33, 36-38 may be "configured on the same **IC chip**," *e.g.*, "**IC** 20," which includes other components like "controller" 61, 73. (Ex. 1005, ¶¶0046, 0081-0084, FIGS. 2, 7.) Such circuitry would have been understood as compact integrated circuitry designed to perform/given certain operations in PTM10, which is consistent with a "**microcontroller**" as understood by a person of ordinary skill in the art in context of the '371 patent. (Ex. 1001, 24:32-45, 39:33-38 (exemplifying an "IC" or "chip" as a "microcontroller").) The same is true where "switching controller 73" is part of such "**communication and control circuit**" since it sends "instructions" to control the switching to select specific primary coils. (Ex. 1005, ¶¶0095, 0101.)

181. I have been asked to consider the scenario where the claimed "**microcontroller**" requires a processor or the like. Under that scenario, it is my opinion that a person of ordinary skill in the art would have been motivated to

configure PTM10 in the modified *Okada* system to include such features because it would have been a foreseeable application of known technologies/techniques to use in PTM10, which uses integrated circuit(s) to perform "control[ler]"-type operations. (*See* my analysis and discussions above in this section; Ex. 1006, 5:65-6:59, FIGS. 4-5 (controller 40); Ex. 1024, 6:60-7:14 (inductive power source including "microprocessor controller 308" for controlling modes of power supply operation), FIG. 3.) In my opinion, a person of ordinary skill in the art would have appreciated that implementing well-known processor-based microcontroller technology with PTM10 would have been a well-known variation to how the module can perform similar functionalities, while providing known programmable functionalities. *Kook* discloses "MPU block 30 for controlling internal elements" of charger 1 (*see* my analysis and discussions in Section IX.A.1(c)(1); Ex. 1059, ¶0041), and a person of ordinary skill in the art would have been motivated to configure the modified *Okada* system to configure the components in the "communication and control circuit" of the modified *Okada* system with a microcontroller (or include a microcontroller to facilitate/work with such components and their associated functionalities), similar to how MPU block 30 operates in *Kook*. In my opinion, a person of ordinary skill in the art would have

had the skills and rationale to implement such a modification, and given the known technology and *Okada*'s teachings, would have done so with a reasonable expectation of success. (*Id.*; *see also* my analysis and discussions in Sections VIII.A-E, IX.A.1(a)-(d), IX.A.1(f)-(k).)

f) detect, through the sense circuit, a received communication of information in the current modulation in the primary coil;

182. In my opinion, the *Okada-Odendaal-Shima-Hui-027-Kook* combination discloses/suggests this limitation. (*See* my analysis and discussions below in this section; *see also* my analysis and discussions in Sections IX.A.1(a)-(e), IX.A.1(g)-(k); *see also* my analysis and discussions in Sections VIII.A-E.) For reasons explained for limitations 28(d)-28(e), one or more circuits 36/37/38 (part of the "**communication and control circuit**" in the modified *Okada* system) (*See* my analysis and discussions in Section IX.A.1(e)) detects, through demodulator 35 ("**sense circuit**") sensing, a current-modulated response signal from PRM40 (including information corresponding to PDA3 (*e.g.*, device compatibility/capability, power level, and charge status information) via coil 19 ("**a received communication of information in the current modulation in the primary coil**") used to facilitate power/charge operations, like that described by

Okada. (*See* my analysis and discussions in Sections IX.A.1(d)-IX.A.1(e); *see also* my analysis and discussions above in this sections IX.A.1(a)-IX.A.1(c); Ex. 1005, FIG. 3, ¶¶0056-0057, 0059-0077.)

g) operate the drive circuit to inductively transfer sufficient power to the inductive receiver unit to activate and power the receiver circuit to enable the receiver circuit to communicate the information in the current modulation in the primary coil;

183. In my opinion, the *Okada-Odendaal-Shima-Hui-027-Kook* combination discloses and/or suggests this limitation. (*See* my analysis and discussions below in this section; *see also* my analysis and discussions in Sections IX.A.1(a)-(f), IX.A.1(h)-(k); *see also* my analysis and discussions in Sections VIII.A-E.) As I discussed, a person of ordinary skill in the art would have been motivated to configure the modified *Okada* system to implement closed-loop feedback controlled frequency switching power delivery based on device information to provide appropriate power to PDA3's battery during power/charging operations. (*See* my analysis and discussions in Section IX.A.1(c).) As I explained (limitations 28(b)-28(f)), the communication/control circuit (*e.g.*, circuit(s) 36/37/38 (and optionally others) including as modified) in the modified *Okada* system would have operated the "**drive circuit**" (*See* my analysis and discussions in Sections

IX.A.1(c)-IX.A.1(f), *e.g.,* with modified switching circuit 15 and *e.g.,* circuits 16-18, 21-24, 33) by *e.g.*, to provide control signal(s) to circuit 24 for selecting a switch 21/22/23 at the **onset** of a charging process, and/or by controlling power transmission based on received/demodulated current feedback information to control the operation frequency of the "**drive circuit**" (*See* my analysis and discussions above in this section and Sections IX.A.1(a)-IX.A.1(f)) **during** the charging process in the modified system to inductively transfer power, via coils 19 and 41, to PRM40 ("**inductive receiver unit**") of PDA3 (the "communication and control circuit…configured to" "**operate the drive circuit to inductively transfer sufficient power to the inductive receiver unit**"), consistent with that disclosed/suggested by *Okada-Odendaal-Kook*. (*See* my analysis and discussions in Sections IX.A.1(a), 1(c)-1(g); Ex. 1005, FIG. 3, ¶¶0040, 0047, 0051, 0057, 0069-0073.)

> [T]he clock extracting circuit 46 connected to the secondary-side coil 41 extracts a clock signal from the carrier wave necessary for modulation, and the modulating circuit 47 uses the clock signal provided by the clock extraction circuit 46 to modulate the carrier wave based on information on a PDA 3: such as "a code indicating that a device is capable of receiving power," "power

> consumption information," and "full capacity information." A modulated wave generated by this modulation is applied to the secondary-side coil 41. When a device (PDA 3) is mounted on the common cradle 4, this "code indicating that a device is capable of receiving power" is used by the power transmission capability evaluating circuit 36 of the power transmitting module 10 to evaluate whether supplying power to the device via the common cradle 4 is feasible (whether the device is equipped with the power receiving module 40), as described below.

(Ex. 1005, ¶0057.)

> The modulated wave provided to the secondary-side coil 41 from the modulating circuit 47 is transmitted to the magnetically coupled primary-side coil 19. Furthermore, a demodulating circuit 35 connected to the tap c of the ***primary-side coil 19 receives and demodulates the transmitted modulated wave, and provides*** *the "code indicating that a device is capable of receiving power," "power consumption information," and "full capacity information" included in the demodulated information signal* ***to the power transmission capability evaluating circuit 36, the power amount evaluating circuit 37, and***

> ***full capacity evaluating circuit 38***. Here, the power transmission capability evaluating circuit 36 determines whether a power receiving apparatus is mounted onto a power transmitting device 1 based on the "code indicating that a device is capable of receiving power" (STEP 3). If a prescribed "code indicating that a device is capable of receiving power" is received (STEP 3: Yes), it is recognized that a device capable of receiving power is mounted onto the common module 4 [sic]. Next it is determined whether the device capable of receiving power (compatible device) is correctly mounted onto the common cradle 4 (STEP 4). Meanwhile, if no prescribed "code indicating that a device is capable of receiving power" is received (STEP 3: No), it is determined that no device capable of receiving power is mounted onto the common cradle 4, and a carrier wave is output again (STEP 2).

(*Id.*, ¶0064.) (*Id.*, ¶0069 ("Meanwhile, when the amount of positional offset of the common cradle 4 and the PDA 3 does not exceed the prescribed amount of offset (STEP 4: Yes), processing proceeds to evaluating an amount of power to transmit (STEP 6)").)

184. For reasons I explained above, a person of ordinary skill in the art would have been motivated to configure the modified *Okada* system to inductively transfer "**sufficient**" power to the "**inductive receiver unit**" (*See* my analysis and discussions in Section IX.A.1(a)) to "**activate and power the receiver circuit to enable the receiver circuit to communicate the information in the current modulation in the primary coil**," consistent with the teachings of *Okada* as modified above. (*See* my analysis and discussions in Sections IX.A.1(a)-(f).) For example, *Okada* discloses that circuit 15's switching signal is converted to a V_{CC} to power components in PTM10, including circuit 33, which generates "a prescribed carrier wave at a certain interval" that is sent to PRM40. (Ex. 1005, ¶¶0039, 0056-0057; *see also* my analysis and discussions in Section IX.A.1(c)(1).) *Okada* explains that a DC signal "generated by a carrier wave provided by the carrier wave oscillating circuit 33 can be **used as a driving power source for the clock extracting circuit 46 and the modulating circuit 47**" in the "**receiver circuit**" of PRM40 ("**activate and power the receiver circuit**," as claimed). (Ex. 1005, ¶0058; *see also* my analysis and discussions in Section IX.A.1(a).)

185. In my opinion, a person of ordinary skill in the art would have understood that such an "activat[tion] and power[ing]" of the "receiver circuit"

(including *e.g.*, modulator 47 (*See* my analysis and discussions in Section IX.A.1(a)) in the modified *Okada* system causes the "receiver circuit" to provide responsive device information that is received/processed by demodulator 35 (*See* my analysis and discussions in Section IX.A.1(e)) based on current modulation in primary coil 19 (*See* my analysis and discussions in Section IX.A.1(d)) ("operate the drive circuit (*See* my analysis and discussions in Section IX.A.1(c)(1))…**to activate and power the receiver circuit to enable the receiver circuit to communicate the information in the current modulation in the primary coil**").

186. For example, consistent with *Okada*, in the above-discussed modified *Okada* system (*e.g.*, *see* my analysis and discussions in Sections IX.A.1(b)-(IX.A.1(f)) circuits 36/37/38 (part of "**communication and control circuit**") control the operating frequency of the modified switching circuit 15, which provides power to drive oscillating circuit 33 via circuits 16-18 (all part of part of "**drive circuit**," *see also* my analysis and discussions in Section IX.A.1(c); Ex. 1005, ¶0060-0064.) Accordingly, after power/charge operations have begun, circuit 33 (part of "**drive circuit**") in the modified system would generate/transmit, via coil 19, the carrier wave that is used to "**activate and power**" components in PRM40 (including "**receiver circuit**") to enable the "**receiver circuit**" (*See* my analysis and

discussions in Section IX.A.1(a)) to generate/communicate the responsive device information that is transmitted back to PTM10 via coils 41 and 19 based on current modulation techniques/technologies as explained (*See* my analysis and discussions in Section IX.A.1(d)) and the closed feedback loop power transfer operations taught and/or suggested by *Okada-Kook*. (Ex. 1005, FIG. 3, ¶¶0062-0064, 0074-0090; Ex. 1059, ¶¶0033, 0041, 0083; *see* my analysis and discussions in Sections IX.A.1(a)-(g).)

h) from the information communicated by the receiver circuit, determine a power parameter; and

i) operate the drive circuit according to the power parameter to provide power inductively from the primary coil to the receiver coil to power the microcontroller and to charge the battery of the portable device,[10]

[10] The '371 patent does not appear to disclose using power provided from the primary coil to the receiver coil "to power the microcontroller," which is included in the communication/control circuit of the "system." (See my analysis and discussions in Section IX.A.1(e); Ex. 1001.) Nevertheless, it is my opinion that the modified *Okada* system as I discuss below meets limitation 28(i) under the scenarios where

187. In my opinion, the *Okada-Odendaal-Shima-Hui-027-Kook* combination discloses and/or suggests limitations 28(h) and 28(i). (*See* my analysis and discussions below in this section; *see also* my analysis and discussions in Sections IX.A.1(a)-(g), IX.A.1(j)-(k); *see also* my analysis and discussions in Sections VIII.A-E.)

188. Consistent with *Okada*, in the above-discussed modified *Okada* system/device, PTM10 receives the device information from the "receiver circuit" of PRM40, *e.g.*, "power consumption information," which is provided to circuits 36/37/38 (part of "**communication and control circuit**") to determine the power transmission output, *e.g.*, determination of power transmission output in three levels: high, intermediate, and low ("**a power parameter**"). (*See* my analysis and discussions in Sections IX.A.1(a)-(g); Ex. 1005, ¶¶0057, 0063-0064, 0069, FIG. 3.) *Okada* explains that the determined/selected power is then inductively provided from coil 19 to coil 41 and is used by PRM40 to charge the PDA3 battery. (*Id.*)

"the microcontroller" refers to (1) "a microcontroller" in the portable device, or (2) "the microcontroller" recited in limitation 28(e). (See my analysis and discussions below in this section.)

189. Thus, for reasons discussed above, and for limitations 28(h) and 28(i) and others, in my opinion, a person of ordinary skill in the art would have been motivated to modify the *Okada-Odendaal-Shima-Hui-027-Kook* combination to "**operate**" the modified charger "system" (including the "**drive circuit**" (*See* my analysis and discussions in Section IX.A.1(c)) according to the determined "**power parameter**" to "**provide power inductively from the primary coil to the receiver coil…to charge the battery of the portable device**," like that claimed. (*See* my analysis and discussions in Sections IX.A.1(a)-(g).)

190. I have been asked to consider the scenario where "the microcontroller" refers to "a microcontroller" in the portable device (*See* my analysis and discussions in the above footnote n.10). Under this scenario, in my opinion, a person of ordinary skill in the art would have been motivated to configure the above modified *Okada* system such that the power provided from coil 19 to coil 41 (As discussed above) would "**power [a] microcontroller**" and the "battery" in PDA3, consistent with *Okada*'s teachings (as modified above). (*See* my analysis and discussions above in this section and Sections IX.A.1(a)-(g).)

191. For example, I understand in such a scenario that the "microcontroller" claimed in limitation 28(i) is deemed to be different from the "microcontroller" that

is claimed in limitation 28(e) (since as the claim language shows, the limitation 28(i) "microcontroller" has to be powered from "power **inductively** from the primary coil to the receiver coil," whereas the limitation 28(e) "microcontroller" is claimed to be in the communication/control circuit of the "system"). (*See* my analysis and discussions above in this section and Section IX.A.1(e).) Under such an interpretation, it is my opinion that a person of ordinary skill in the art would have understood the modified *Okada* combination discloses or suggests such features. For example, *Okada* explains circuits 46-47 (and circuits 45/48/49) (in PRM40) may be "configured on the same IC chip," *e.g.*, "power receiving control IC 50." (Ex. 1005, ¶¶0047-0048, 0057, 0063, 0086-0092, FIGS. 2, 7.) Such circuitry would have been understood by such a skilled person as compact integrated circuitry designed to perform certain operations in PRM40, which is consistent with a "**microcontroller**" as understood by a person of ordinary skill in the art and in context of the '371 patent. (Ex. 1001, 24:32-45, 39:33-38 (exemplifying an "IC" or "chip" as a "microcontroller"); Ex. 1064, ¶0023 (describing a secondary-side module "[as] an *integrated circuit*, such as a *microprocessor*." (Ex. 1064, ¶0023.) Thus, it is my opinion that the modified *Okada* combination discloses "**a microcontroller**" in the "**receiver unit**." And for reasons explained, and consistent

with *Okada*'s teachings, the power inductively provided from coil 19 to coil 41 is used to activate and power components in PRM40 (*See* my analysis and discussions in Sections IX.A.1(a)-(g)), and thus such "microcontroller" would likewise be powered by such received "power" as claimed/interpreted above. *Okada* explains, after power/charge operations have begun, circuit 33 (part of "**drive circuit**") in the modified system would generate/transmit, via coil 19, the carrier wave that is used to activate and power components in PRM40 (which includes such a "microcontroller") to enable its "**receiver circuit**" (*See* my analysis and discussions in Sections IX.A.1(a)) to generate/communicate the responsive device information that is transmitted back to PTM10 via coils 41 and 19, as explained (*See* my analysis and discussions in Sections IX.A.1(e)). (Ex. 1005, FIG. 3, ¶¶0062-0064, 0074-0090.)

192. I have been asked to consider the scenario where the claimed "microcontroller" requires a processor or the like and *Okada* does not expressly disclose such features. Under that scenario, it is my opinion that a person of ordinary skill in the art would have been motivated to configure PRM40 in the modified *Okada* system to include such features because it would have been a foreseeable application of known technologies/techniques in a portable device/system, which

uses ICs to perform "control[ler]"-type operations, consistent with *Okada*. (Ex. 1006, 5:65-6:59, FIGS. 4-5 (controller 40); Ex. 1024, 6:60-7:14 ("microprocessor controller 308" controlling power-supply operation/modes), FIG. 3; Ex. 1064, ¶0023.) In my opinion a person of ordinary skill in the art would have appreciated implementing well-known processor-based microcontroller technology with PRM40 would have been a well-known variation to how a PDA would perform similar/other functionalities, while providing known programmable functionalities. Thus, in my opinion, a person of ordinary skill in the art would have been motivated to configure the portable device in the modified *Okada* combination to include a "**microcontroller**" for controlling PRM40 components that is provided with power via the inductive coupling between coils 19-41, where such power also charges PDA3's battery, as discussed above. (*See* my analysis and discussions in Sections IX.A.1(a)-(g) and above in this Section (charging battery).) A person of ordinary skill in the art would have had the skills and rationale to implement such a modification, and given the known technology and *Okada*'s teachings, would have done so with a reasonable expectation of success. (*Id.*)

193. I have been asked to consider the scenario where "the microcontroller" refers to "the microcontroller" recited in limitation 28(e) (*See* my analysis and

discussions in footnote n.10). Under this scenario, in my opinion, a person of ordinary skill in the art would have been motivated to configure the above modified *Okada* system such that the "**drive circuit**" operates according to the "**power parameter**" to "**provide power inductively from the primary coil to the receiver coil to power the microcontroller**" in PTM10/cradle 4 (*See* my analysis and discussions in Section IX.A.1(e)), consistent with *Okada*'s teachings (as modified above). (*See* my analysis and discussions above in this section and Sections IX.A.1(a)-(g).)

194. Consistent with *Okada*'s teachings, for reasons explained (*See* my analysis and discussions in Section IX.A.1(a)-(g)), in my opinion, a person of ordinary skill in the art would have understood that the modified *Okada* system (in light of, e.g., *Kook*) would have been configured to use device information provided by PRM40 to control/adjust power delivery in a closed-loop feedback fashion, where the modified switching circuit 15 and related components (part of "**drive circuit**") adjusts the signals used to drive coil 19 for transferring appropriate power to PDA3 during charging operations. (*See* my analysis and discussions in Section IX.A.1(c).) Consistent with those operations, and with those of *Okada,* switching circuit in the modified system also provides signal(s) to circuits 16-18 to generate Vcc, which is

used to power components in PTM10 (which would include the "microcontroller" in the "communication and control circuit" in the modified system (*See* my analysis and discussions in Section IX.A.1(e)). (Ex. 1005, FIG. 2, ¶¶0044, 0055, 0060-0062, 0108.) For the reasons I explained above, it is my opinion that a person of ordinary skill in the art would have had similar rationale and skills to configure, and reasonable expectation of success in achieving, the above configuration/modification that would have predictably resulted in the "**drive circuit**" to operate according to the "**power parameter**" to "**provide power inductively from the primary coil to the receiver coil to power the microcontroller**" in PTM10/cradle 4, and charge PDA3's "**battery**" (as discussed above) (*See* my analysis and discussions in Sections IX.A.1(a)-(g) and above in this section (charging battery using inductively delivered power).)

j) wherein to charge the battery of the portable device the communication and control circuit is further configured to: receive additional information in the current modulation in the primary coil from modulation of the current in the receiver coil corresponding to a voltage or current at an output of the receiver circuit while charging the battery of the portable device; and

195. In my opinion, the *Okada-Odendaal-Shima-Hui-027-Kook* combination discloses/suggests this limitation. (*See* my analysis and discussions

below in this section; *see also* my analysis and discussions in Sections IX.A.1(a)-(i), IX.A.1(k); *see also* my analysis and discussions in Sections VIII.A-E.)

196. As I discussed, consistent with *Okada*'s operations, in my opinion, a person of ordinary skill in the art would have configured the modified *Okada* system such that the communicated information includes information **corresponding to a voltage/current** induced by the first primary coil **at the output of the receiver circuit** (*see* my analysis and discussions in Section IX.A.1(a)) that would have been communicated to circuits 36-38 ("**communication and control circuit**") (*see* my analysis and discussions in Section IX.A.1(e)) for closed-loop feedback control of power delivery for charging PDA3's battery (*see* my analysis and discussions in Section IX.A.1(c)), where such information would have been detected in the **current modulation** in primary coil 19 from the **current modulated** in **receiver coil** 41 (*see* my analysis and discussions in Sections IX.A.1(d)-IX.A.1(g)). In my opinion, a person of ordinary skill in the art would have understood that such features would have been consistent with those described by *Okada* and *Kook*. (*Id.*; *see also* Ex. 1059, ¶0041 (describing how current sensing block 60 "stably control[s] an electric power through a current feedback using an automatic variation algorithm of primary frequency… to control a voltage of a secondary rectification terminal in the charging

battery-pack 200" (*e.g.,* additional information corresponding to a receiver circuit output while charging a portable device battery), 0047, 0054, 0071, 0083; *see also* my analysis and discussions in Section IX.A.1(c).)

197. Additionally, as I explained, *Okada* discloses continuously providing device information after the onset of power transfer operations (receiving additional information "**while charging the battery of the portable device**"). (Ex. 1005, ¶¶0074-0090, FIG. 3; *see also* my analysis and discussions in Sections IX.A.1(f)-1(i).) Further, *Kook* discloses that "a voltage of the secondary rectification terminal in [the battery/device] is controlled to a **constant voltage**" via coils 70/80 by "using an automatic variation algorithm of primary frequency of the non-contact charger 1." (Ex. 1059, ¶0047; *id.*, ¶0041 (current sensing block 60 "**stably controlling**" power "through a current feedback using an automatic variation algorithm of primary frequency").)

198. Accordingly, consistent with the above-discussed modified *Okada* system in view of, *e.g.,* the teachings and suggestions of *Kook* (*see* my analysis and discussions in Section IX.A.1(c)), and for similar reasons, in my opinion, a person of ordinary skill in the art would have been motivated to configure the "**communication and control circuit**" (*see* my analysis and discussions in Section

IX.A.1(e)) in the *Okada-Odendaal-Shima-Hui-027-Kook* system (*see* my analysis and discussions in Sections IX.A.1(c)-IX.A.1(i)) to continuously "**receive additional information**" (*e.g.*, information corresponding to a voltage/current induced by coil 19 at the output of the "receiver circuit") "**while charging the battery of the portable device**" in order to "stably control[]" an output voltage to "a constant voltage," thus allowing the charger system to adjust its operation, and thus the transmitted power (similar to that taught/suggested by *Kook* and *Okada* and explained above (*see* my analysis and discussions in Section IX.A.1(c)).

199. Such a skilled person would have understood that such a modification/implementation would have ensured the modified system continuously receives PDA3 information (*e.g.,* including voltage or current at output of receiver circuit, which is associated with the voltage/current used to power the load (battery) so adjustments can be made according to the closed feedback loop processes consistent with the *Okada-Kook* combined teachings. (*See* my analysis and discussions in Section IX.A.1(c).) Given the above modified system would have been configured to communicate such information using current modulation/demodulation techniques/components for reasons explained (*see* my analysis and discussions in Sections IX.A.1(d)-(i)), a person of ordinary skill in the

art would have understood such "additional information" would have been received "**in the current modulation in the primary coil** [19] **from the modulation of the current in the receiver coil** [41]" in the above discussed modified *Okada* system, similar to that claimed.

> **k) regulate in a closed loop feedback manner, the voltage or current at the output of the receiver circuit in accordance with the received additional information corresponding to the voltage or current at the output of the receiver circuit by adjusting at least one of the operating frequency, the duty cycle, and the DC voltage input to the drive circuit during charging of the battery of the portable device.**

200. In my opinion, the *Okada-Odendaal-Shima-Hui-027-Kook* combination discloses and/or suggests this limitation for reasons I explained. (*See* my analysis and discussions below in this section; *see also* my analysis and discussions in Sections IX.A.1(a)-(j); *see also* my analysis and discussions in Sections VIII.A-E.) As discussed for limitations 28(c)-(j), a person of ordinary skill in the art would have understood to configure the *Okada-Odendaal-Shima-Hui-027-Kook* system to perform a closed loop feedback process (*see* my analysis and discussions in Section IX.A.1(c)) to stably control, using current feedback, the portable device's rectification terminal voltage (provided as output of receiver circuit (*see* my analysis and discussions in Section IX.A.1(a) used to charge PDA3's

battery) ("**regulate in a closed loop feedback manner, the voltage or current at the output of the receiver circuit**"). (*See* my analysis and discussions in Sections IX.A.1(c)-IX.A.1(j).) For reasons similar to those that I explained above, a person of ordinary skill in the art would have understood such features would have been provided in accordance with the current feedback information continuously received during operation ("**the received additional information corresponding to the voltage or current at the output of the receiver circuit**") (*see* my analysis and discussions in Section IX.A.1(j)) by varying the "**operating frequency**" of the primary-side circuit (via, *e.g.*, modified switching circuit 15 (part of "**drive circuit**")) (*see* my analysis and discussions in Section IX.A.1(c)) while transferring power to charge PDA3's battery (*see* my analysis and discussions in Sections IX.A.1(d)-IX.A.1(j)) ("**during charging of the battery of the portable device**"). (*See also* my analysis and discussions in Sections IX.A.1(a)-(c) and IX.A.1(i)-(j).) Therefore, for the reasons I explained (and referenced above), it is my opinion that the *Okada-Odendaal-Shima-Hui-027-Kook* combination discloses and/or suggests this limitation 28(k).

B. Ground 2: *Okada* in view of *Odendaal*, *Shima*, *Hui-027*, *Kook*, and *Kazutoshi* Discloses and/or Suggests the Features of Claim 29

1. Claim 29

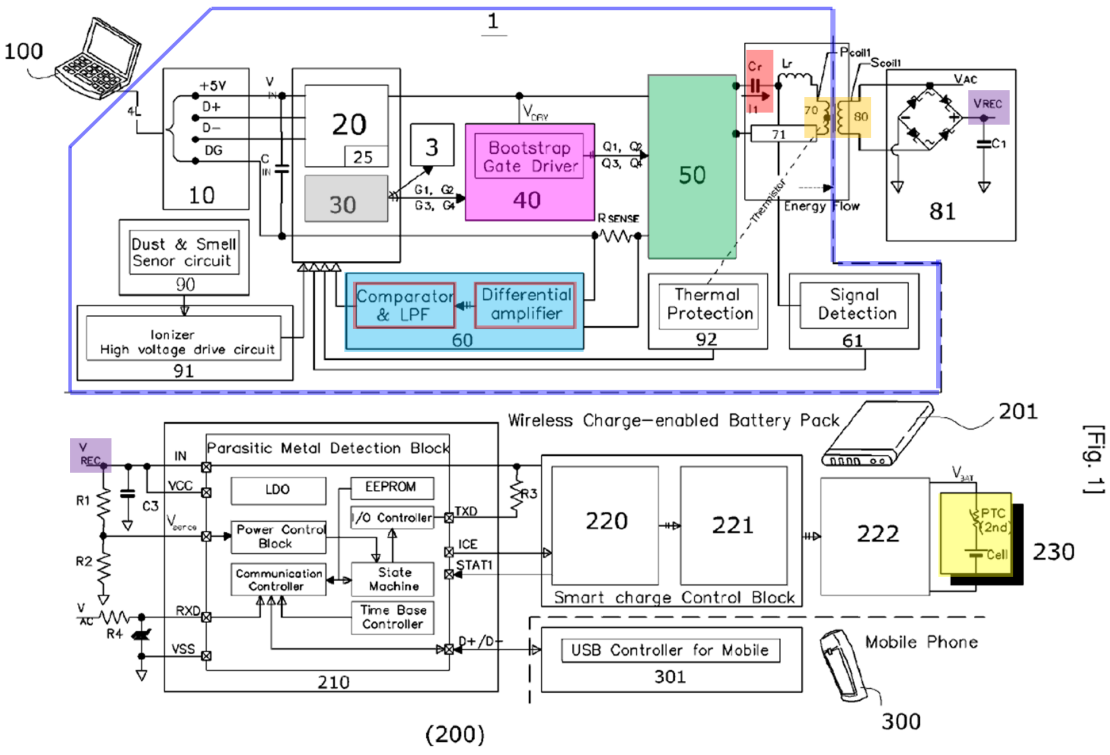
a) The system of claim 28, wherein: the sense circuit includes a low pass filter and an amplifier; and

201. In my opinion, the *Okada-Odendaal-Shima-Hui-027-Kook* combination discloses and/or suggests this limitation. (*See* my analysis and discussions below in this section; *see also* my analysis and discussions in Section IX.A.1; *see also* my analysis and discussions in Sections VIII.A-E.)

202. Although *Okada* does not expressly disclose the sense circuit including a low pass filter and amplifier, in my opinion, a person of ordinary skill in the art would have been motivated to configure the above modified *Okada* system (*see* my analysis and discussions in Section IX.A.1) to implement such features in view of the additional teachings in *Kook*.

203. In addition to what I explained above, (*see* my analysis and discussions in Section IX.A.1), *Kook* discloses that charger 1 includes **current sensing block 60** (blue in FIG. 1 below) that **monitors primary coil 70** to receive signals and associated information. (Ex. 1059, ¶¶0008, 0010, 0032-0033, 0041 ("a current

sensing block 60 for stably controlling an electric power through a current feedback"), 0045 ("current sensing block 60 receives a signal").)



(Ex. 1059, FIG. 1 (annotated).)

204. *Kook* explains that current sensing block 60 includes a differential "**amplifier**" and a "LPF" ("**Low Pass Filter**" (red above)). In my opinion, a person of ordinary skill in the art would have understood that that the "LPF" and "amplifier" would have improved the sensing/detecting of a signal as well as amplifying such a signal from a primary coil (similar to that described by) because it was known that

an amplifier increases signal strength and a LPF reduces impacts of unwanted noise/distortion for optimizing signal detection/sensing.

205. Based on such teachings/knowledge, and further to the rationale and support that I explained for claims 28 and 29, in my opinion, a person of ordinary skill in the art would have been motivated to configure the "**sense circuit**" in the modified *Okada* system (*e.g.*, demodulating circuit 35 (*see* my analysis and discussions in Section IX.A.1(d))) to include amplifier/LPF circuitry ("**a low pass filter and an amplifier**") to provide similar features like that suggested by *Kook*'s current sensing block 60 (*e.g.*, to amplify and filter the signal received by circuit 35 to ensure proper/efficient demodulation of the current modulated information signal(s) sent by coil 41 in the receiver circuit.

206. In my opinion, a person of ordinary skill in the art would have had the requisite skills and rationale to design/implement such features in the above modified *Okada* system, and done so with a reasonable expectation of success given the teachings of *Okada* and *Kook* in context the state-of-art knowledge of a person of ordinary skill in the art at the time. Especially since such modification would have involved applying known technologies/techniques (e.g., known signal enhancement/processing and filter technologies/techniques to foreseeably result in

an inductive power transfer system having an optimized/improved sense circuit (through the use of known LPF and amplifier components/techniques (*Kook*)) for monitoring current flow through the primary coil in accordance with the above-modified *Okada-Odendaal-Shima-Hui-027-Kook* system. (*See* my analysis and discussions above in this section and section IX.A.1(d).)

b) the closed loop feedback manner comprises a Proportional-Integral-Derivative (PID) control technique for regulating the voltage or current at the output of the receiver circuit.

207. In my opinion, *Okada-Odendaal-Shima-Hui-027-Kook* in view of *Kazutoshi* discloses/suggests this limitation. (*See* my analysis and discussions below in this section; *see also* my analysis and discussions in Sections IX.A.1 and IX.A.2(a); *see also* my analysis and discussions in Sections VIII.A-F.)

208. As I explained for limitation 28(k), the **communication/control circuit** in the modified *Okada* system (*see* my analysis and discussions in Section IX.A.1(e)) would have been configured to regulate in a "**closed loop feedback manner**" the voltage/current at the receiver circuit output (*see* my analysis and discussions in Section IX.A.1(k)). To the extent that the *Okada-Odendaal-Shima-Hui-027-Kook* combination does not expressly disclose that such a closed loop feedback process/techniques comprises "**a…(PID) control technique**," it is my opinion that

a person of ordinary skill in the art would have been motivated to implement such features in view of *Kazutoshi*.

209. *Kazutoshi* discloses "[a] contactless power supply system" with a power supply device 21 providing power to portable object (cart 3). (Ex. 1034, Abstract, FIG. 1, ¶¶0001, 0005-0014, 0024-0030.) *Kazutoshi* explains that power supply device 21 may provide power through inductive wires 19, where power is induced on a signal pickup coil 20A used to operate a load (motor 15) in the portable object. (Ex. 1034, FIG. 3 (below), ¶0029.)

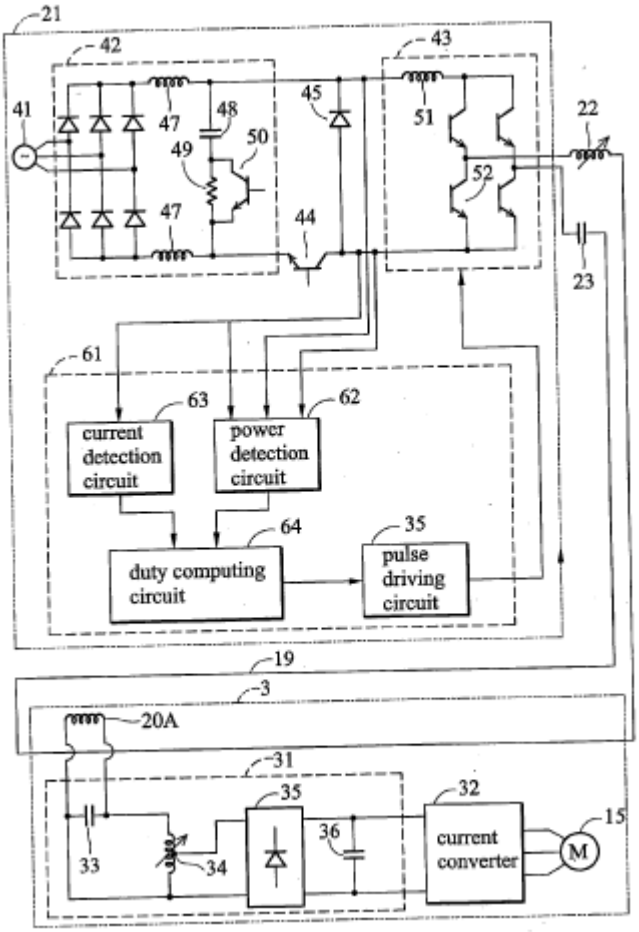


FIG. 3

(Ex. 1034, FIG. 3 (annotated).) *Kazutoshi* also explains that device 21 includes controller 61 having power detection circuit 62, current detection circuit 63, duty computing circuit 64, and pulse driving circuit 65. (*Id.*, ¶0038.) *Kazutoshi* also explains that duty computing circuit 64 receives signals (associated with the output of current converter 42 and current alternator 43, and output power of inductive wires 19) from power detection circuit 62 and current detection circuit 63. (*Id.*)

Kazutoshi also explains that circuit 64 "employs the output current of the current detection circuit 63 as a reference, evaluates the duty of the square wave driving the transistor 52 in the current alternator 43," and provide an output signal to pulse generating circuit 65 to drive transistor 52 and inductive 19 in order to power cart 3. (*Id.* ¶¶0038, 0043.)

210. In my opinion, a person of ordinary skill in the art would have understood that *Kazutoshi* is in the same technical field as *Okada* (including as modified) and the '371 patent, and also discloses features that were reasonably pertinent to one or more particular problems the '371 patent was trying to solve. (*See* my analysis and discussions in Sections IX.A.1(a)-IX.A.1(b); Ex. 1001, Abstract, 3:55-5:17, 33:39-35:3; Ex. 1034, Abstract, ¶¶0029, 0036-0039.) Therefore, a person of ordinary skill in the art would have considered *Kazutoshi* in context of modified *Okada* apparatus, looking to design/implement an inductive charging system like that described by the modified *Okada* apparatus. (*See* my analysis and discussions in Section IX.A.1.)

211. *Kazutoshi* additionally discloses duty computing circuit 64 comprises other components (*e.g.,* 71-76), where "[t]he multiplier 72, the integrator 73, and the differentiator 74 make up a ***proportional integral derivative (PID)*** controller." (Ex.

1034, ¶0039.) *Kazutoshi* explains that, in operation, the controller uses the difference between the output current (current detection circuit 63) and a reference value to determine an output signal to pulse generating circuit 65 for driving transistor 52 and inductive wires 19 to inductively power cart 3. (*Id.*; *id.*, ¶¶0040-0043.) *Kazutoshi* also explains that the PID controller provides "an output voltage for load resistance R and an output current within the range of the reference current." (*Id.*, ¶0043; *id.*, ¶0044.)

212. In my opinion, in light of such teachings/suggestions, a person of ordinary skill in the art would have been motivated to configure the **communication/control circuit** in the modified *Okada* combination (*See* my analysis and discussions in Sections IX.A.1(c), IX.A.1(k)) to use a PID control technique to regulate one or more outputs of the one or more receiver rectifier circuits (similar to features described by *Kazutoshi*) for regulating the receiver circuit output. (*See* my analysis and discussions in Section IX.A.1(k).) A person of ordinary skill in the art would have recognized/appreciated the known use of PID control techniques/technologies in a controller of a powering/charging system and to regulate a rectified/output DC voltage, as demonstrated by *Kazutoshi* and known in the art. (Ex. 1044, ¶¶0031, 0078; Ex. 1046, ¶0073 ("Persons of ordinary skill in

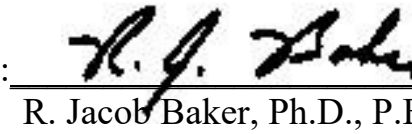
the art will be aware that many different algorithms may be employed to enable the aforementioned tuning of the device. For example…the algorithm may implement PID (proportional, integral, differential) processing").)

213. In my opinion, a person of ordinary skill in the art would have had the skill and rationale in implementing, and reasonable expectation of success in achieving, such modification. Especially where it would have involved applying known technologies (PID control technologies) (*Kazutoshi* and state-of-art knowledge) with wireless power transfer/charging systems (*Okada-Odendaal-Shima-Hui-027-Kook*) according to known techniques (e.g., regulating an output signal of a powering/charging system) to yield the foreseeable result of providing an inductive power/charging system with a regulated current/voltage output signal at the receiver circuit, consistent with the features of the modified *Okada* combination I discussed above . (*See* my analysis and discussions in Section IX.A.1.)

X. CONCLUSION

214. In summary, it is my opinion that all of the features recited in claims 28 and 29 of the ’371 patent are disclosed and/or suggested by the prior art.

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

Dated: June 27, 2023 By: 

R. Jacob Baker, Ph.D., P.E.