

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INDUCTEV, INC.
Petitioner

v.

WITRICITY CORPORATION
Patent Owner

Inter Partes Review No.: IPR2023-01208
U.S. Patent No. 8,912,687

**DECLARATION OF MARK N. HORENSTEIN REGARDING
VALIDITY OF CHALLENGED CLAIMS FOUND IN
U.S. PATENT NO. 8,912,687**

Declaration of Dr. Mark N. Horenstein in Support of Patent Owner's Response

1. I, Dr. Mark N. Horenstein, declare as follows:

2. I am over the age of 18 years and am fully competent to make this declaration. I make the following statements based on personal knowledge and, if called to testify to them, could and would do so.

I. INTRODUCTION

3. I have been retained on behalf of WiTricity Corporation to provide my opinions regarding U.S. Patent No. 8,912,687 (“the ’687 patent”) and the patentability of the claims challenged by Petitioner InductEV. In this declaration, I provide my opinions regarding the applicability of prior-art references put forth by Petitioner and the failure of these references to invalidate the challenged claims. I also opine in rebuttal to the July 16, 2023 Declaration of Dr. Mark Allen in this matter. I herein provide my opinions in consideration of the state of the art at the time of the claimed inventions and the knowledge that a person having ordinary skill in the art (POSA) would have had at the time of the claimed inventions.

4. My opinions and views set forth in this declaration are based on my education, training, and experience in the field of electrical engineering, inductive energy transfer, battery-powered electric vehicles (“EV”) and related technical areas, as well Petitioner's Exhibits 1001-1031 and other materials that are cited and discussed herein.

II. BACKGROUND & QUALIFICATIONS

5. My curriculum vitae (“vita”), which includes a summary of my background, experience, publications, and expert-witness experience is marked as Exhibit 2002.

6. I am a Professor of Electrical Engineering in the Department of Electrical and Computer Engineering at Boston University (now Emeritus) where I have been a faculty member since 1979. In addition to my primary academic appointment, I held various administrative positions at Boston University, including the Associate Dean for Graduate Programs and Research for the College of Engineering (1999-2007), Associate Chair for Undergraduate Programs for the ECE Department (1990-1998 and 2012-2015), as well as appointments at the ranks of Associate Professor (1985-2000) and Assistant Professor (1979-1985).

7. I have a Ph.D. in Electrical Engineering from the Massachusetts Institute of Technology (MIT) which I earned in 1978 while working in the Electric Power Systems Engineering Laboratory. I also hold an M.S. degree in Electrical Engineering from the University of California at Berkeley (1975), and an S.B. degree in Electrical Engineering from MIT (1973).

8. I am a Life Fellow of the Institute of Electrical and Electronic Engineers (IEEE) and have been a Registered Professional Engineer (Electrical) in

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the Commonwealth of Massachusetts. I hold certification from the National Association of Radio and Telecommunications Engineers.

9. I am the author of two textbooks: *Microelectronic Circuits and Devices, 2nd Ed.* (Prentice-Hall 1996) and *Design Concepts for Engineers, 5th Ed.* (Pearson Education, 2016). I have authored book chapters in two reference books related to electrical engineering. I have authored or co-authored over 70 journal articles on a variety of topics in my fields of expertise, and approximately 125 conference papers. I have advised various Ph.D. students performing research in my fields of expertise; these students have gone on to hold positions in industry and academia.

10. The courses that I taught over the 40 years I spent as a regular faculty member at Boston University encompassed electromagnetics, antennas, and radio communication, as well as basic electrical circuits, analog and digital electronics, control circuits, power electronics, electric motors, electric machines, microcontrollers, robotics, and engineering design. I was named "Teacher of the Year" in Engineering at Boston University four times.

11. I am a named inventor on six U.S. patents. I have also provided technical expertise in the design and analysis of consumer and industrial electronic products, integrated circuits, power supplies, DC/DC converters, and

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electromagnetic devices.

12. I have considerable experience in the areas of transformers, antennas, wireless charging devices, battery charging methods, and power circuits in general. I also have extensive experience in the design, analysis, and testing of consumer electrical products, including power supplies, battery chargers, microcontroller-based systems, and control systems of all types. In support of my research in deformable mirror systems, I designed two different analog-multiplexed, high-voltage storage arrays. Similarly, as part of my work in developing self-cleaning solar panels, I have designed switching power supplies that produce low-frequency, 3-phase, 1.5-kV outputs which in turn are powered by low-voltage DC/DC power converters.

13. As part of my work overall in applied electromagnetics, I have designed DC power controllers for thermal management systems, power-amplifier circuits, and analog amplifiers. I also have designed and used transformers of all types, including ferromagnetic, ferrite, and air-core varieties. I have practical knowledge of outdoor wiring methods and have wired numerous residential and industrial electric supplies, both indoor and outdoor. I have considerable hands-on experience in electrical wiring (e.g., 12-V DC, 120 VAC and 240 VAC) for commercial and residential purposes and a working knowledge of the National

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Electric Code (NEC) published by the National Fire Protection Association (NFPA-70).

14. At Boston University, I initiated and taught our department's course in power electronics which I devised and designed over a period of nine years. In support of this activity, I designed circuits for laboratory experiments in power electronics, including solar battery charging circuits, buck and boost converters and controllers, H-bridge DC/AC switching converters, and DC to AC-grid interface circuitry. Each year, my assigned capstone project has been the design (from basic parts) of an interface between a photovoltaic panel and the AC power grid.

15. My curriculum vitae ("vita"), which includes a summary of my background, experience, publications, and expert-witness experience is marked as Exhibit 2002.

16. My training and profession encompass broad areas of engineering. The opinions I express in this declaration involve the application of my engineering knowledge, expertise, and experience to the evaluation of U.S. Patent No. 8,466,654 with respect to various claim terms found therein.

17. The opinions proffered in this declaration are based on the documents I have reviewed, my experience and background in the field, my knowledge of electrical engineering, and my professional judgment.

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18. In the course of conducting my analysis and forming my opinions, I have reviewed the references and materials cited herein, including those listed below.

19. I am being compensated for services provided in this matter. I was recruited for this engagement by Cahn Litigation Services who is billing my time at a rate of \$400 per hour. I am also being reimbursed for reasonable expenses, such as travel expenses, should any arise. My compensation is not contingent on my opinions, on the outcome of any aspects of this matter, or on any of the technical positions that I explain in this declaration. I have no financial interest in Petitioner InductEV, the Patent Owner (who I understand to be WiTricity Corporation), or the '687 Patent.

III. BASES FOR OPINIONS EXPRESSED

20. The opinions set forth in this declaration are my own. My opinions are based on my review of the materials cited throughout this Declaration as itemized in the "Exhibits Considered" list provided above, my educational background, my experience working in the areas of inductive coupling and wireless charging, and my experience as a technical consultant providing expert testimony in numerous cases involving similar and/or related technology.

I. The Challenged Claims

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21. Petitioner is challenging claims 1-18 of the '687 patent, including independent claims 1, 7, and 13, plus dependent claims 2-6, 8-12, and 14-18. In my opinion, as discussed herein, Petitioner and Dr. Allen have failed to show that each and every element of the challenged claims appears in the cited prior art. In particular, Petitioner has failed to show where the cited prior art discloses the “authorization facility” claim element found in each of the independent claims.

22. Independent claims 1, 7, and 13 of the '687 patent read as follows (emphasis added):

Claim 1

A vehicle powering wireless receiver for use with a first electromagnetic resonator coupled to a power supply, the first electromagnetic resonator having a mode with a resonant frequency ω_1 , an intrinsic loss rate Γ_1 , and a first Q-factor $Q_1 = \omega_1/2\Gamma_1$, the wireless receiver comprising:

a load configured to power the drive system of a vehicle using electrical power;

a second electromagnetic resonator adapted to be housed upon the vehicle and configured to be coupled to the load, the second electromagnetic resonator having a mode with a **resonant frequency ω_2 , an intrinsic loss rate Γ_2 , and a second Q-factor $Q_2 = \omega_2/2\Gamma_2$,**

wherein the second electromagnetic resonator is configured to be wirelessly coupled to the first electromagnetic resonator to provide resonant, non-radiative wireless power to the second electromagnetic resonator from the first electromagnetic resonator;

and

an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.

Claim 7

A power source for wirelessly providing power to a wireless receiver of an at least partially electrically powered vehicle, the power source comprising:

a power supply, the power supply configured to supply power at a rate sufficient to charge the battery of a vehicle that is driven at least in part by electrical power;

a first electromagnetic resonator coupled to the power supply and having a mode with a **resonant frequency ω_1 , an intrinsic loss rate Γ_1 , and a first Q-factor $Q_1 = \omega_1/2\Gamma_1$** , the first electromagnetic resonator housed in a housing configured to be disposed in proximity to the vehicle;

wherein the first electromagnetic resonator is configured to be wirelessly coupled to a second electromagnetic resonator located on the vehicle and coupled to a load associated with the drive system of the vehicle to provide non-radiative wireless power to the second electromagnetic resonator, the second electromagnetic resonator having a mode with **a resonant frequency ω_2 , an intrinsic loss rate Γ_2 , and a second Q-factor $Q_2 = \omega_2/2\Gamma_2$** ;

and

an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.

Claim 13

A vehicle wireless power system, comprising:

a power supply, the power supply configured to supply power at a rate sufficient to charge the battery of a vehicle that is driven at least in part by electrical power;

a first electromagnetic resonator coupled to the power supply and having a mode with **a resonant frequency ω_1 , an intrinsic loss rate Γ_1 , and a first Q-factor Q_1**

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= $\omega_1/2\Gamma_1$, the first electromagnetic resonator housed in a housing configured to be disposed in proximity to the vehicle;

a load configured to power the drive system of the vehicle using electrical power;

a second electromagnetic resonator adapted to be housed upon the vehicle and configured to be coupled to the load, the second electromagnetic resonator having a mode with a resonant frequency ω_2 , an intrinsic loss rate Γ_2 , and a second Q-factor $Q_2 = \omega_2/2\Gamma_2$,

wherein the second electromagnetic resonator is configured to be wirelessly coupled to the first electromagnetic resonator to provide resonant, non-radiative wireless power to the second electromagnetic resonator from the first electromagnetic resonator; and

an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.

23. I understand that patent claims are given their ordinary and customary meaning as understood by one of ordinary skill in the art ("POSA") in view of the specification and the prosecution history of the patent. I also understand that the parties agree that a POSA would have a bachelor's degree in electrical engineering (or equivalent) and at least two years of industry or equivalent research experience in the field of wireless energy transfer. Below I provide my opinions regarding how a POSA would understand certain terms of the challenged claims of the '687 patent.

24. Each of these independent claims requires two resonators having

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parameters ω , Q , and Γ representing, respectively, the resonant frequency, quality factor, and loss rate of the first and second resonators.¹ Each of the claims also includes the requirement of “an authorization facility.” The claimed authorization facility is “to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.” For reasons explained below, it is my opinion that a POSA would understand this term to mean “verify that parameters of the resonators will power transfer and provide authorization prior to initiating the transfer of power.”

25. As I show below, the specification describes the claimed authorization facility as having two functions, namely a) to confirm that the two resonators are compatible by having the parameters needed for the desired form of power transfer; and b) to identify the user as having permission for the initiation of power transfer. As part of the compatibility check, the authorization facility may confirm such parameters as resonant frequency, quality factor Q , coupling efficiency, physical dimensions, safety metrics, and manufacturer of the resonators.

26. The second function of the claimed authorization facility, namely that of “providing authorization,” refers to the validation needed for “initiation of

¹ Note that ω in “radians/second” is equal to $2\pi f$, where f is in Hz (cycles per second). That is, one cycle of an electrical waveform is equivalent to two cyclical radians.

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transfer of power.” (See, e.g., ’687 claims 1, 7, and 13). Such validation will confirm that the user has, for example, a subscription, a user ID, a proper account, and/or means to pay. (See, e.g., ’687 patent, 65:24-26; 87:49, 102:17-21).

27. As the ’687 patent explains, the system manages both authorization *and* authentication, where the former ensures that the user is a subscriber or has paid, and latter is validation of resonator compatibility.

28. For example:

“The security and cryptography algorithms may be used to **authenticate and verify compatibility between resonators** ...and may use a public key infrastructure (PKI) and secondary communication channels for **authorization and authentication.**” (*Id.* 184, 19-23; emphasis added).

29. As this citation and others that follow indicate, the claimed authorization facility thus verifies both the parameters of the transmit and receive resonators, and also the account or billing information of the user.

30. For the purpose of further discussion, I will refer to the two functions of the claimed authorization facility as the “check for compatible resonator parameters” and the “check for a valid user” requirements, respectively. Details and examples of these two requirements appear in several places in the ’687 patent:

Examples of “Check for Physical Compatibility of Resonators”

Compatibility:

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“Authentication may be used to ensure that **only compatible sources** and devices are able to transmit and receive power.” (’687 patent, 102:15-17; emphasis added). “In some wireless energy transfer systems and configurations a wireless energy converter may be used to convert the parameters or configurations of wireless power transfer. In some embodiments a system may have one or more sources or one or more devices that are capable or configured to operate and transfer wireless energy with **one or more different and possibly incompatible parameters**. A wireless energy converter may be used to **translate or convert the parameters or characteristics of wireless power transfer** allowing energy transfer between sources and devices that may be configured to receive or capture wireless energy with incompatible or different parameters.” (*Id.* 143, 12-23; emphasis added).

Electrical Parameters:

“The system optimization may include ... efficiency, Q [factor], ... strong coupling factor, and the like.” (*Id.*, 23:30-33)

“In some systems it may be advantageous to make each of the resonators and its respective additional circuitry have the **same effective impedance** as seen from the power and control circuitry.” (*Id.*, 114:8-13; emphasis added)

“In some cases the circuit elements may be adjusted to achieve a **specified or predetermined impedance** value for the source and device resonators. In other cases the impedance may be adjusted to achieve a desired impedance value for the source and device resonators **when the device resonator is connected to a power consumer or consumers**.” (*Id.*, 70:4-9; emphasis added).

Physical Dimensions, Separation, and Orientation:

“When the source and device resonators are close to each other, power transfer efficiency may be optimized **when the characteristic sizes or the**

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effective sizes of the resonators are similar." (*Id.*, 111:21-24; emphasis added).

"In this inventive wireless energy transfer technique, energy may be exchanged efficiently over a wide range of distances, but the technique is distinguished by **the ability to exchange useful energy** for powering or recharging devices over midrange distances and **between resonators with different physical dimensions, components and orientations.**" (*Id.*, 28-66-29:4; emphasis added)

"The relationship between wireless power transfer efficiency and **source-device resonator separation** is shown in FIG. 59(a). (*Id.*, 112:5-8; emphasis added).

"Likewise, **position and orientation information** may be used to move or provide feedback to a user or operator of a device to place a device in a favorable orientation or location **to maximize power transmission efficiency, minimize losses, and the like.**" (*Id.*, 101:36-40; emphasis added).

"The inventors have discovered that the efficiency of wireless power transfer at **fixed separations can be optimized by adjusting the relative size of the source and device resonators.** For a fixed size and geometry of a device resonator, a source resonator may be sized to optimize the efficiency of wireless power transfer at a certain separations, positions, and/or orientations. When the source and device resonators are close to each other, power transfer efficiency may be optimized when the characteristic sizes or the effective sizes of the resonators are similar." (*Id.*, 111:14-24; emphasis added)

"...at smaller separations the efficiency is highest when the source and device resonators are **sized to be substantially equal.** For larger separations, the efficiency of 25 wireless power transfer is highest when the source resonator is **substantially larger than the device resonator.**" (*Id.*, 12:22-26; emphasis added).

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“At a fixed separation between a source and a device, devices with two different sizes of device resonators may realize maximum transfer efficiency for different sized source resonators. Then, depending on the charging protocols and the device power requirements and hierarchies, **the source may alter its size** to preferentially charge or power one of the devices, a class of devices, all of the devices, and the like.” (*Id.*, 112:41-47; emphasis added).

Examples of “Check for Valid User”:

“...and the source and other devices may initiate ... defensive measures to **prevent or deter unauthorized use.**” (*Id.*, 102:1-5; emphasis added).

“The system also includes “source power and control circuits” that “may be configured to monitor power usage for monitoring account, billing, control, and like functionalities.” (*Id.* 65: 24-27).

“...only devices that are part of a **specific subscription or plan**, are able to receive power from a source.” (*Id.*, 102:20-21; emphasis added)

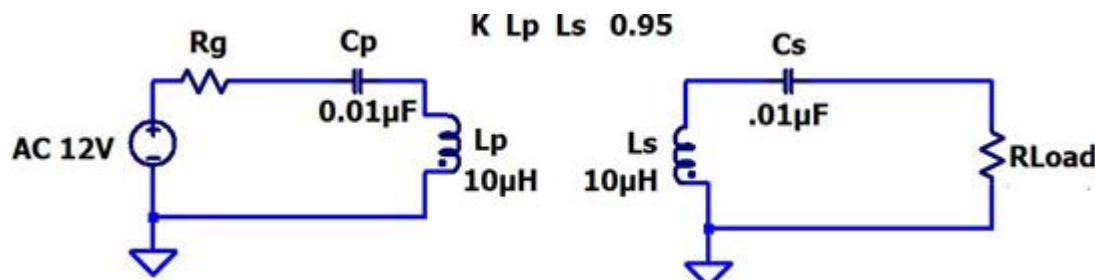
“In embodiments a theft deterrent or detection system may be incorporated into the source and device that utilizes the various sensors and cameras of the wireless power transmission system **to detect unauthorized use of the vehicle.**” (*Id.*, 150:33-36; emphasis added)

31. The '687 patent further explains aspects of resonator parameter compatibility, such as resonant frequency and Q-factor, that at times requires the same resonant frequency, and at other times allows for resonant frequency mismatch between the two resonators:

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“Note that, even though certain frequency and Q matching conditions may optimize the system efficiency of energy transfer, **these conditions may not need to be exactly met** in order to have efficient enough energy transfer for a useful energy exchange.” (*Id.* 237-12; emphasis added).

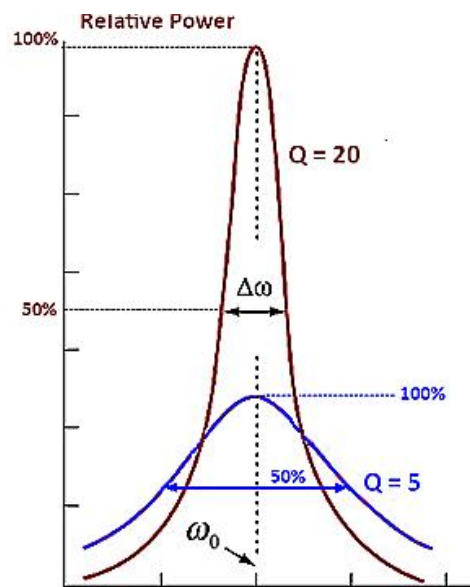
32. In general, the two resonators should have the same quality factor Q if maximum transfer efficiency is desired. This concept would have been understood by a POSA. Also, larger values of Q values will lead to higher energy transfer rates (joules of energy per second). The effect of Q on the relative power transfer is easily illustrated by the simple circuit shown below. The resonant circuit on the primary side consists of capacitance C_P and inductance L_P ; the resonant circuit on the secondary side comprises C_S and L_S . The transmit side is driven by an AC voltage source that has an internal generator source resistance of R_g . On the secondary side, R_{Load} represents the load device being charged or consuming power. The parameter K is the magnetic coupling factor between L_P and L_S :



33. The values of R_g and R_{Load} were chosen to achieve two values of $Q = 20$ and $Q = 5$. The plots below show the relative power transferred to the load R_{Load}

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versus driving frequency for each value of Q . The plots are normalized to the peak power for $Q = 20$. For both values of Q , the maximum occurs at the resonant frequency ω_0 . As is evident, however, the $Q = 20$ plot has a sharper and higher response than does the $Q = 5$ plot, indicating a larger power transfer (joules of energy per second) with the $Q = 20$ value at the resonant frequency. These plots show that the electrical parameters of the two resonators have a profound effect on the response of the circuit:



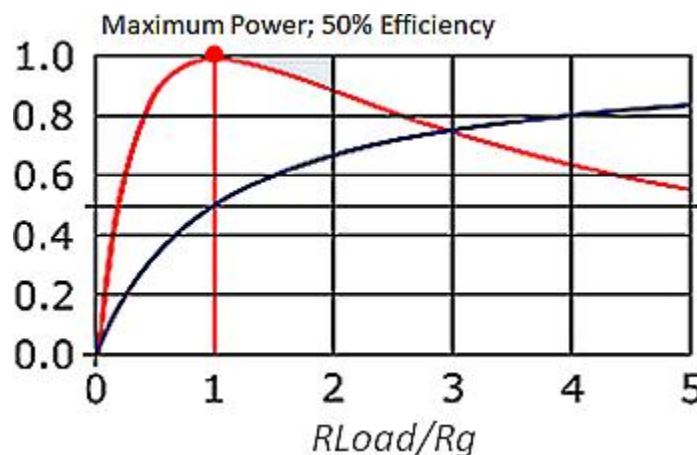
Frequency ω in rad/s. Remember that $f(\text{Hz}) = \omega/2\pi$

34. A POSA would have understood that the *amount* of power transferred and the *efficiency* at which power is transferred are both functions of the ratio R_{Load}/R_g . “Efficiency” is defined as the ratio of load power delivered divided by the power provided by the source. The difference between power-in and power-out is

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the power wasted in the system, e.g., dissipated in R_g . “Maximum power transfer” refers to the largest amount of power that *can* be delivered to R_{Load} .

35. As a POSA would similarly have understood, the condition for maximum efficiency (lowest possible loss) and maximum power transfer (fastest rate of energy exchange) are not the same. With reference to the circuit introduced previously, the plots below show, respectively, the power delivered to the load (red, normalized to the maximum), and the efficiency at which the power is delivered (blue), both as functions of the ratio R_{Load}/R_g . Note that the efficiency is only 50% (0.5) at the maximum power ratio $R_{Load}/R_g = 1$. The efficiency rises monotonically as R_L is increased, but at the expense of a lower rate of power transfer.



36. The point of the above illustration is to show that different resonator parameters, including Q and R_g , will yield different power-transfer and efficiency values. The highest power transfer (which would produce the fastest charging in a

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wireless battery-charging system) comes at the expense of lower efficiency, where the efficiency at maximum power transfer is only 50%. Higher efficiency requires a power transfer rate below the maximum possible value.

37. In one example of a power-transfer system, the system designer might choose desired values for power transfer to meet specific needs. In other example, the designer might choose a specific value of efficiency. In such cases, one metric of compatibility would be the ability of the two resonators to yield the chosen value of power transfer rate or power transfer efficiency.

38. Other aspects of compatibility involving the confirmation of parameters is further discussed in the '687 patent, for example in the following:

Efficiency of Energy Exchange

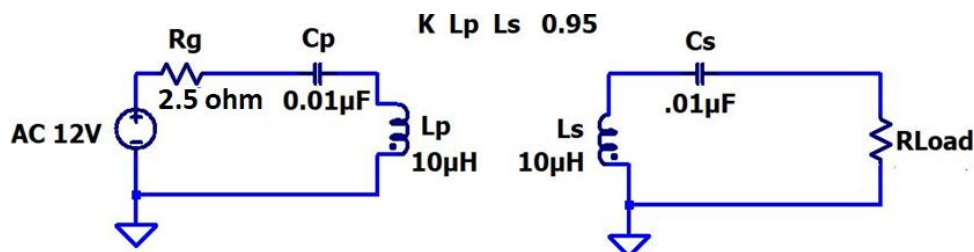
“The so-called “useful” energy in a useful energy exchange is the energy or power that must be delivered to a device (or devices) in order to power or charge the device. The transfer efficiency that corresponds to a useful energy exchange **may be system or application dependent**. For example, high power vehicle charging applications that transfer kilowatts of power may need to be at least 80% efficient in order to supply useful amounts of power resulting in a useful energy exchange sufficient to recharge a vehicle battery, **without significantly heating up various components of the transfer system**.

“In some consumer electronics applications, a useful energy exchange may include any **energy transfer efficiencies greater than 10%**, or any other amount acceptable to keep rechargeable batteries “topped off” and running for long periods of time. For some wireless sensor

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applications, transfer efficiencies that are much less than 1% may be adequate for powering multiple low power sensors from a single source located a significant distance from the sensors. For still other applications, where wired power transfer is either impossible or impractical, **a wide range of transfer efficiencies may be acceptable for a useful energy exchange** and may be said to supply useful power to devices in those applications.” (’687 patent, 30-52; emphasis added)

39. The importance of resonator parameters in determining the outcome of power transfer can further be illustrated by way of the simple example of two coupled resonating circuits, such as the circuit shown below. (This circuit is useful for illustration-of-concept purposes.) For the purpose of simplicity, both primary (left) and secondary (right) inductors have the same value, as do the two capacitors: $L = 10 \mu\text{H}$ and $C = 0.01 \mu\text{F}$. The coupled L and C pairs yield a resonant frequency of $f_0 = 360 \text{ kHz}$. The SPICE directive ($\text{K Lp Ls } 0.95$) at the top of the diagram means that inductors L_p and L_s are magnetically coupled with a coupling factor of 95%. The source on the right-hand side is a 12-V, 360-kHz sinusoidal voltage having an internal resistance $R_g = 2.5 \Omega$. The load R_{Load} can be set to various values.



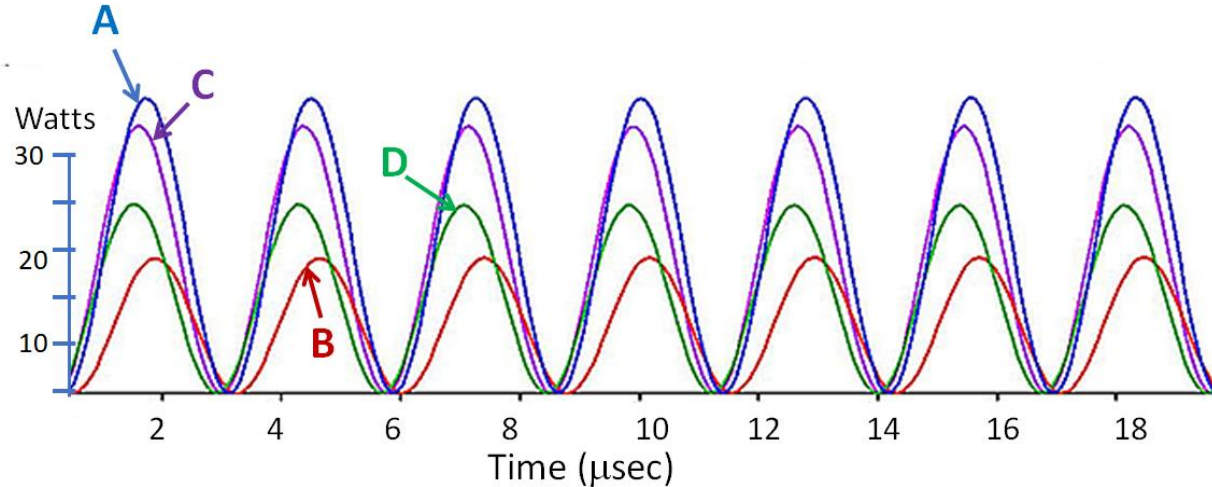
40. I was able to simulate this circuit using the well-known simulation

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program LTSpice. Note that the circuit can also be analyzed using equations found in the '687 patent. (See, e.g., '687 patent, 18:44 -20:65). I ran the simulation using values of load resistance R_{LOAD} over the range 0.2Ω to 5Ω . These R_{LOAD} values yield, respectively Q values between 6 (very low) and 158 (within the range of the '687 patent example embodiments). LT-Spice was instructed to calculate the values of power leaving the AC source and delivered to the load R_{LOAD} . The difference between the two represents power loss in the source resistance R_g . As the results below show, the various R_{LOAD} and Q parameters have a profound effect on the resulting peak magnitude of transferred power, and the phase difference between the load current and the AC source.

Primary Side:	R_g	C_p	L_p	f_{res}	Q_p
	2.5Ω	$0.01 \mu F$	$10 \mu H$	360 kHz	32
Secondary Side:	R_{LOAD}	C_s	L_s	f_{res}	Q_s
Case A	1Ω	$0.01 \mu F$	$10 \mu H$	360 kHz	32
Case B	0.2Ω	$0.01 \mu F$	$10 \mu H$	360 kHz	158
Case C	2.5Ω	$0.01 \mu F$	$10 \mu H$	360 kHz	6
Case D	5Ω	$0.01 \mu F$	$10 \mu H$	360 kHz	13

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41. Therefore, in view of the claim language of the '687 patent claims, and the description of the various resonator parameters in the '687 patent specification, it is my opinion that a POSA would understand the term “confirm compatibility of the resonators and provide authorization for initiation of transfer of power” to mean “verify that parameters of the resonators will power transfer and provide authorization prior to initiating the transfer of power.”

II. Prior Art Cited by Petitioner

42. Petitioner has relied on the Cook and Bennett prior-art references in an effort to show invalidity. While each of these references disclose authorization to check for a valid user, neither of them check for physical compatibility of the resonators.

Bennett

43. U.S. Patent Application No. 2010/0036773 to Bennett (“Bennett”),

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entitled “Integrated Wireless Resonant Power Charging and Communication Channel”, was filed on September 30, 2008. The focus of Bennett is on, “A power delivery system wirelessly deliver electric power and a communication signal to a target device.” (Bennett at Abstract). In particular, Bennett discloses that, “Operations may include target device authentication, target resonant frequency information communication, billing, and device management.” (*Id.*)

44. Specifically, Bennett discloses a system that checks for a valid user, e.g. a user that has a proper USERID and Password. This feature is described, for example, in the following excerpt from Bennett:

“During resonant power delivery the user **authorization module 121** exchanges the **authentication information** with the power transmitting unit 103. The power transmitting unit 103 compares the information (or a computed value thereof) with the **subscriber's** information in its database accessed by the target device authenticator 109. If the match is determined, then resonant power delivery is initiated.” (Bennett. at [0037]; emphasis added).

Similarly,

“The rechargeable electronic device may authenticate with the power transmitting unit employing a **username and password.**” (*Id.* at [0047])

“The target device authenticator **209** receives the identity of the magnetic resonant target device **211** and verifies a user's authentication or user's subscription to a power charging service.” (*Id.* at [0052])

and

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“The target device authenticator 109 identifies the target device by comparing the **identity data** received with the **subscription data** stored in the database 507 of FIG. 5.” (*Id.* at [0072])

45. These passages disclose the checking of subscriber information and user identification. Except for resonant frequency, however, nothing in Bennett, discloses or even suggests comparing resonators for the compatibility of their physical parameters.

46. Bennett does mention the “quality factor of the tuning elements” (*Id.* at [0071]) but only discusses the need to maximize the value of Q :

“Also the **quality factor** of the tuning elements **is maximized** by appropriately biasing the active devices to the low resistive region of operation.” (*Id.*; emphasis added).

47. Nowhere does Bennett discuss or mention the actual Q -factor of any particular resonators, i.e., actual numerical values of the parameter “ Q ” do not appear in Bennett.

48. Bennett does disclose the need for the transmitting and receiving resonators to be tuned to the same resonant frequency: “...the power source and the target devices are tuned to the same frequency.” (Bennett at [0023]). Bennett also discloses a system which checks the incoming resonant frequency and tunes the resonance of the receive before initiating power transfer:

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“The target device resonant power charging module 603 consists of a receiving resonant coupling component 625, **a resonant frequency seeking module 605...**” (Bennett 0070])

49. However, the system does not check *a priori* for resonant frequency compatibility, but rather tunes the receiving resonator to match that of the transmitting resonator. This is not the same as checking ahead of time that the resonant frequencies match.

“The resonant frequency seeking module **605** tries to receive optimum incoming power signal by proper coupling by way of tuning the frequency of magnetic coupling. The maximization of the power signal reception is achieved by the automatic tuning of the resonant coupling circuit component, **so that the tuning matches with the incoming magnetic field power frequency.**” (*Id.* at [0071], emphasis added).

In other words, the resonant frequency seeking module initiates automatic tuning of the receiver, but this action does not involve any authentication on the part of the power transfer device. Rather, it is part of the “Target Device Resonant Power Charting Module 603” indicated in Bennett Fig. 6. As the previous citation shows, tuning is automatic, not the result of any authentication process.

50. As Bennett further explains, the tuning of the receiver is automatic and is accomplished electronically:

“Automatic tuning is achieved, such as using the varactor diode by controlling its bias voltage appropriately which works as a variable capacitor.” (Bennett at [0074])

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51. Given all of the above, it is my opinion that Bennett does not disclose an authorization facility that confirms compatibility of the resonators, as required of the claims in the '687 patent.

Cook

52. U.S. Patent Application No. 2009/0299918 to Cook and Allred ("Cook"), entitled "Wireless Delivery of Power to a Mobile Powered Device", was filed on May 28, 2008. The focus of Cook is on, "A system that automatically detects the presence of an auto mobile that can operate wirelessly to recharge the battery therein, and detects account information associated with that automobile." (Cook, Abstract).

53. Like Bennett, Cook discloses authentication only of the user account but does not check for the compatibility of the resonators. For example, in explaining Fig. 2 (reproduced below)², Cook explains:

"At 205, a detection is made of whether that detected identification **has an account** associated therewith. This is sent to a controller that has the ability to **detect whether there is an existing account**, e.g. controller 180. This may be at a remote location that stores the vehicle identification information. If the controller **verifies the ID** as being one

² In the context of Fig. 2 and [0015], a POSA would have known that "DO NOT CHANGE VEHICLE" should read: "DO NOT CHARGE VEHICLE")

that is associated with an account at 205, charging is enabled.” (Cook [0015]; emphasis added)

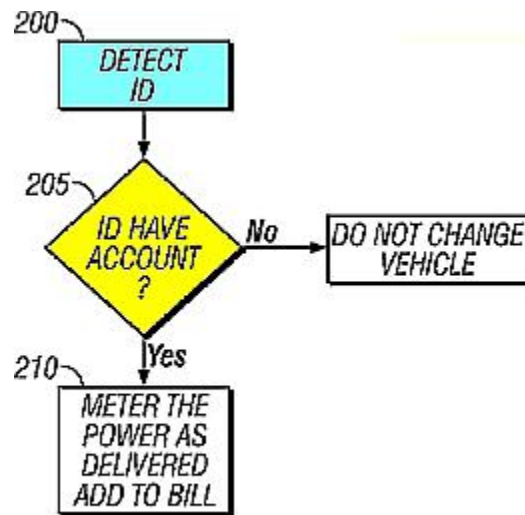


FIG. 2

Similarly,

“The charger 150 also includes an information detecting part. This may be a send and receive portion 160 that wirelessly detects a unique identifier indicative of the vehicle 100.” (Cook at [0014])

54. Thus, like Bennett, Cook is concerned with making sure the authorization module ensures the user has a *subscription* before it enables charging. Indeed, the various claims of Cook are based only on ID verification, not the checking of resonator parameters. Examples include:

“...providing billing data to an owner of the vehicle based on an amount of power that has been wirelessly supplied.”(Claim 1)

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“...detecting identification information about the vehicle, and metering an amount of power that is supplied to the vehicle.” (Claim 2)

“determining whether said identification information is associated with an existing account...” (Claim 3)

“a billing computer, receiving billing information for a specific account associated with a specific vehicle...” (Claim 8)

55. Neither Cook nor Bennett discloses or suggests “an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power,” as recited in each of the independent claims of the ‘687 Patent (Claims 1, 7, and 13). Petitioner asserts that Cook discloses a charger with “controller” having an “information detecting part” to “detect a unique identifier indicative of the vehicle 100”, and that power should only be “allowed to be dispensed if an encrypted value properly agrees with the proper encryption code and proper token time.” (Petition at pg. 47, citing Cook [0014] and [0018]). However, these cited portions of Cook fail to disclose an authorization facility that confirms compatibility of the first and second resonators prior to initiating the transfer of power. Rather, Cook merely discloses the use of a unique identifier (e.g., via an RFID device) to confirm that an account is associated with the identifier before allowing charging to begin. (*See, e.g.,* Cook [0015]).

56. Petitioner claims that Cook discloses the use of encrypted messages to indicate that “charging is enabled” for the vehicle, thus “indicating that it has a

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compatible resonator.” (Petition at pg. 47). Paragraph [0015] of Cook, however, says nothing about resonator compatibility. Rather, it references the flowchart of Fig. 2 which outlines the following steps: 1) Detect User ID; 2) Verify Account; 3) Meter the Power Delivered, and 4) Add to Bill. These steps have nothing to do with checking for resonator compatibility

57. In other words, Cook is concerned only with checking to see if the user has an account before charging can be initiated, but is silent about the compatibility of the resonators. In contrast, the '687 Patent specification distinguishes confirming the compatibility of resonators from authenticating the user account. In particular, the '687 Patent specification explains that the authentication capability can a) “ensure that only compatible sources and devices are able to transmit and receive power,” and, separately, is b) used “to ensure that only authentic devices that are of a specific manufacturer and not clones or devices and sources from other manufacturers, or only devices that are part of a specific subscription or plan, are able to receive power from a source.” ('687 patent, 102:14-21). That is, by separately explaining the ability of the authorization facility to confirm resonator compatibility *and* verify that the receiving device belongs to an authorized subscriber, Petitioner's implicit claim construction combining resonator compatibility and authentication is inconsistent with the specification.

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58. Bennett does not add to the deficient teachings of Cook in this regard. Bennett discloses a “target device authenticator 109” of a power transmitting unit, and a “user authorization module 121” of the target electronic device. (Bennett at [0029], [0030], and [0041]). Bennett explains that the target device authenticator and the user authorization module verify the identity of the target device, and confirm whether the user has subscribed to the power-charging service. (*Id.*, [0037], and [0052]). As is the case with Cook, this portion of Bennett simply assesses whether or not the user has an account that can be billed for use of the charging facility. It says nothing about compatibility of the resonators.

59. Petitioner further relies on Bennett's teaching that a “power control signal exchange operation is required for the authentication of the target electronic device 115 before a successful resonant power delivery.” (Petition at pg. 49 , citing Bennett [0039]). But this statement is also silent with respect to resonator compatibility. Paragraph [0039] of Bennett describes monitoring the battery level of the rechargeable battery and initiating a “resonant power charge operation” when the battery level is low. Thus, while one skilled in the art would have understood that the “power control signal exchange operation” relates to the automatic triggering of the resonant power charge operation based on the battery level of the rechargeable battery, it says nothing about the compatibility of the resonators.

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60. Petitioner further cites to Bennett's disclosure of automatically tuning the power transmission frequency "to achieve the optimum reception from an antenna/resonant coupling mechanism." (Petition at pg. at 49, citing quoting Bennett at [0038]). This excerpt from Bennett, however, describes a "source resonant frequency selector 123", not the target device authenticator 109 or the user authorization module 121. Thus again, this selection of the resonant frequency of the source, which "provides a tuning mechanism in order to achieve the required resonant coupling effect", does not "confirm compatibility of the resonators . . . for initiation of transfer of power," as required in the '687 patent claims.

61. Conversely, Bennett explains that the power transmitting unit (i.e., the charger) authenticates the target device by comparing information received from the target device with *subscriber information* contained in a database. (Bennett at [0037]). If a match is determined, "then resonant power delivery is initiated." (*Id.*) Importantly, however, Bennett explains that "[t]he authentication is followed by optional frequency selection." (*Id.*). Thus, the selection of the resonant frequency of the source (via selector 123) relied upon by Petitioner is, in fact, an optional step that occurs only *after* a valid user authentication has occurred. Thus, in my opinion, this portion of Bennett cited by Petitioner does not disclose or suggest "an authorization facility to confirm compatibility of the resonators and provide

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authorization for initiation of transfer of power,” as required of independent '687 patent claims 1, 7, and 13.

62. As I have discussed previously, the '687 Patent specification distinguishes between an authorization facility that confirms compatibility of the resonators, and the adjusting of resonant frequencies to optimize power transfer. For example, the '687 Patent specification explains that “[e]nergy exchange between two electromagnetic resonators can be optimized when the resonators are tuned to substantially the same frequency.” ('687 patent, 4:18-21). The specification also explains that:

“...even though certain frequency and Q matching conditions may optimize the system efficiency of energy transfer, these conditions may not need to be exactly met in order to have efficient enough energy transfer for a useful energy exchange.” (*Id.*, 23:7-11).

63. That is, unlike the first claimed function of the authorization facility to confirm resonator compatibility for “initiation of power transfer”, the process of frequency tuning, which Petitioner asserts is confirmation of compatibility, is instead a process for optimizing energy transfer, as the above passage indicates. compatibility.

III. Comments on Dr. Allen Expert Report Regarding Cook and Bennett

64. With regard to Dr. Allen's report, first of all, in his section “VIII.

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Claims 1-18 are Obvious Over Cook in View of Bennett” (Allen pg. 55), he devotes 11 pages to justifying why a POSA would have been motivated to combine Cook and Bennett. Regarding the opinions on the '687 patent, claim 13 on pg. 66, his arguments for invalidity of Claims 1-8 do not consider “compatible resonators.” Dr. Allen does devote many paragraphs in an attempt to show that the concept of resonance, including Q , ω_{res} , and Γ , were well known in the time frame of the '687 patent, but his explanations simply argue that these were important parameters. He does not contend that they are related to resonator compatibility, contrary to what I have explained above.

65. In Dr. Allen's arguments for obviousness of “Element 13[f] Authorization Facility,” he points only to the ID verification aspects of Cook and Bennett:

“Cook provided the basics of an authentication system, teaching that the ‘charger 150 also includes an information detecting part” that can consist of “a send and receive portion 160 that wirelessly detects a **unique identifier indicative of the vehicle 100.**” Cook at [0014]. The charger only initiates power transfer ‘if an encrypted value [**for the vehicle ID**] agrees with the proper encryption code and proper token time.” (Allen ¶179; emphasis added)

66. Dr. Allen also states that:

“...in the combined Cook/Bennett system, the authorization facility would have included both components and would authorize a vehicle in the manner taught by Bennett.” (Allen at par. 180)

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and

“In Cook, this power exchange operation would occur between the charger and the vehicle, and ensure that power is transferred only to vehicles where “charging is enabled” with a compatible resonator. Cook [0015]”. (Allen at par. 182).

67. But contrary to Dr. Allen's assertions, the word “compatible” is not found anywhere in Cook [0015], nor any other part of Cook. While Bennett mentions making sure that the resonant frequencies are the same, this frequency tuning occurs after charging is initiated, and does not correspond to confirming the compatibility of resonators. Bennett offers nothing about the Q and other electrical parameters, resonator dimensions, separation, and orientation, resonator manufacturer, frequency-hopping capability, and all other physical parameters related to resonator compatibility.

IV. A POSA Would Not Have Combined Cook and Bennett

68. I understand that in order to show that a patent claim is obvious in view of multiple prior art references, it must be shown that a POSA would have been motivated to combine the references in the same way that the elements of the challenged claim are arranged. I have reviewed the portions of the Petition and Dr. Allen's declaration that purport to explain why a POSA would have combined the teachings of Bennett with the teachings of Cook in order to achieve an authorization facility that confirms the compatibility of the resonators to initiate the transfer of

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power. As I explain above, it is my opinion that neither Cook nor Bennett teach this feature. But even if it is determined that Bennett does teach this feature, I disagree that with the reasons provided by the Petition and Dr. Allen for why a POSA would have combined Bennett and Cook in the manner Petitioner suggests.

69. More specifically, the Petition argues that Cook includes an authentication system, but “left the details” of the authentication system to a POSA, which would have looked to Bennett for those details. Pet. at 47-48. But as I explain above, the authorization system disclosed in Bennett verifies that the user has an account before charging occurs. A POSA would have easily understood how to implement such a verification, and there would be no reason to look to Bennett for any “details.”

70. The Petition also identifies several other features of Bennett that Petitioner argues would have motivated a POSA to combine the feature of confirming resonator compatibility (as allegedly disclosed by Bennett) with Cook. But a POSA would have understood that the features cited by the Petition are unrelated to confirming resonator compatibility. For example, the Petition notes that Bennett discloses tuning to different frequencies to accommodate different vehicles. Pet. at 21. But as I explain above, the frequency tuning in Bennett occurs after tuning begins, and does not correspond to confirming resonator compatibility

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to initiate power transfer.

71. The Petition also argues that Bennett provides additional detail about how encrypted signals are transmitted between the vehicle and the charger. Pet. at 22. In my opinion, a POSA would have understood how to implement the encryption scheme described in Cook, and would not have needed to consult Bennett for details regarding encryption. Even if a POSA would have a reason to consult Bennett for encryption details to implement into the authorization system of Cook, the encryption details of Bennett would not have motivated a POSA to combine any steps for confirming resonator compatibility from Bennett into Cook. Encrypting signals protects the signals from being corrupted, which is unrelated to confirming the compatibility of the resonators for power transfer.

72. The Petition also argues that a POSA would have been motivated to combine Cook and Bennett to prevent the battery in Cook from overcharging. Bennett does include a feature for monitoring the charge level of the vehicle battery, but like the other features cited by the Petition, monitoring of the charge level does not indicate whether the resonators are compatible, and would not have motivated a POSA to add the ability to confirm resonator compatibility to Cook.

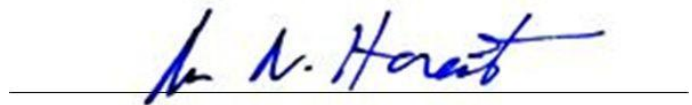
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V. CONCLUSION

73. For the reasons set forth above, it is my opinion that the prior art cited by Petitioner does not render obvious claims 1 through 18 of the '687 Patent.

Executed on May 24, 2024, in the city of Boston, Massachusetts.



Dr. Mark N. Horenstein