

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re *Inter Partes* Review of:)
U.S. Patent No. 8,912,687)
Issued: Dec. 16, 2014)
Application No.: 13/288,589)
Filing Date: Nov. 3, 2011)

For: **Secure Wireless Energy Transfer For Vehicle Applications**

**DECLARATION OF MARK ALLEN IN SUPPORT OF
PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 8,912,687**

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I. INTRODUCTION

1. I have been retained as an expert witness on behalf of InductEV Inc., (“InductEV” or “Petitioner”) in the above-captioned inter partes review (“IPR”) relating to U.S. Patent No. 8,912,687 (“the ’687 patent”).

2. I understand that InductEV is petitioning for IPR of claims 1-18 of the ’687 patent and that it requests that the United States Patent and Trademark Office (“PTO”) cancel those claims.

3. In preparing this Declaration, I have reviewed the ’687 patent and considered the documents identified in Section III in light of the general knowledge in the relevant art. In forming my opinions, I have relied on my education, knowledge, and experience (including my extensive research and development experience with wireless power transfer, which I summarize below), and I considered the level of ordinary skill in the art as discussed below.

4. I am being compensated for my time in connection with this IPR at my standard consulting rate, which is \$625.00 per hour, plus actual expenses. My compensation is not dependent in any way upon the outcome of this matter.

II. BACKGROUND AND QUALIFICATIONS

5. I received a B.A. degree in Chemistry, a B.S.E. degree in Chemical Engineering, and a B.S.E. degree in Electrical Engineering from the University of Pennsylvania, and a S.M. and Ph.D. (1989) from the Massachusetts Institute of

Technology. From 1989 to 2013, I was a member of the faculty of the School of Electrical and Computer Engineering of the Georgia Institute of Technology, ultimately holding the rank of Regents' Professor and the J.M. Pettit Professorship in Microelectronics. In 2013, I joined the University of Pennsylvania faculty as the Alfred Fitler Moore Professor of Electrical and Systems Engineering and was named the founding director of the Singh Center for Nanotechnology at Penn.

6. As discussed below, my technical expertise is in microelectromechanical systems (MEMS), microfabrication technologies for MEMS, and the application of MEMS in multiple fields. A particular research interest area of mine is the application of microfabrication technologies to magnetics, including magnetoquasistatic problems such as those inherent in near-field wireless power transfer based on magnetic field coupling.

7. In 1989, I founded a research group, the Microsensors and Microactuators Group. This group, consisting of graduate students and postdoctoral associates of both the Georgia Institute of Technology and the University of Pennsylvania, has been in continuous existence since then. Though the composition and the specific research topics of the group have changed over time, the group has maintained a focus since its founding on the development of new microfabrication technologies and their application to MEMS.

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8. In 1990 I began a project on integrated magnetics with my first Ph.D. student. Our group has continuously worked on magnetics projects since then, with applications including magnetic energy storage and conversion, inductors and transformers, magnetically driven relays, magnetic generators, permanent magnets, magnetic sensors, and wireless power transfer based on magnetic coupling.

9. In 1994 my student and I gave a plenary address to the IEEE Applied Power Electronics Conference and Exposition on the topic of micromachined inductors.

10. Over the past three decades, our group has published its work on magnetics in multiple IEEE journals, including the IEEE Journal of Microelectromechanical Systems, IEEE Transactions on Magnetics, IEEE Magnetics Letters, and IEEE Transactions on Power Electronics.

11. I am co-founder of multiple MEMS-related companies, including CardioMEMS, Axion Biosystems, and EnaChip.

12. CardioMEMS was founded in 2001 and has commercialized wireless implantable microsensors for treatment of aneurysms and congestive heart failure, ultimately becoming the first MEMS-based medical-device transducer FDA-approved for permanent human implantation. CardioMEMS received the 2006 Company of the Year award from Small Times magazine and the 2006 Frost and

Sullivan Patient Monitoring Product Innovation of the Year Award, and the FDA highlights its wireless aneurysm pressure monitor in its 2005 ODE annual report as a cleared medical device likely to have a significant impact on patient care. CardioMEMS completed a 550-patient clinical trial for its second product, a MEMS-based wireless implantable hemodynamic monitor for patients with congestive heart failure. After CardioMEMS received FDA approval for its hemodynamic monitor, St. Jude Medical (now Abbott) acquired it in 2014.

13. The CardioMEMS wireless pressure sensor relies on near-field magnetic coupling between a source coil and a sensor coil, as detailed in U.S. Patents 6,111,520 and 7,245,117, among others, of which I am a co-author.

14. I was involved in EnaChip's launch in 2017. EnaChip is focused on exploiting electroplatable, nanoengineered materials for the realization of ultracompact power supplies. It is using these nanoengineered materials as the magnetic core of integrated inductors to produce multiwatt power supplies on a chip.

15. I have graduated approximately 50 PhD students and approximately 24 postdoctoral associates from the MSMA Group in the MEMS field, and, together with this group, I have published approximately 400 technical articles in the MEMS field. I also hold approximately sixty U.S. patents in the MEMS area.

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16. My research group's work has been cited approximately 31,000 times as estimated by Google Scholar.

17. In addition to the above, I have maintained my leadership position within the MEMS community. I was co-chair of the 2012 Power MEMS Conference and chair of the 2016 Solid State Sensors, Actuators, and Microsystems Conference ('Hilton Head'). In 2021, I chaired the IEEE PwrSoC ('Power Supply on a Chip') conference, sponsored in part by the IEEE Power Electronics Society.

18. I am an IEEE Fellow, with the citation "for contributions to micro and nanofabrication technologies for microelectromechanical systems."

19. I received the 2016 IEEE Daniel P. Noble award in emerging technologies, with the citation "[f]or contributions to research and development, clinical translation, and commercialization of biomedical microsystems."

20. I was elected to the U.S. National Academy of Inventors in 2017.

21. I was elected to the U.S. National Academy of Engineering in 2023.

22. Additional details are provided in my CV, attached as Ex. 1004.

III. DOCUMENTS CONSIDERED IN FORMING MY OPINIONS

23. In addition to the information identified above relating to my background and qualifications and elsewhere in this Declaration, in forming my opinions I have considered the following documents:

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Ex.	Description
1001	U.S. Patent No. 8,912,687 B2 (“’687 patent”)
1002	U.S. Patent No. 8,912,687 B2 File History (“’687 FH”)
1005	U.S. Patent Publication No. 2010/0036773 A1 (“Bennett”)
1006	U.S. Provisional Application No. 61/086,380 (“Bennett Provisional” or “BProv”)
1007	U.S. Patent Application Publication No. 2009/0299918 A1 (“Cook”)
1008	U.S. Patent Application Publication No. 2003/0115468 A1 (“Aull”)
1009	U.S. Patent No. 8,266,075 B2 (“Ambrosio”)
1010	U.S. Patent No. 7,602,143 B2 (“Capizzo”)
1011	U.S. Patent No. 8,547,069 B2 (“Jang”)
1012	U.S. Patent No. 5,462,439 (“Keith”)
1013	U.S. Patent No. 5,821,731 (“Kuki”)
1014	U.S. Patent No. 7,804,272 B2 (“Morita”)
1015	U.S. Patent No. 8,030,888 B2 (“Pandya”)
1016	H. Sakamota et al., <i>Large Air-Gap Coupler for Inductive Charger</i> , 35 IEEE Transactions on Magnetics 3526 (1999) (“Sakamoto”)
1017	Estill I. Green, <i>The Story of Q</i> , in 43 Am. Scientist 584 (1955) (“Story of Q”)
1018	Chwei-Sen Wang, <i>Design Considerations for Inductively Coupled Power Transfer Systems</i> (2004) (Ph.D. Thesis, Univ. of Auckland) (“Wang”)
1019	U.S. Patent No. 8,880,889 B1 (“Ward”)
1020	Frederick Emmons Terman, <i>Electronic and Radio Engineering</i> (4th ed. 1955) (“Terman”)

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Ex.	Description
1021	U.S. Patent No. 9,774,086 B2 (“Cook-086”)
1022	U.S. Patent No. 8,749,334 B2 (“Boys”)
1023	David H. Staelin et al., <i>Resonators</i> , in <i>Electromagnetic Waves</i> 336 (1994) (“Staelin”)
1024	U.S. Patent No. 5,745,574 (“Muftic”)
1025	U.S. Patent No. 5,815,573 (“Johnson”)
1026	U.S. Patent No. 6,240,187 B1 (“Lewis”)
1027	U.S. Patent No. 6,442,688 B1 (“Moses”)
1028	U.S. Patent No. 6,718,470 B1 (“Adams”)
1029	U.S. Patent No. 7,741,734 B2 (“Joannopoulos”)
1031	File History for Patent Application No. 13/789,860 (“13/789860 FH”)

IV. UNDERSTANDING OF LEGAL PRINCIPLES

A. Understanding of Legal Principles Relevant to Anticipation and Obviousness

24. I understand that a prior art reference can anticipate a patent claim when the prior art’s disclosure renders the recited claim elements not novel. I understand that in order to anticipate a patent claim, a prior art reference must teach each and every element of the claim, expressly or inherently, with the same arrangement as in the claims.

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25. In analyzing anticipation, I understand that it is important to consider the scope of the claims, the level of skill in the relevant art, and the scope and content of the prior art.

26. I understand that a prior art reference or combination of prior art references can render a patent claim obvious to one of ordinary skill in the art if the differences between the subject matter set forth in the patent claim and the prior art are such that the subject matter of the claim would have been obvious at the time the claimed invention was made.

27. I understand that the obviousness inquiry typically requires an analysis of whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue. I understand that there should be some kind of motivation so that one would understand why a person of ordinary skill would have thought of either combining two or more references or modifying one to achieve the patented invention.

28. I understand that when a POSA would be motivated to combine two references, the test for obviousness does not require that the features of a secondary reference be bodily incorporated into the structure of the primary reference. Put another way, I understand that a determination of obviousness based on teachings from multiple references does not require an actual, physical substitution of

elements. Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art.

29. In addition, there is no requirement that a combination only unite old elements without changing their respective functions. Rather, I understand that the obviousness framework permits, for example, modifying one reference and combining it with a second reference.

30. I understand that obviousness does not require absolute predictability of success when modifying or combining prior art elements. Rather, all that is required is a reasonable expectation of success.

31. I further understand that in an obviousness analysis, a reference is considered prior art whether or not it is enabled. Prior art patents and publications are presumed enabled, however, and a party challenging enablement of the prior art may only overcome that presumption with evidence that the practice of the invention would have required undue experimentation. The presumption of enablement in prior art patents applies to both the claimed and unclaimed disclosures.

32. In analyzing obviousness, I understand that it is important to consider the scope of the claims, the level of skill in the relevant art, the scope, and content of the prior art, the differences between the prior art and the claims, and any secondary considerations.

33. I understand that when the claimed subject matter involves combining pre-existing elements to yield no more than one would expect from such an arrangement, the combination is obvious. I also understand that in assessing whether a claim is obvious one must consider whether the claimed improvement is more than the predictable use of prior art elements according to their established functions. I understand that there need not be a precise teaching in the prior art directed to the specific subject matter of a claim because one can consider the inferences and creative steps that a person of skill in the art would employ. I further understand that a person of ordinary skill is a person of ordinary creativity, not an automaton.

34. I understand that obviousness cannot be based on the hindsight combination of components selectively culled from the prior art. I understand that in an obviousness analysis, neither the motivation nor the avowed purpose of the inventors controls the inquiry. Any need or problem known in the field at the time of the invention and addressed by the patent can provide a reason for combining elements, even if that reason is different from the reason(s) that subjectively led the inventor to make its claimed combination. For example, I understand that it is important to consider whether there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims. I understand that known techniques can have obvious uses beyond their

primary purposes, and that in many cases a person of ordinary skill can fit the teachings of multiple pieces of prior art together like pieces of a puzzle.

35. I understand that, when there is a reason to solve a problem and there is a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. I further understand that, if this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense, which bears on whether the claim would have been obvious.

36. I understand that secondary considerations can include, for example, evidence of commercial success of the invention, evidence of a long-felt need that was solved by an invention, evidence that others copied an invention, or evidence that an invention achieved a surprising or unexpected result. I further understand that such evidence must have a nexus, or causal relationship to the elements of a claim, in order to be relevant. I am unaware of any such secondary considerations for the '687 patent. To the extent that Patent Owner puts forth any secondary considerations in these IPRs, I reserve the right to rebut those considerations with rebuttal evidence.

B. Person of Ordinary Skill in the Art

37. I understand that a person of ordinary skill in the art (“POSA”) is a hypothetical person who is presumed to be aware of all pertinent art, possesses

conventional wisdom in the art, is a person of ordinary creativity, and has common sense. I understand that this hypothetical person is considered to have the normal skills and knowledge of a person in a certain technical field, including knowledge of known problems and desired features in the field.

38. I have been asked to focus my analysis on claims 1 through 18 of the '687 patent and prior art relating thereto from the perspective of such a person at the time of the alleged inventions. I understand that the '687 patent was filed on November 3, 2011, and claims priority to multiple provisional applications, the earliest of which was filed on September 27, 2008.

39. It is my opinion that a person of ordinary skill in the art in the 2008 to 2009 timeframe would have had at least a bachelor's degree in electrical engineering (or equivalent) and at least two years' industry experience or equivalent research in the field of wireless energy transfer. This description is approximate, and a higher level of education or skill might make up for less experience, and vice-versa.

40. As of either September 27, 2008, I would have had at least ordinary skill in the art. My opinions herein are informed by my own knowledge based on my personal experiences and observing others of various skill levels (including those above and below the level of a POSA).

41. My opinions below are not restricted to the precise definition of a POSA above. The claims of the '687 patent are directed to common wireless charging systems that were well-known in the art, for vehicles or otherwise, and were taught by numerous prior art references, including the references discussed below. Thus, my opinions below would apply under any reasonable definition of a POSA.

V. OVERVIEW OF THE '687 PATENT

A. Background

42. The '687 patent is entitled "Secure Wireless Energy Transfer For Vehicle Applications." '687 patent at Title. It was filed November 3, 2011, and issued December 16, 2014. It claims priority to multiple provisional applications, the earliest of which is dated September 27, 2008. '687 patent at 1:7-2:45. The '687 patent relates to systems for charging vehicles by securely and wirelessly transferring "non-radiative wireless power" from a first resonator to a second resonator. '687 patent at Abstract, 2:55-57, 3:36-39, cl. 1 at 229:42-46, cl. 7 at 230:6-13, cl. 13 at 230:46-50. The wireless power is securely transferred through an "authorization facility" that "confirm[s] compatibility of the resonators and provide[s] authorization for initiation of transfer of power." '687 patent at Abstract, cl. 1 at 229: 47-49, cl. 7 at 230 at 14-16, cl. 13 at 230 at 51-53. The '687 patent states as background that wireless energy transfer using "non-radiative, or near-

field, techniques” was already known. ’687 patent at 2:55-57 (“Energy or power may be transferred wirelessly using a variety of **known** radiative, or far field, and **non-radiative, or near-field, techniques.**”).¹ Those known near-field techniques, according to the ’687 patent, included “traditional induction schemes” that could transfer “modest to large amounts of power” wirelessly by “us[ing] an oscillating current passing through a primary coil, to generate an oscillating magnetic near-field that induces currents in a near-by receiving or secondary coil.” ’687 patent at 3:12-22.

1. Coupled Resonators

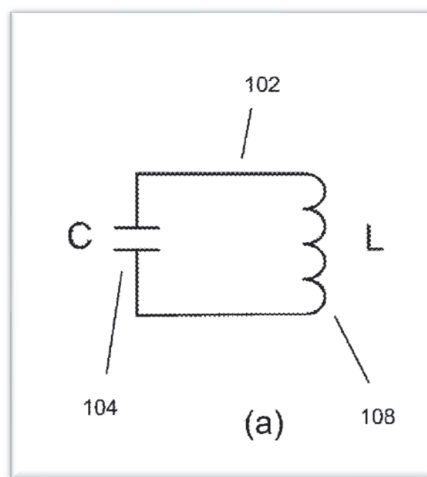
43. The ’687 patent states that, instead of traditional induction, its “inventive technique” for near-field wireless energy transfer uses “coupled electromagnetic resonators with long-lived oscillatory resonant modes to transfer power from a power supply to a power drain.” ’687 patent at 3:38-42. However, the use of “electromagnetic resonators” were already widely known, as were the use of electromagnetic resonators to transfer energy wirelessly through near-field magnetic coupling. For example, Dr. Frederick Terman’s seminal textbook *Electronic and Radio Engineering*, Fourth Edition (published in 1947), was directed to describing the “basic tools of the electronic and radio engineer.” Terman at Preface. Terman taught that resonant circuits were discussed in “every

¹ Throughout this declaration, all emphasis is added unless otherwise noted.

book on alternative currents” and that, even then, wireless energy transfer using magnetically coupled resonators was well understood. Terman at 45, 51. Indeed, Terman explains that “fundamental relations of a parallel resonant circuit,” such as those described in the ’687 patent, “are derived in every introductory book on a-c circuit theory.” Terman at 51; *see also* 63-77 (“Section 3-5. Behavior of Systems Involving Resonant Primary and Resonant Secondary Circuits”—describing energy transfer between mutually coupled resonators, the same wireless power transfer mechanism that the ’687 patent uses).

44. The ’687 patent does not purport to have invented novel resonator designs, stating that the described technique is “general and may be applied to a wide variety of resonators and resonant objects.” ’687 patent at 16:59-64. The ’687 patent then “describes the general technique” followed by “disclos[ing] electromagnetic examples for wireless energy transfer.” ’687 at patent 16:62-65.

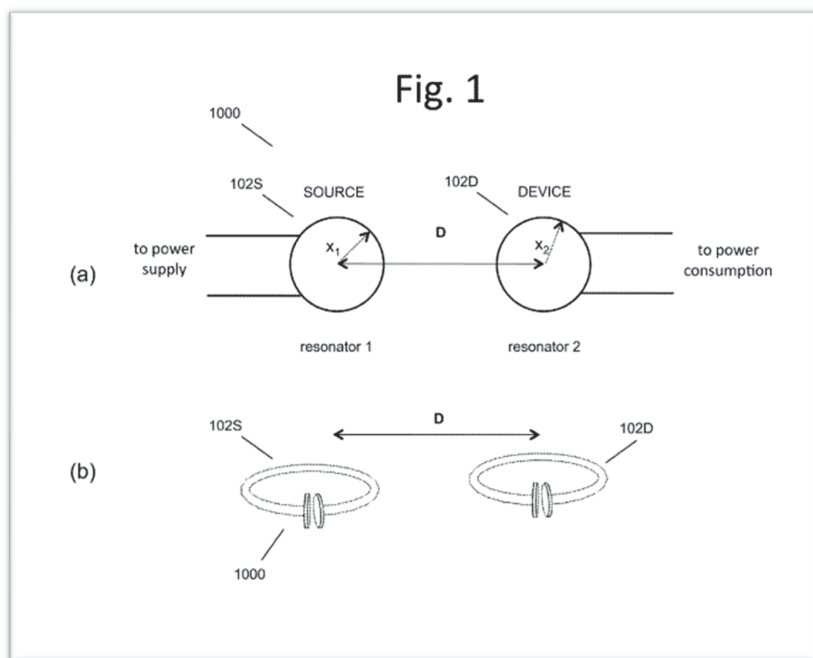
45. As the ’687 patent explained, and as was well known to a POSA, a “resonator” is “a system that can store energy in at least two different forms, and where the stored energy is oscillating between the two forms.” ’687 patent at 16:66-17:1. For example, a resonator can be formed from either a parallel or series connection of an inductor and a capacitor, as shown, for example, in Figure 6(a) below. ’687 patent at 8:36-43 (stating that Figure 6(a) “shows a circuit diagram” of one example of a resonator).



'687 patent at Fig. 6(a), 8:36-43. The '687 patent states that the inductance and capacitance can be separate “bulk circuit elements,” or the inductance and capacitance can be “distributed and may result from the way the conductors are formed, shaped, or positioned, in the structure.” '687 patent at 24:53-25:46.

46. As explained by the '687 patent, if a resonator is provided with an initial energy, that energy will oscillate between the capacitor and inductor as the “capacitor discharges transferring energy into magnetic field energy stored in the inductor 108 which in turn transfers energy back into electric field energy stored in the capacitor 104.” '687 patent at 24:21-26. The frequency at which energy would “continually be exchanged between the electric field in the capacitor 104 and the magnetic field in the inductor 108”—in the absence of any losses in the system—is referred to as the “resonant frequency.” '687 patent at 25:54-60.

47. The '687 patent also explained that, when a second resonator is located near a first source resonator, the two resonators may “interact and exchange energy” if they have “substantially the same resonant frequency.” '687 patent at 18:44-47. One manner in which energy could be exchanged is the “source” resonator generating an oscillating magnetic field, which induces a current in the inductor of the second resonator, causing energy to be wirelessly transferred to the second resonator over a distance D. If the “source” resonator is connected to an appropriately configured power supply, replenishing the energy transferred from the “source” resonator to the “device” resonator, the net result is that power can be transferred from the power supply to the “device” resonator, as shown in Figure 1 below.



'687 patent at 8:20-23 (stating that Figure 1 “depict[s] exemplary wireless power systems containing a source resonator 1 and device resonator 2 separated by a distance D.”).

2. Resonator Parameters

48. The '687 patent uses three parameters to describe the claimed resonators:

- Q – Quality Factor
- ω – Resonant Frequency
- Γ – Intrinsic Loss Rate

'687 patent at claims 1, 7, 13.

49. These parameters were well known, as I describe in more detail below.

a. Q – “Quality Factor”

50. The '687 patent states that its first “source” resonator has a “first Q-factor” and its second resonator has a “second Q-factor.” '687 patent at 6:30-40. It also describes these as “Q” values or “quality factors.” '687 patent at 17:26.

51. The '687 patent's claims similarly recite a “first electromagnetic resonator having” a first Q-factor and a “second electromagnetic resonator having” a second Q factor. '687 patent at cls. 1, 7, 13. The claims do not recite any particular values for the quality factors.

52. The patent explains that a resonator's quality factor “characterizes the energy decay” of the resonator and “is inversely proportional to these energy losses.” '687 patent at 17:26-28. A POSA would have understood that the '687 patent was not describing anything new; a POSA would have known that Q is a dimensionless constant that has been used to measure the “quality,” or losses, of resonators for decades and that a high Q value corresponds to low losses and therefore more efficient energy transfer in a resonator system. *See, e.g.,* The Story of Q at 584, 588 (describing Q as “ubiquitous” and definable “in terms of losses” for a resonator); Terman at 30 (“The most convenient way to express the merit of the coil is, however, in terms of the ratio of the reactance ωL of the coil to this

equivalent series resistance R . This ratio approximates the reciprocal of the coil power factor, and is usually referred to by the symbol Q ...”), 45 (“The characteristics of a series resonant circuit depend primarily upon the ratio of inductive reactance ωL to *circuit* resistance R , i.e., upon $\omega L/R$. This ratio is frequently denoted by the symbol Q and is called the circuit Q .”).

53. The ’687 patent does not state that a resonator having a “ Q ” is novel.

b. ω – “Resonant Frequency”

54. The ’687 patent states that the variable “ ω ” refers to the “angular resonant frequency” which “may be defined as $\omega=2\pi f$ ” where f is the “resonant (modal) frequency.” ’687 patent at 17:1-5. The ’687 patent further explains that “[t]his resonant frequency is the frequency at which the energy stored by the resonator oscillates between that stored by the electric field ... and that stored by the magnetic field ... of the resonator.” ’687 patent at 25:50-55.

55. The ’687 patent’s claims similarly recite a “first electromagnetic resonator having a mode with a resonant frequency ω_1 ” and a “second electromagnetic resonator having a mode with a resonant frequency ω_2 .” ’687 patent at cls. 1, 7, 13. The claims do not recite any particular values for the resonant frequencies.

56. Although each electromagnetic resonator has its own resonant frequency, the ’687 patent explains the disclosed systems preferably use resonators

that have matching resonant frequencies to maximize efficiency. '687 patent at 20:1-8.

57. The '687 patent states, as a POSA would know, that the resonant frequency of a resonator made of a capacitively loaded wire loop can be calculated as:

$$\omega = \frac{1}{\sqrt{LC}}$$

where L is the inductance of the wire that forms the loop and C is the capacitance to which it is connected. '687 patent at 20:58-21:3; Terman at 45 (defining resonant frequency using same equation as a “basic quantitative relation[]” for “series resonant circuits” that is “discussed in every book on alternating currents.”). The '687 patent also refers to the “resonant frequency” as the “characteristic” or “natural” frequency of a resonator that is “determined by its physical properties.” '687 patent at 25:47-50. As the language in the '687 patent implies, a POSA would have recognized that the resonant frequency described in the '687 patent is a fundamental property of resonators. For example, Staelin describes using the same variable “ ω ” to describe “discrete values called *resonant frequencies*.” Staelin at 336-37 (emphasis original); Terman at 44-45 (describing the “resonant frequency” as a “basic quantitative relation[]” of a resonator, which is “discussed in every book on alternating currents”).

58. The '687 patent does not state that a resonator having a “resonant frequency” is novel.

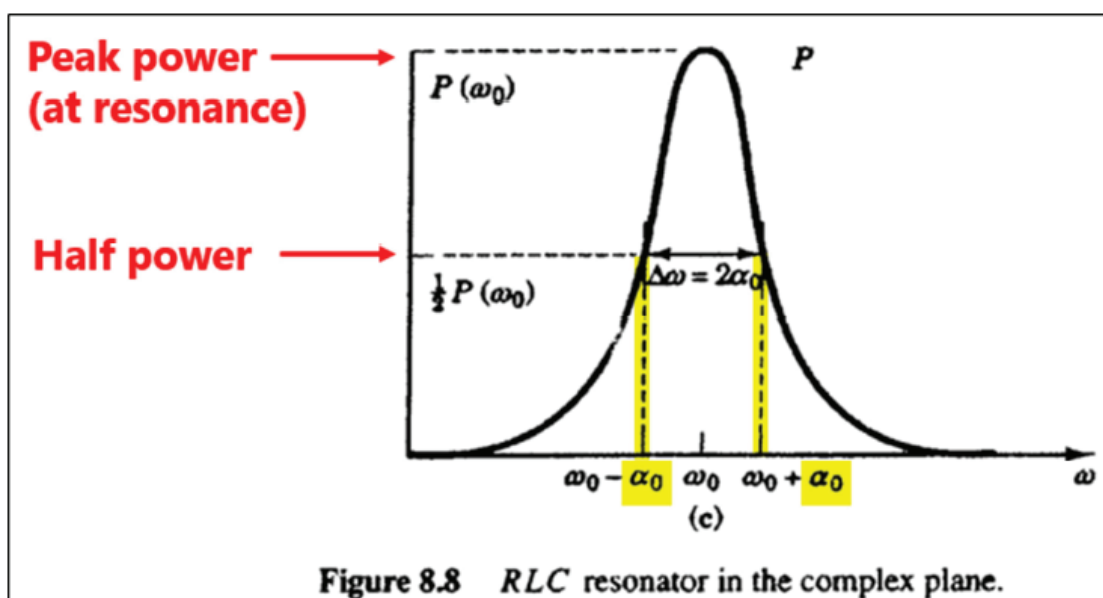
c. Γ – “Intrinsic-Loss Rate

59. The '687 patent states that the symbols Γ_1 and Γ_2 are the “intrinsic energy decay rates” of an electromagnetic resonator that are “given by the absorption (or resistive) losses and the radiation losses of the resonator.” '687 patent at 23:57-60; 26:12-15. The '687 patent states that the intrinsic loss rate is “inversely proportional” to Q because Q “characterizes the energy decay.” '687 patent at 26:12-30.

60. The '687 patent's claims similarly recite “a first electromagnetic resonator ... having ... an intrinsic loss rate Γ_1 ” and “a second electromagnetic resonator ... having ... an intrinsic loss rate Γ_2 .” '687 patent at cls. 1, 7, 13. The claims do not recite any particular values for the intrinsic loss rates.

61. The '687 patent states that “the intrinsic loss rate may be given by $\Gamma = (R_{\text{abs}} + R_{\text{rad}}) / 2L$, and the quality factor, Q , of the resonator is given by $Q = \omega / 2\Gamma$.” '687 patent at 27:50-52. Rearranging the formula for Q , which is the same formula recited in the '687 patent's independent claims, yields $\Gamma = \frac{\omega}{2Q}$. The '687 patent does not state that a resonator having an intrinsic loss rate is novel or that it is novel to describe a resonator as having losses. A POSA would have more commonly understood what the '687 patent calls an “intrinsic loss rate” as one half

of the the half power bandwidth of a resonator as I describe in greater detail with respects to Elements 13[b][iii] and 13[d][iii] below (“Intrinsic Loss Rate” of first and second resonator). Shown graphically, what the ’687 patent calls the “intrinsic loss rate” of a resonator is equal to α_0 below.



Staelin at 360 (annotated). A POSA would have recognized that the claimed variable “ 2Γ ” is equivalent to the “half-power bandwidth” of the resonator ($2\alpha_0$ above) which is the distance between the two angular frequencies at either side of the resonance curve at half power. So the “intrinsic loss rate” is one half of the half-power bandwidth, the frequency difference between the resonant frequency and a half power point, or α_0 shown graphically above. The half-power bandwidth is a metric that has been used to describe resonators for decades. *See, e.g., The Story of Q* at 588 (describing Q as “equal to the ratio of the resonant frequency to

the bandwidth between those frequencies on opposite sides of resonance (known as ‘half-power points’)).

3. Applications for Wireless Power Transfer

62. Following its description of the general technique of wireless power transfer, the ’687 patent describes a variety of potential applications that wireless power transfer could be useful for, which could include as examples:

placing a source (e.g. one connected to the wired electricity grid) on the ceiling, under the floor, or in the walls of a room, while devices such as robots, vehicles, computers, PDAs or similar are placed or move freely within the room. Other applications may include powering or recharging electric-engine vehicles, such as buses and/or hybrid cars and medical devices, such as wearable or implantable devices. Additional example applications include the ability to power or recharge autonomous electronics (e.g. laptops, cell-phones, portable music players, household robots, GPS navigation systems, displays, etc), sensors, industrial and manufacturing equipment, medical devices and monitors, home appliances and tools (e.g. lights, fans, drills, saws, heaters, displays, televisions, counter-top appliances, etc.), military devices, heated or illuminated clothing, communications and navigation equipment, including equipment built into vehicles, clothing and protective-wear such as helmets, body armor and vests, and the like, and the ability to transmit power to physically isolated devices such as to implanted medical devices, to hidden, buried, implanted or embedded sensors or tags, to and/or from roof-top solar panels to indoor distribution panels, and the like.

’687 patent at 6:6-29.

63. The patent begins describing these “Applications” in column 77. *See* ’687 patent at 77:54 onward. According to the ’687 patent, the claimed resonators need only “be sized and configured for the appropriate power levels for each

application[,] which may be more than 3 kW for a car charging system or may be 500 W for a robot charging system.” ’687 patent at 130:4-8. The ’687 patent concedes that a POSA would “understand” how to select the shape, size, and material composition for the resonators in each application:

FIG. 49 shows a source resonator 4904 that is physically separated from a power supply and a device resonator 4902 that is physically separated from the device 4900, in this illustration a laptop computer. Power may be supplied to the source resonator, and power may be taken from the device resonator directly, by an electrical connection. One of ordinary skill in the art will understand from the materials incorporated by reference that the shape, size, material composition, arrangement, position and orientation of the resonators above are provided by way of non-limiting example, and that a wide variation in any and all of these parameters could be supported by the disclosed technology for a variety of applications.

’687 patent at 77:1-13.

64. The ’687 patent also states that even small amounts of power can be sufficient to charge an electric vehicle, such as a “few kW transfer” overnight, and the disclosed resonators could provide this to “trickle charge” an electric vehicle battery. ’687 patent at 97:14-31, 98:4-11.

65. The ’687 patent states that “it will be understood by one of ordinary skill-in-the-art that there are a variety of ways that the resonator structures used to enable wireless power transmission may be connected or integrated with the objects that are supplying or being powered.” For example, in vehicle applications,

the source resonator can be placed “outside the vehicle,” and the device resonator can be “on, under, alongside, attached to, and the like, a vehicle, for charging the vehicle battery.” ’687 patent at 148:20-28, 205:19-25. There are no limitations on where the resonators may be placed; any location in, on, or around the car that permits battery charging is sufficient. ’687 patent at 86:22-34, 205:43-55, 212:33-46, cls. 1-20.

4. Authorization Facility

66. In addition to the claimed resonators and vehicle applications, the ’687 patent claims an authorization facility that “confirm[s] compatibility of the resonators and provide[s] authorization for initiation of transfer of power.” ’687 patent at Abstract; *see also* cls. 1, 7, 13. The ’687 patent states that “authentication capability” is not limited to vehicle applications and can apply to any “source and device” to “ensure that only compatible sources and devices are able to transmit and receive power,” such as those “that are part of a specific subscription or plan[.]” ’687 patent at 102:14-21. According to the ’687 patent, “[a]uthentication may be based on cryptographic request and respond protocols and secondary communication channels for authorization and authentication,” or it “may be based on the unique signatures of perturbations of specific devices allowing them to be used and authenticated based on properties similar to physically unclonable functions.” ’687 patent at 102:21-26.

67. The '687 patent does not elaborate on the implementation of security protocols. Rather, it notes that “[t]hose skilled in the art will appreciate a signaling and communication channel capable of transmitting messages may be secured with any number of encryption, authentication, and security algorithms.” ’687 patent at 184:10-13. One example the patent gives of “known security and cryptography protocols” that “may be used to authenticate and verify compatibility between resonators” is “a public key infrastructure (PKI).”

Those skilled in the art will appreciate a signaling and communication channel capable of transmitting messages may be secured with any number of encryption, authentication, and security algorithms. In embodiments the out-of-band communication may be encrypted and the secured communication channel may be used to transmit random sequences for verification using the in-band channel. In embodiments the in-band communication channel may be encrypted, randomized, or secured by any known security and cryptography protocols and algorithms. 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.

’687 patent at 184:16-23.

B. The Challenged Claims

68. The '687 patent has 18 claims. Claims 1, 7, and 13 are each independent. Every remaining claim depends from and therefore incorporates one of these three claims, either directly or indirectly.

69. My analysis in this Declaration focuses on all of the '687 patent's 18 claims, which I refer to as the "Challenged Claims." I have reproduced each of the Challenged Claims in Appendix A to this Declaration. For clarity, where a claim contains more than one element, I have added a bracketed label to each element in the claim. I refer to these label numbers throughout this specification.

70. The '687 patent's independent claims each describe the same system from different perspectives. Claim 13 covers a "vehicle wireless power system" generally, so I present that claim first. Claim 13 recites:

13[pre] A vehicle wireless power system, comprising:

[a] 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;

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

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

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

[e] 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

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

71. Independent claim 1 describes substantially the same wireless vehicle charging system from the perspective of the receiving device. It recites:

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

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

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

[d] 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

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

72. Finally, independent claim 7 describes substantially the same wireless vehicle charging system, this time from the perspective of the transmitting power source. It recites:

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

[a] 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;

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

[c] 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;

[d][i] the second electromagnetic resonator having [ii] a mode with a resonant frequency ω_2 , [iii] an intrinsic loss rate Γ_2 , and [iv] a second Q-factor $Q_2 = \omega_2 / 2\Gamma_2$; and

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

73. Independent claim 1 describes a wireless vehicle charging system from the perspective of the receiving device. Other than the preamble, claim 1 lists a subset of the elements in claim 13 regarding the structure and characteristics of the wireless power system, as I've shown in the table below.

Claim 1	Claim 13
1[pre] A vehicle powering wireless receiver for use with . . . the wireless receiver comprising	13[pre] A vehicle wireless power system, comprising:
1[a][i] a first electromagnetic resonator coupled to a power supply, the first electromagnetic resonator having	13[b][i] a first electromagnetic resonator coupled to the power supply and having
1[a][ii] a mode with a resonant frequency ω_1 ,	13[b][ii] a mode with a resonant frequency ω_1 ,
1[a][iii] an intrinsic loss rate Γ_1 , and	13[b][iii] an intrinsic loss rate Γ_1 , and
1[a][iv] a first Q-factor $Q_1=\omega_1/2\Gamma_1$;	13[b][iv] a first Q-factor $Q_1=\omega_1/2\Gamma_1$,
1[b] a load configured to power the drive system of a vehicle using electrical power;	13[c] a load configured to power the drive system of the vehicle using electrical power;
1[c][i] a second electromagnetic resonator adapted to be housed upon the vehicle and configured to be coupled to the load, the second electromagnetic resonator having	13[d][i] a second electromagnetic resonator adapted to be housed upon the vehicle and configured to be coupled to the load, the second electromagnetic resonator having
1[c][ii] a mode with a resonant frequency ω_2 ,	13[d][ii] a mode with a resonant frequency ω_2 ,
1[c][iii] an intrinsic loss rate Γ_2 , and	13[d][iii] an intrinsic loss rate Γ_2 , and
1[c][iv] a second Q-factor $Q_2=\omega_2/2\Gamma_2$;	13[d][iv] a second Q-factor $Q_2=\omega_2/2\Gamma_2$;
1[d] 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	13[e] 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
1[e] an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.	13[f] an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.

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74. Claim 7 describes substantially the same system as claim 13 but is written from the perspective of the transmitting power source. It claims, “a power source for wirelessly providing power to a wireless receiver” and further recites essentially the same elements to claim 13 regarding the structure and characteristics of the wireless power transfer system as I show in the table below:

Claim 7	Claim 13
7[pre] A power source for wirelessly providing power to a wireless receiver of an at least partially electrically powered vehicle, the power source comprising:	13[pre] A vehicle wireless power system, comprising:
7[a] 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;	13[a] 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;
7[b][i] a first electromagnetic resonator coupled to the power supply and having	13[b][i] a first electromagnetic resonator coupled to the power supply and having
7[b][ii] a mode with a resonant frequency ω_1 ,	13[b][ii] a mode with a resonant frequency ω_1 ,
7[b][iii] an intrinsic loss rate Γ_1 , and	13[b][iii] an intrinsic loss rate Γ_1 , and
7[b][iv] a first Q-factor $Q_1 = \omega_1 / 2\Gamma_1$,	13[b][iv] a first Q-factor $Q_1 = \omega_1 / 2\Gamma_1$,
7[b][v] the first electromagnetic resonator housed in a housing configured to be disposed in proximity to the vehicle;	13[b][v] the first electromagnetic resonator housed in a housing configured to be disposed in proximity to the vehicle;

Claim 7	Claim 13
7[c] 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,	13[c] a load configured to power the drive system of the vehicle using electrical power; 13[e] 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
7[d][i] the second electromagnetic resonator having	13[d][i] a second electromagnetic resonator adapted to be housed upon the vehicle and configured to be coupled to the load, the second electromagnetic resonator having
7[d][ii] a mode with a resonant frequency ω_2 ,	13[d][ii] a mode with a resonant frequency ω_2 ,
7[d][iii] an intrinsic loss rate Γ_2 , and	13[d][iii] an intrinsic loss rate Γ_2 , and
7[d][iv] a second Q-factor $Q_2 = \omega_2 / 2\Gamma_2$; and	13[d][iv] a second Q-factor $Q_2 = \omega_2 / 2\Gamma_2$;
7[e] an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.	13[f] an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.

75. As noted above, Element 7[c] maps to Elements 13[c] and 13[e] other than some minor wording differences that would be understood to have the same meaning. First, Element 7[c] and Element 13[e] above list the “coupling” of the first and second electromagnetic resonators in a different order. A POSA would understand that these Elements have the same meaning because the wireless coupling between the resonators is the same no matter which one is listed first.

Second, Element 7[c] refers to “a load *associated with* the drive system of the vehicle” whereas Element 13[c] recites “a load *configured to power* the drive system of the vehicle.” A POSA would understand that a load that is “configured to power” a drive system is also “associated with” that drive system, and thus a prior art reference that discloses Element 13[c] also discloses the corresponding portion of Element 7[c].

76. The '687 patent's dependent claims are also significantly overlapping. Indeed, the same set of dependent claims follows each independent claim because they recite identical language except for in each preamble, as I illustrate with the table below.

Claims depending from claim 1	Claims depending from claim 7	Claims depending from claim 13
2. The wireless receiver of claim 1, wherein the authorization facility uses public key infrastructure.	8. The power source of claim 7, wherein the authorization facility uses public key infrastructure.	14. The wireless power system of claim 13, wherein the authorization facility uses public key infrastructure.
3. The wireless receiver of claim 1, wherein the authorization facility uses a secure communication channel.	9. The power source of claim 7, wherein the authorization facility uses a secure communication channel.	15. The wireless power system of claim 13, wherein the authorization facility uses a secure communication channel.
4. The wireless receiver of claim 3, wherein the channel is an in-band communication channel.	10. The power source of claim 9, wherein the channel is an in-band communication channel.	16. The wireless power system of claim 15, wherein the channel is an in-band communication channel.

5. The wireless receiver of claim 3, wherein the channel is an out-of-band communication channel.	11. The power source of claim 9, wherein the channel is an out-of-band communication channel.	17. The wireless power system of claim 15, wherein the channel is an out-of-band communication channel.
6. The wireless receiver of claim 1, wherein the authorization facility further determines a safety condition for initiation of transfer of power.	12. The power source of claim 7, wherein the authorization facility further determines a safety condition for initiation of transfer of power.	18. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

C. Prosecution History

77. I have reviewed the file history of the '687 patent. (Ex. 1002, "'687 FH"). I understand that the Examiner allowed the claims in the application without a rejection. The applicant included Bennett and Cook in an Information Disclosure Statement, but the Examiner did not substantively comment on either one.

D. The '687 Patent's Priority Date

78. The '687 patent claims priority to 31 non-provisional patent applications and 29 provisional patent applications, the earliest of which is dated September 27, 2008. I have been informed by counsel that it is Patent Owner's burden to prove that the '687 patent claims are entitled to the benefit of an earlier filed application. Based on my review of the provisional applications that are cited in the '687 patent that were filed before April 24, 2009, those provisional applications do not support each and every limitation of the '687 patent claims.

79. In particular, each of the '687 patent's claims requires either directly or indirectly via dependency "an authorization facility to confirm compatibility of the resonators and to provide authorization for initiation of the transfer of power." Ex. 1001, '687 patent cl. 1, 7, 13. I did not find support for that element in at least the following provisional applications:

- No. 61/169,240 filed April 14, 2009
- No. 61/163,695 filed March 26, 2009
- No. 61/156,764 filed March 2, 2009
- No. 61/152,390 filed February 13, 2009
- No. 61/152,086 filed February 12, 2009
- No. 61/147,386 filed January 26, 2009
- No. 61/142,977 filed January 7, 2009
- No. 61/143,058 filed January 7, 2009
- No. 61/142,796 filed January 6, 2009
- No. 61/142,889 filed January 6, 2009
- No. 61/142,880 filed January 6, 2009
- No. 61/142,885 filed January 6, 2009
- No. 61/142,818 filed January 6, 2009
- No. 61/142,887 filed January 6, 2009
- No. 61/121,159 filed December 9, 2008

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- No. 61/108,743 filed October 27, 2008
- No. 61/100,721, filed September 27, 2008

80. Based on my review, the applications listed above do not describe or discuss the use of an authorization facility, and also do not appear to discuss authorization or authentication at all. I similarly found no support for the claim element “an authorization facility to confirm compatibility of the resonators and to provide authorization for initiation of the transfer of power,” which is an element of every single one of the Challenged Claims. To the extent that Patent Owner or its expert identifies support for those elements in the foregoing applications, I reserve the right to respond.

81. Nevertheless, my opinions below do not turn on any particular priority date, and they would be the same if the '687 patent could claim priority to its earliest listed provisional application in September 27, 2008, up through the actual November 3, 2011 filing date of the '687 patent.

VI. CLAIM CONSTRUCTION

82. In my analysis, I have applied the plain meaning of every term that appears in the Challenged Claims. The plain meaning is the meaning that a POSA would have understood the term to have at the relevant time in the context of the '687 patent. My analysis does not depend on any particular or precise construction.

Rather, the prior art that I discuss in this declaration disclosed the subject matter of the Challenged Claims under any reasonable construction of the claim terms.

VII. OVERVIEW OF THE PRIOR ART

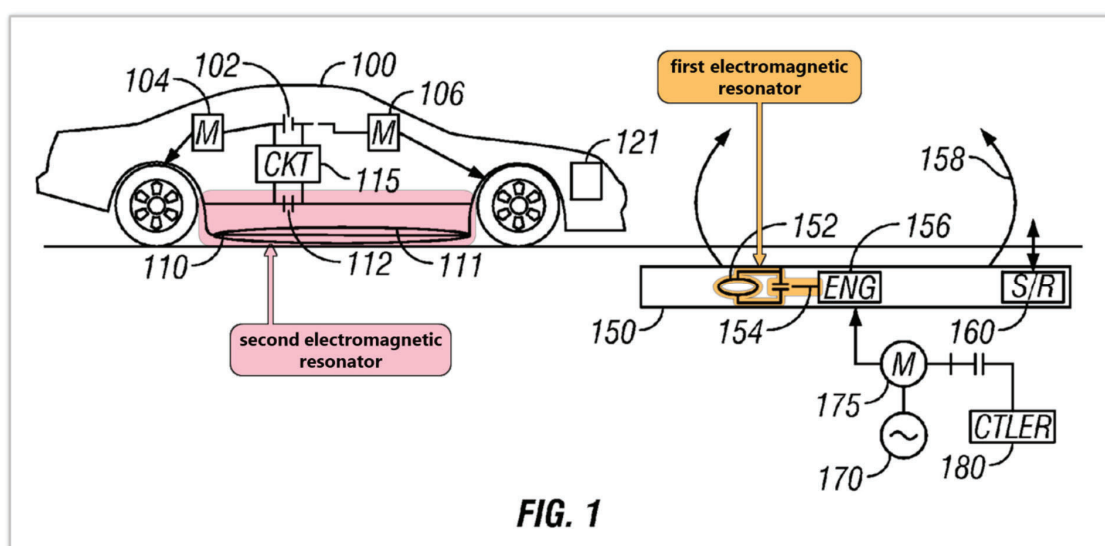
83. I have been informed that the documents described in this section constitute prior art to the '687 patent. I am not a lawyer, and I do not purport to be an expert in determining whether a document constitutes prior art.

A. Overview of Cook (Ex. 1007)

84. U.S. Patent Application Publication No. 2009/0299918 to Cook et al. ("Cook") was filed on May 28, 2008.

85. Cook is titled "Wireless Delivery of Power to a Mobile Powered Device." Cook at Title. Cook is like the '687 patent and describes "wireless delivery of power" using mutually coupled electromagnetic resonators. Cook at [0001, [0011], [0013], Fig. 1. More particularly, Cook explains that resonators can be used to charge the battery of an electric vehicle. As Cook explained, "[d]elivery of electric power to automobiles may become more prevalent as electrically powered automobiles enter and occupy a more significant portion of the market." Cook at [0006]. According to Cook, there were already pre-existing plug-in "vehicle charging stations," but they were "not a long-term practical solution." Cook at [0007].

86. Cook therefore proposes a wireless power delivery system to charge “an electric powered mobile device, such as an automobile.” Cook at [0008]. Cook taught that “the automobile” can include a receiving electromagnetic resonator, referred to as a “magnetic resonant antenna shown as 110 formed from an inductive loop 111 in parallel with a capacitor 112.” Cook at [0011]. The receiving electromagnetic resonator receives power from a transmitting electromagnetic resonator that can be placed in the ground within a “charger 150.” Cook at [0012]. The transmitting resonator includes “a coil 152, a capacitor 154, and a charging circuit 156 that produces signal of appropriate frequency for magnetic transmission.” Cook at [0012]. As shown in annotated Figure 1 below, the transmitting (first) electromagnetic resonator in the “charger 150” is in “the ground near a parking space,” and the second electromagnetic resonator for receiving wireless energy is mounted under the vehicle.



Cook at Fig. 1 (annotated). Cook taught that “whenever an appropriate vehicle comes into range of the magnetic field 158 it may receive power from that magnetic field, and hence be charged thereby.” Cook at [0013].

87. Cook also describes an authentication process in which the system detects an identification of a vehicle in charging range, determines whether the detected identification has an account, and verifies the identification to enable charging. Cook at [0015]. This can be used to monetize Cook’s wireless charging system. A meter “automatically keeps track of exactly how much power is delivered to the charging antenna.” Cook at [0015]. This allows the system to add a “premium over utility costs” because the “system is reselling power from the electricity manufacturer to any vehicle with an appropriate account that comes into range of the antenna.” Cook at [0016]. According to Cook, this ID-verification process can “use encryption techniques” such as “a real-time token type system.” Cook at [0017]. If using encryption, Cook explains, the vehicle has a private encryption key, and the controller has a decryption key to decrypt encrypted messages. Cook at [0017]. Cook taught that “[t]his cryptographically determines whether the power delivery is accurate by the controller 180,” and “[p]ower is allowed to be dispensed only if an encrypted value properly agrees with the proper encryption code and proper token time.” Cook at [0018].

88. In order to describe the “wireless transfer of power to a load” used by the Cook electric-vehicle charging system, Cook incorporates by reference U.S. Patent Application Publication No. 2008/0211321, now U.S. Patent No. 9,774,086, to Cook et al. (“Cook-086”). *See* Cook at [0001] (“For example, U.S. patent application Ser. No. 12/018,069, filed Jan. 22, 2008, entitled ‘Wireless Apparatus and Methods’, the disclosure of which is herewith incorporated by reference, describe [sic] wireless transfer of power to a load.”); Cook-086 at Cover element (21) (identifying the application number as “12/018,069”). A POSA would therefore have considered Cook-086’s disclosures as part of Cook’s disclosures. For example, Cook-086 provides specific equations that a POSA could use to implement Cook’s resonators used for charging vehicles. *See* Cook-086 at 1:41-42 (“Techniques of wireless power transfer are disclosed herein.”), 2:29-33 (“A receiver is associated with a small mobile unit or client device carried by the user, or mounted on a portable device, vehicle, or with a stationary device such as a lamp, toaster, flat-screen TV on a wall, computer or computerized device, PDA, personal media device, etc.”). Cook also described in Cook-086 that the same “transmitter” and “receiver” that could be used for powering electric vehicles would also be applicable to charging a myriad of other devices in other applications:

For example, other antenna forms and selections can be used. The term “power” as used herein can refer to any kind of energy, power or force transfer of any type. The receiving source can be any device that operates from stored energy, including a computer or peripheral, communicator, automobile, or any other device. **Myriad applications of the foregoing transmitter, receiver and transceiver apparatus of the invention are recognized.** By way of example and without limitation, such applications include: **(i) powering or charging portable computers. PMDs. client devices. cellular phones. etc.;** (ii) powering or charging flat screen or wall-mounted televisions or displays; (iii) powering or charging refrigerators (e.g., by placing a transmitter on the wall behind the refrigerator. and a receiver in the refrigerator proximate to the transmitter); **(iv) powering or charging electric cars; e.g., by placing or building in a transmitter in the floor of a garage, and placing a receiver on the bottom of the car;** (v) powering or charging home or office lighting: e.g., incandescent, fluorescent or LED, based lamps with no cords: (vi) powering or charging home or office appliances such as toasters, blenders, clocks, televisions, microwave ovens, printers, computers, etc.: (vii) powering or charging multiple devices simultaneously (e.g., through the use of a substantially omni-directional transmitter arrangement); and (viii) powering or charging devices where the presence of electrical conductors with voltage would represent a hazard; e.g., near water, near children, etc.

Cook-086 at 23:59-24:19.

89. This is substantively similar to the '687 patent's own statements that magnetically coupled resonators are general and can be applied in any number of different applications. '687 patent at 6:6-29.

B. Bennett (Ex. 1005)

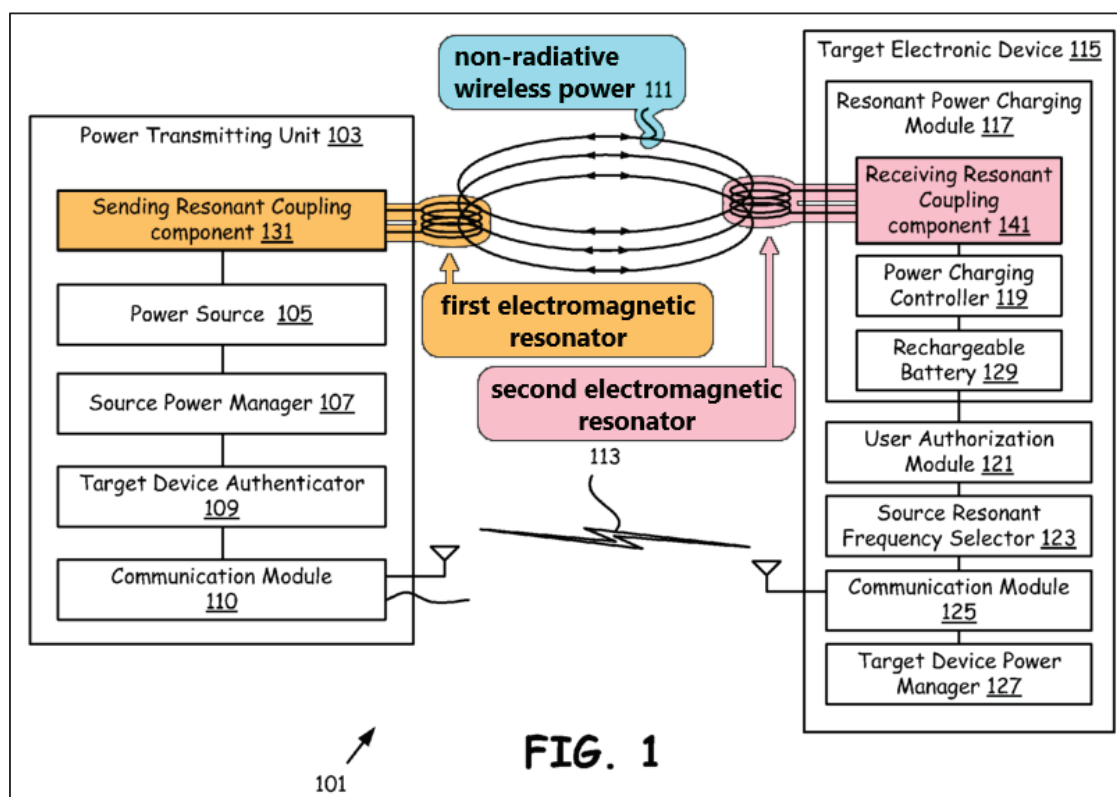
90. U.S. Patent Application Publication No. 2010/0036773 to Bennett ("Bennett") was filed on September 30, 2008.

1. Overview

91. Bennett is titled "Integrated Wireless Resonant Power Charging and Communication Channel." Bennett at Title; BProv at Title ("Integrated Resonant Power Charging and Communication Channel"). Like Cook and the '687 patent, Bennett generally describes "[a] power delivery system [to] wirelessly deliver power and a communication signal to a target device." Bennett at Abstract; BProv at 34:1-15. Bennett also explains that its system permits "power transfer" from "a power transmitting unit and a target device" via "magnetic coupling," just like both Cook and the '687 patent. Bennett at [0024]; BProv at 7:8-15.

92. As I've annotated in Figure 1 below, the power transmitting unit includes a first electromagnetic resonator that Bennett refers to as a "sending resonant coupling component." Bennett at [0030]; BProv at 9:6-20. It includes a "resonant coil that fills the space around it with a non-radiated magnetic field oscillating at the target resonant frequency." Bennett at [0030]; BProv at 9:6-20.

The target electronic device has a second electromagnetic resonator for receiving the non-radiated magnetic field from the source resonator. Bennett at [0030]; BProv at 9:6-20. The second electromagnetic resonator is referred to as a “receiving resonant coupling component” and includes a “resonating coil and associated tuning elements such as capacitors.” Bennett at [0034]; BProv at 10:21-11:2.



Bennett at Fig. 1 (annotated), [0030]; BProv at Fig. 1 (same as Bennett Fig. 1), BProv at 9:6-20.

93. Bennett also describes a similar embodiment with respect to Figure 2, where transmitting and receiving resonators are referred to as “magnetic resonant

power charging circuitry,” and the resonant magnetic field of the transmitting resonator can be used to “transmit power to multiple target devices.” Bennett [0048], [0060]-[0061]. Fig. 2; BProv Fig. 2, 14:1-11, 17:21-18:16.

94. Bennett’s sending and receiving coupling components are electromagnetic resonators, and more specifically magnetic resonators that transmit and receive energy through their magnetic fields. *See* ’687 patent 3:39-59 (stating that a “magnetic resonator” may “also be referred to as an electromagnetic resonator”). Bennett taught that the sending resonant coupling component “generate[s] magnetic fields that are used to transmit power to the target devices” and that “[t]ypically, the sending resonant coupling component 113 includes a resonant coil that fills the space around it with a non-radiated magnetic field oscillating at the target resonant frequency that is received by the target electronic device 115 employing the receiving resonant coupling component 141.” Bennett at [0030]; BProv at 9:6-20. During resonant power transfer, the power transmitting unit and the target electronic device are “communicatively coupled with each other.” Bennett at [0031]; BProv at 9:21-10:11.

95. Bennett explains that “[t]he power transmitting unit 103 includes a power source 105 capable of generating power for power transmission.” Bennett at [0029]; BProv at 8:16-9:5. The power transmitting unit also includes “a sending resonant coupling component 131 capable of power transmission employing

magnetic waves 111, such as a non-radiated magnetic field waves of a specific target resonant frequency.” Bennett at [0029]; BProv at 8:16-9:5. A target electronic device 115 includes a resonant power charging module 117 that “includes a receiving resonant coupling component 141, a power charging controller 119, and a rechargeable battery 120.” Bennett at [0030]; BProv at 9:6-20. Bennett explains that the receiving resonant coupling component “is used to receive the power transmissions provided by the power transmitting unit 113 employing the target resonant frequency.” Bennett at [0030]; BProv at 9:6-20. The received power charges the battery. Bennett at [0030]; BProv at 9:6-20 (“The target electronic device 115 employs the received power for ... charging the rechargeable battery 129.”).

96. Bennett further taught that a “user authorization module 121 facilitates authentication of the target electronic device 115, for resonant power delivery, with the target device authenticator 109 of the power transmitting unit 103.” Bennett at [0037]; BProv at 11:18-12:5. Bennett explains that the user authorization module exchanges authentication information with the power transmitting unit, which compares that information with a subscriber database. Bennett at [0037]; BProv at 11:18-12:5. Resonant power delivery is initiated if the information matches. Bennett at [0037]; BProv at 11:18-12:5. Bennett also explains how to implement a communication link in a magnetic resonant wireless

charging system, where the communication link can be used for authorizing power transfer and other compatibility and safety checks between the resonators, including transmitting information in the same or different frequency channels as the magnetic field used for power transfer, and securing those communications using token and key based encryption. Bennett [0031], [0042], [0060]-[0063], [0076]; BProv 9:21-10:11, 13:14-22, 17:21-19:6, 22:15-19.

97. Bennett generally applies to any “electronic device that runs on a portable rechargeable battery embedded in it.” Bennett at [0022]; BProv at 6:18-7:3 (stating there is a “target device i.e. [sic] the gadget having rechargeable battery in it.”). Because electric cars were one type of electric device running on a portable rechargeable battery embedded in it, one could read Bennett and recognize that its principles could be used for an electric car charger too, such as in Cook, as I explain in more detail below.

2. The Bennett Provisional Supports Bennett’s Claim 14

98. Counsel has asked me to analyze whether the disclosures in the Bennett Provisional provide support for at least one claim in the published Bennett application. As I explain below, it is my opinion that the Bennett Provisional supports at least Bennett’s claim 14.

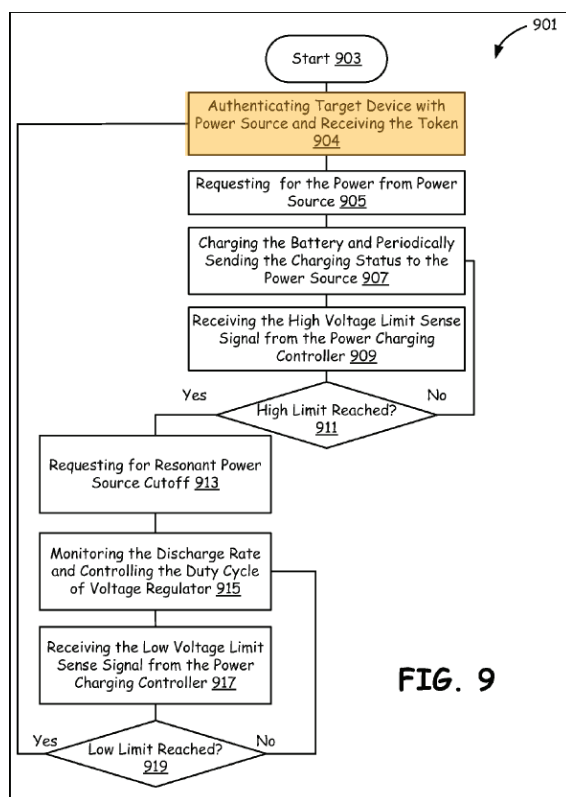
a. 14[pre] Preamble

99. The preamble of Bennett’s claim 14 recites “[a] method performed by a rechargeable electronic device comprising a rechargeable battery.” The Bennett Provisional taught this preamble. For example, the Bennett Provisional disclosed “[a] rechargeable electronic device, such as the target electronic device, typically comprises the rechargeable battery 129.” BProv at 13:14-15; *see also id.* Figs. 1-3. The Bennett Provisional explains that “[t]he present invention relates generally to charging a rechargeable battery of an electronic gadget” and that “the present invention deals with the battery power charging in-situ from a remote power source (station).” BProv at 1:7-8, 6:19-21. A POSA would therefore have understood that the Bennett Provisional disclosed a “method performed by a rechargeable electronic device comprising a rechargeable battery.”

b. 14[a] Authentication

100. Bennett’s claim 14 also recites “authenticating with a power transmitting unit including receiving a token from the power transmitting unit.” The Bennett Provisional taught this claim element. It disclosed that “[t]he rechargeable electronic device authenticates with the power transmitting unit 103 and receives a token that is used for subsequent communication and power charging (in one or more charging sessions).” BProv at 13:15-17. The flow chart in the Bennett Provisional’s Figure 9, which illustrates actions performed by the

target device power manager and which I reproduce and annotate below, includes a step 904 labeled “Authenticating Target Device with Power Source and Receiving the Token”:



BProv at Fig. 9. Additional relevant disclosures in BProv are available at 17-18 (further describing token exchange), Fig. 1 (a block diagram of a “wireless power delivery system,” per 4:2-4), Fig. 3 (a flowchart showing the resonant power transfer operation performed using the power system of FIG. 1, per 4:8-10), and Fig. 4 (a block diagram of magnetic resonant power charging circuitry, per 4:11-13).

101. A POSA would therefore have understood that the Bennett Provisional describes “authenticating with a power transmitting unit including receiving a token from the power transmitting unit.”

c. 14[b] Power Transmission By A Non-Radiated Magnetic Field

102. Bennett’s claim 14 also recites “requesting power transmission by a non-radiated magnetic field from the power transmitting unit.” The Bennett Provisional taught this claim element. According to the Bennett Provisional, “[t]he rechargeable electronic device requests the power transmission unit 103 for power, with the power to be transmitted employing non-radiated magnetic field waves of a target frequency.” BProv at 13:17-19. Figure 3 in the Bennett Provisional, which illustrates steps performed by the target electronic device, includes a step 305 in which the target devices “[c]ommunicates [a r]equest for [r]esonant [p]ower.” BProv at Fig. 3. And the provisional further taught that “[t]he present invention ... provides a power transmission unit that employs magnetic means, such as non-radiated magnetic field waves of a target frequency, to power remote devices.” BProv 6:8-15; *see also* 21:7-15 (further describing use of non-radiated magnetic fields), Fig. 9. A POSA would therefore have understood that the Bennett Provisional describes “requesting power transmission by a non-radiated magnetic field from the power transmitting unit.”

d. 14[c] Power Transfer At The Target Resonant Frequency

103. Bennett's claim 14 also recites "receiving power non-radiated magnetic field at the target resonant frequency from the power transmitting unit." The Bennett Provisional taught this claim element. It disclosed that "[t]he rechargeable electronic device 115 receives power transmitting over non-radiated magnetic field waves of the target resonant frequency from the power transmission unit 103." BProv at 13:20-21. Figure 3 includes a step 311 in which "[r]esonant [f]requency [p]ower is [d]elivered." BProv at Fig. 3; *see also* Fig. 1. Additional disclosures similarly describe power transmission from the power transmission unit to the target electronic device, including 8:20-22 ("The power delivery system 101 comprises the power transmitting unit 103, the target electronic device 115, and other target devices capable of receiving power being transmitted"), 10:21-22 (which explains that a "resonant power charging module 117 of the target electronic device" acts as receiving hardware), and 12:6-7 ("The source resonant frequency selector 123 provides a tuning mechanism in order to achieve the required resonant coupling effect"). The Bennett Provisional also describes a "source resonant frequency selector" that "provides a tuning mechanism in order to achieve the required resonant coupling effect," which a POSA would recognize results in transmitting power at a selected target resonant frequency. BProv at 12:6-7. Accordingly, a POSA would have understood that the Bennett Provisional

describes “receiving power non-radiated magnetic field at the target resonant frequency from the power transmitting unit.”

e. 14[d] Recharging A Battery

104. Finally, Bennett’s claim 14 recites “recharging a rechargeable battery of the rechargeable electronic device.” The Bennett Provisional taught this claim element. The Bennett Provisional disclosed that “[a] rechargeable electronic device, such as the target electronic device, typically comprises the rechargeable battery 129.” BProv at 13:14-15. That “rechargeable electronic device 115 receives power transmitted over non-radiated magnetic field waves of the target frequency from the power transmission unit 103,” which “recharges the rechargeable battery 129 of the rechargeable electronic device 115.” BProv at 13:20-22; *see also* Figs. 1, 3. The Bennett Provisional also taught the specific mechanism of that recharging, explaining that “voltage multipliers in the resonant power charging module 117 builds up the required voltage across a capacitor array to achieve the recharging of the rechargeable battery 129 of the target electronic device 115.” BProv at 11:9-13. Accordingly, a POSA would have understood that the Bennett Provisional describes “recharging a rechargeable battery of the rechargeable electronic device.”

* * *

105. It is therefore my opinion that the Bennett Provisional supports at least Bennett Claim 14. I also note that the relevant portions of Bennett Provisional's disclosures were generally carried forward into Bennett, as I illustrate by citing to both Bennett and the Bennett Provisional throughout this declaration. To the extent that it is not immediately apparent that the same disclosures were carried forward, I've explained the relevant differences below.

VIII. CLAIMS 1-18 ARE OBVIOUS OVER COOK IN VIEW OF BENNETT

106. It is my opinion that Cook and Bennett, in combination, taught or suggested each and every claim element as arranged in the Challenged Claims and, therefore, rendered those claims obvious.

A. Motivation to Combine Cook and Bennett

107. As discussed below, a POSA would have been motivated to look to Cook and Bennett in combination, including to apply Bennett's teachings regarding wireless communication links, frequency tuning, and battery level monitoring to Cook's system for wirelessly charging electric vehicles.

108. Initially, it is my opinion that Cook and Bennett are both directed to the same field of endeavor, i.e., wireless power transfer between magnetically coupled resonators, which is also the same field of endeavor as the '687 patent. Both references taught wireless power transfer to electronic devices by non-

radiative magnetic field waves using electromagnetic resonators, the same mechanism that the '687 patent describes.

109. For example, Cook describes wireless delivery of power to an electrically powered automobile by “forming a magnetic field and receiving a magnetic field in a resonant antenna that is resonant with at least one characteristic of a magnetic field.” Cook at [0001] (“Wireless delivery of power may be used to provide power to a load.”), [0002] (“The present application describes wireless delivery of power to a mobile powered device such as an automobile.”), [0008] (“The inventors also recognize that it may be desirable to wirelessly deliver power to an electric powered mobile device, such as an automobile.”), [0011]-[0013] (describing the specifics of wireless power delivery between a charger 150 and a magnetic resonant antenna 110 mounted on a vehicle), Fig. 1 (illustrating the charging system).

110. Similarly, Bennett disclosed a system for delivering wireless power from a source resonator to a second resonator using “near field wireless resonance power delivery” using “magnetic waves.” Bennett at Abstract, [0003] (“The present invention relates ... particularly to techniques for near field wireless resonance power delivery to a target device”), [0010] (“FIG. 1 is a block diagram illustrating a wireless power delivery system that includes a power transmitting unit and a target electronic device, wherein power is delivered wirelessly

employing magnetic waves.”), [0021]-[0022] (describing the principles of wireless charging), [0029]-[0030] (providing detailed information about the power transmitting unit 103 and the target electronic device 115), Fig. 1 (illustrating the wireless charging system); BProv at 1:6-8, 4:2-3, 6:2-7:3, 8:16, 9:20, 34:1-15 (Abstract), Fig. 1.

111. The '687 patent likewise describes the same mechanism for wireless energy transfer as Cook and Bennett, i.e., using coupled magnetic resonators to wirelessly transfer power in the near field. '687 patent at Abstract, 2:53-54 (“This disclosure relates to wireless energy transfer, also referred to as wireless power transmission.”), 3:36-44 (“There is disclosed herein a non-radiative or near-field wireless energy transfer scheme that is capable of transmitting useful amounts of power over mid-range distances and alignment offsets.”), 3:48-49 (“the energy exchange is mediated primarily by the resonant magnetic near-field.”), 3:60-65 (“The omni-direction but stationary (non-lossy) nature of the near-fields of the resonators we disclose enables efficient wireless energy transfer...”).

112. A POSA implementing a wireless power transfer system also would have thought to look to Cook and Bennett in combination because they have common goals in terms of monetization of a wireless power transfer system and ways of achieving those goals. For example, Cook explained how a wireless power system could charge for electricity by initiating power transfer only for authorized

vehicles and that “[a] premium over utility costs may also be added to the bill” such that the “system is reselling power from the electricity manufacturer[] to any vehicle with an appropriate account that comes into range of the antenna.” Cook [0016]. Bennett likewise explains enabling a provider of electrical power to authorize wireless energy transfer only to subscribers and to bill those subscribers based on the amount of power delivered. Bennett [0052], [0059], [0069]; BProv 15:12-18, 17:15-20, 20:18-23.

113. A POSA could have built Cook’s wireless vehicle charging system in view of Bennett’s frequency control and communications systems because (1) Bennett’s dynamic frequency tuning would make Cook’s charger more versatile, (2) Bennett provides details for how to implement a communication system in a magnetic resonance power transfer system that Cook lacks, (3) the token-based system Bennett describes is a more detailed explanation of the cryptographic disclosures in Cook, and (4) Bennett’s high and low voltage battery sensing before initiating power transfer would improve safety in Cook’s vehicle charging system.

114. First, a POSA would have recognized that Bennett’s dynamic tuning capabilities would drastically improve the usefulness of Cook’s wireless charger because it would allow the charger to interface with multiple different types of vehicles and associated antennas. Cook itself recognized that different cars could

have resonators tuned to different frequencies, stating that chargers can only provide power to “wireless charging circuits of appropriate type, e.g. the right frequency.” Cook at [0012]. And Cook-086 (incorporated by reference in Cook) pointed out that “[d]ifferent frequencies will require different capacitance values for resonance with th[e] antenna.” Cook-086 at 7:44-56. In Cook, however, the charger is depicted as having a fixed capacitor with a single resonant frequency. Cook at Fig. 1. A POSA would have understood that it would be more effective for a public charging station as contemplated by Cook to instead be generally applicable to multiple target vehicles tuned to different frequencies. *See* Cook at [0012] (automobiles in the system receive power only at “wireless charging circuits of appropriate type, e.g. the right frequency”); Cook-086 at 7:44-56 (describing transmitting antennas at different resonant frequencies). This would have led a POSA to Bennett, which taught dynamic frequency tuning. Specifically, Bennett taught a “power transmitting unit 103 [that] is capable of dynamically tuning the power transmission to the target resonant frequency associated with the target electronic device 115, wherein the target resonant frequency is specified dynamically.” Bennett at [0029]; BProv at 8:16-9:5. Bennett’s system also ensured that the device and the charger were compatible. Bennett at [0039] (describing “[a] power control signal exchange operation” occurring “before a successful resonant power deliver”); BProv at 12:11-20. Those capabilities, when implemented in

Cook's charger, would have resulted in a more effective system for distributing power wirelessly to multiple vehicle types and a broader range of wireless power receiving resonators.

115. Second, Cook generally described “a send and receive portion 160 that wirelessly detects a unique identifier indicative of the vehicle 100,” indicating some sort of communication link between the vehicle resonator and the charger resonator. Cook at [0014]. Cook similarly taught that the charger and the vehicle exchange encrypted data. Cook at [0017]-[0018]. Cook did not, however, describe the communication link used by the vehicle Charging system, including how the charging system would transmit communication signals near a system that is also used to transmit wireless power without interference between the two sets of signals (communication and power). A POSA would have looked to Bennett for those implementation details.

116. Bennett explained how encrypted control signals used for authenticating a target electronic device and initiating power transfer in a magnetic resonant charging system could “employ[] the same frequency” as the “power” signal, or “the power link (such as the magnetic field), the control signal, and the normal communication (i.e. the normal function) operation takes place in separate channels.” Bennett [0031], [0043], [0070] (“receives power on a single frequency

on a wireless power & communication channel 111”), [0084], Fig. 6; BProv 8:16-9:5, 9:21-10:11, 20:1-6, 25:9-15, Fig. 6.

117. Bennett’s alternative communication channels would provide flexibility for Cook’s system. For example, for applications where the quality factor of the resonators needs to be preserved and should be as high as possible, the out-of-band communication channel could be used. Bennett at [0084]; BProv at 25:9-15 (noting that an in-band communication configuration “will disturb the resonant tuning of target device by lowering the quality factor”). Alternatively, a POSA seeking to reduce the number of components could have used an in-band communication channel. Bennett at [0031], [0084]; BProv at 9:21-10:11, 25:9-15; Cook-086 at 18:39-46 (“in one embodiment, the (predominantly) magnetic field of the transmitter is modulated or impressed with information so as to transfer information, along with power . . . thereby obviating any separate data or communications link (and hence simplifying the system and making it more robust).”).

118. Third, Cook taught that an electric vehicle to be charged and the charger used to charge it would exchange information for identification and billing purposes and that those signals may need to be provided in a secure way: “[a]nother embodiment may ... use encryption techniques to verify the ID.” Cook at [0017]. While Cook provided some details for how encryption could be implemented using

“tokens” and “keys” (Cook at [0017]-[0018]), Bennett described how those tokens and keys could actually be generated. *See* Bennett at [0042] (“The rechargeable electronic device authenticates with the power transmitting unit [] and receives a token that is used for subsequent communication and power charging (in one or more charging sessions).”); BProv at 13:14-22. Bennett described “a token generator” residing in the power transmitting unit; that token generator “may include a pseudorandom number generator operable to generate the token,” and the system delivers the token “to the target device during a target device registration operation,” permitting the power transmitting unit to authenticate the target device. Bennett at [0046], [0062]; BProv at 17:21-18:5 (“The magnetic resonant power charging circuitry 403 [] comprises a token generator 407.”), 18:17-23 (describing a pseudo random number generator), 31:8-19 (“claiming a “token generator”). Bennett also explains how the target electronic device (e.g., Cook’s vehicle) would decrypt the generated token. Bennett at [0062]-[0063]; BProv at 18:17-19:6.

119. Fourth, a POSA would have been motivated to modify Cook in view of Bennett to monitor Cook’s electric vehicle battery levels for safety reasons. Cook taught automatic wireless charging of electric vehicle batteries when the electric vehicle is in range of an appropriate transmitter. Cook at [0011]-[0012]. Cook did not expressly discuss any mechanism for ensuring that the wireless electric vehicle could or should be charged or that it would be safe to do so. This

would have been important to a POSA implementing Cook's system because electric vehicles had high-capacity batteries, which were often made from lithium-ion batteries, which had a known problem that overcharging could cause internal pressure of the battery and risk causing explosions or fires. Jang at 1:33-54; Bennett at [0036] ("The high voltage limit protects the battery"); BProv at 11:9-17. A POSA would have therefore looked to Bennett, which provided battery level monitoring including to determine whether the battery level of a target device for wireless charging was below a preset/threshold level as a condition for initiating transfer of power. Bennett at [0075]; *see also* [0076] ("The low voltage sensor 621 monitor the low voltage limit of the rechargeable battery and the high voltage sensor 623 monitor the high voltage limit."), [0077] (describing the components of the "target device magnetic resonant power charging module," including "a magnetic resonant target device authentication module" and "a magnetic resonant battery charging circuit"), [0082] (describing operation of low- and high-voltage limits); BProv at 11:9-17 ("The high voltage limit protects the battery"), 22:10-14 ("When the voltage falls below a preset value the power request module 611 communicates with the power source 203"), 22:15-19 ("The low voltage sensor 621 monitor the low voltage limit of the rechargeable battery and the high voltage sensor 623 monitor the high voltage limit."), 22:20-23:5 ("a magnetic resonant target device authentication module 707, a magnetic resonant frequency seeking

module 709, a magnetic resonant battery charging circuit 711”). As Bennett explained, this would help “maintain the rechargeable battery charge” of Cook’s electric vehicle “at a safer limit.” Bennett at [0076]; BProv at 22:15-19.

120. A POSA would have had a reasonable expectation of success in combining Bennett and Cook as described above. As I already explained above, Cook and Bennett described similar systems (transferring wireless power transfer from a source to a device using magnetic resonance) using similar components (a first resonant antenna coupled to a source that transmits power, and a second resonant antenna for receiving power and charging a battery), used for the same purpose of charging a rechargeable battery. *See, e.g.*, Sections VII.A., VII.B.1; *see* Cook at [0011] (“[W]hen the antenna 110 comes into range of an appropriate transmitter, it receives a magnetic signal from that transmitter, and the receiving circuit 115 converts that power into output current.”); Bennett at [0025] (“Magnetic signals/fields created by the power source are received by an antenna/coil of the target device.”); BProv at 7:16-22. Although Bennett referred to receiving wireless power at a “target electronic device” with batteries like a laptop or phone, and Cook’s receiver was the battery of an electric vehicle, a POSA would have understood that those are merely “battery powered device” applications that could benefit for wireless power delivery using similar systems. Bennett at [0005], [0021]; Cook at [0009]-[0012]; BProv at 1:10-20, 6:2-17.

121. Indeed, a POSA would have understood this from Cook-086 (incorporated by reference in Cook), which explained that the “receiving device” for wireless power transfer can be “any device that operates from stored energy.” Cook-086 at 23:59-64; *see also* Bennett at [0005] (“All electronic devices require electrical power to operate”); BProv at 1:2-17. As Cook-086 taught, and as a POSA would have known, the same general system having a resonant “transmitter” and resonant “receiver” in a magnetically coupled system could be used for applications involving “powering or charging portable computers, PMD’s, client devices, cellular phones” and “powering or charging electric cars.” Cook-086 at 23:64-24:10. Bennett included similar teachings, describing its system as general and useful for “near field wireless resonance power delivery to a target device,” where the target device is a “battery powered device.” Bennett at [0003]; BProv at 1: 2-17 (“The present invention relates generally to charging a rechargeable battery of an electronic gadget without interrupting its normal functionality.”). A POSA therefore would have reasonably expected that Bennett’s system would be compatible with Cook’s, and Cook’s system compatible with Bennett’s, because “an automobile” is a type of “mobile powered device” that can receive “wireless delivery of power.” Cook at [0002]; Bennett at [0003], [0005]; BProv at 1:6-7, 1:10-20.

122. Another factor demonstrating Bennett's compatibility with Cook's charger is the subscription and billing system Bennett described. Bennett taught a system that only authorizes wireless power transfer to subscribers, who it can bill for the power delivered. Bennett at [0052] ("The confirmation of the user's subscription is conducted by comparing information available within the target device authenticator 209 (or a database maintained or accessed by it) with the information provided by the user authorization module 219."), [0059] (describing "metering and subsequent billing"), [0069] ("The target device power metering circuitry 511 records the resonant power delivered to the target device 115, 211."); BProv at 15:12-18, 17:15-20, 20:18-23. Cook similarly describes a system that charges "[a] premium over utility costs" because the "system is reselling power from the electricity manufacturer[] to any vehicle with an appropriate account that comes in range of the antenna." Cook at [0016]. A POSA would therefore have reasonably expected that Bennett's subscription-based system could be combined with Cook's electric car charger.

123. Accordingly, a POSA could have and would have implemented Bennett's system to wirelessly charge electric cars, as taught in Cook.

B. Independent Claim 13 Is Obvious In View of Cook and Bennett

1. Element 13[pre]: Preamble

124. The preamble to claim 13 recites "A vehicle wireless power system."

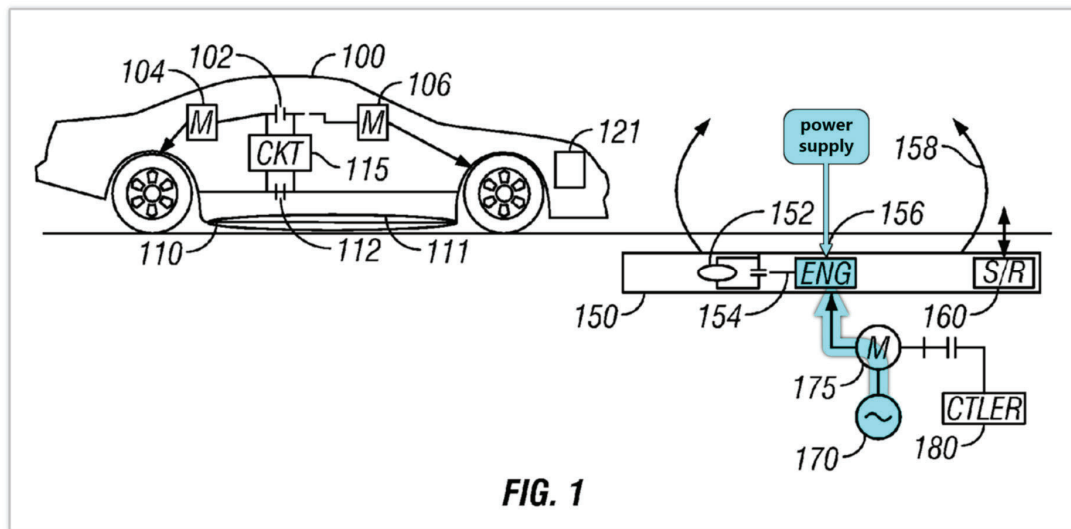
125. The Cook/Bennett combination taught the preamble.

126. Cook taught “[w]ireless delivery of power” to charge the batteries of electric vehicles. *See* Cook at [0001]; [0009]-[0012] (describing basic design of car charger).

2. Element 13[a]: Power Supply

127. This claim element recites “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.” The Bennett/Cook combination taught this claim element.

128. Cook described a “charger 150” that includes “a charging circuit 156.” Cook at [0013]. The charging circuit corresponds to the claimed power supply because it “produces a signal of appropriate frequency for magnetic transmission” that charges “an appropriate vehicle [that] comes into range of the magnetic field.” Cook at [0013]. Cook’s Figure 1 also shows that the charging circuit is connected to 170, which is drawn as a circuit element indicating a source of alternating current (AC). The charging circuit 156 would supply the resonator with energy drawn from the AC source as shown in the figure below



Cook at Fig. 1 (annotated), [0015] (“power delivered from the AC Main, through a meter 175, to the charging device 150”).

129. The vehicle “includes at least one battery 102,” which “may be the primary power source of the automobile.” Cook at [0009]; *see also* [0010] (“The battery 102 is shown driving an electric motor 104, 106 which may drive vehicle wheels, for example.”). The power the car receives via the “magnetic signal from th[e] transmitter” can be “used for charging the battery 102.” Cook at [0011]. The power the charging circuit (power supply) supplies is therefore sufficient to charge the battery of the vehicle.

3. Element 13[b]: First Electromagnetic Resonator And Characteristics

130. This element in claim 13 recites

[b][i] a first electromagnetic resonator coupled to the power supply and having

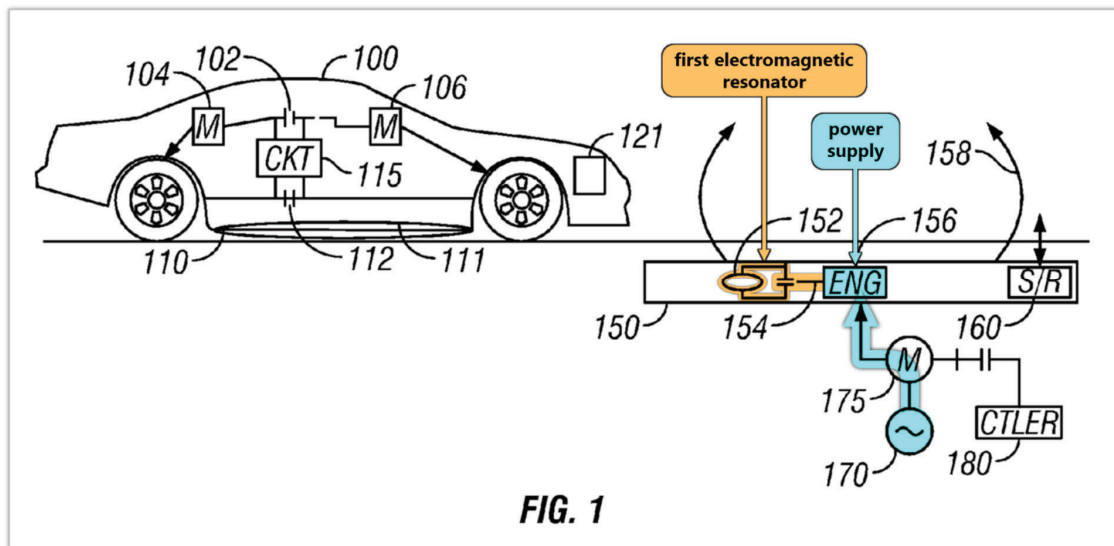
- [ii] a mode with a resonant frequency ω_1 ,
- [iii] an intrinsic loss rate Γ_1 ,
- [iv] and a first Q-factor $Q_1 = \omega_1 / 2\Gamma_1$,
- [v] the first electromagnetic resonator housed in a housing configured to be disposed in proximity to the vehicle.

131. I note that the '687 patent claims do not require the first electromagnetic resonator have any particular resonant frequency ω_1 , intrinsic loss rate Γ_1 , or Q-factor Q_1 , any values will do. The Cook/Bennett combination taught each part of this element as detailed below

a. Element 13[b][i]: Electromagnetic Resonator Coupled to Power Supply

132. This claim element recites “a first electromagnetic resonator coupled to the power supply.” The Cook/Bennett combination taught this claim element.

133. Cook’s charger 150 included “a coil 152” and “a capacitor 154.” The coil and the capacitor together form a first electromagnetic resonator (i.e., an “LC” circuit) and are coupled to the charging circuit 156, that is, the power supply. Cook at [0013]. I’ve annotated Figure 1 below to show the first resonator and the power supply:



Cook at Fig. 1 (annotated).

134. Cook’s claims also described wirelessly supplying power using magnetic resonance: for example, claim 6 states, “wherein said wirelessly supplying power comprises applying power using a magnetically resonant antenna which includes an inductor and a capacitor,” as does claim 13. Cook at cl. 6, 13. Cook-086 (incorporated by reference in Cook) further confirms that Cook’s coil and capacitor are an electromagnetic resonator, stating that “[a] typical loop antenna is inherently inductive” and that “[a] capacitive element may be used in the tuning circuit to induce resonance in the antenna.” Cook-086 at 4:55-57; *see also* Cook-086 at 5:13-22 (providing a “well known resonance equation” that depends on inductance and capacitance); Cook at [0001] (incorporating by reference Cook-086).

135. Cook's LC resonant circuit is a "magnetic" resonator that produces a "magnetic field" illustrated in Figure 1 as element 158, which is used to transmit energy in the near field to an in-range vehicle with a compatible receiving resonator. Cook at [0001], [0011]-[0013]. Cook's magnetic resonator is also an "electromagnetic resonator," as the '687 patent admits. In particular, the '687 patent states that "magnetic resonators" are "designed such that ... the energy stored by the magnetic field is primarily in the region surrounding the resonator" and, accordingly, "the energy exchange is mediated primarily by the resonant magnetic near-field," while "electric resonators" are "designed such that ... the energy stored by the electric field is primarily in the region surrounding the resonator" and, accordingly, "the energy exchange is mediated primarily by the resonant electric near-field"; either type of resonator, the '687 patent says, "may [] be referred to as an electromagnetic resonator." '687 patent at 3:42-58.

136. Cook's source magnetic resonator was similar to Bennett's "sending resonant coupling component," which is "capable of power transmission employing magnetic waves 111, such as non-radiated magnetic field waves of a specified target resonant frequency." Bennett at [0029]; BProv at 8:16-9:5. Like Cook's charger, Bennett's transmitting component "typically ... includes a resonant coil that fills the space around it with a non-radiated magnetic field." Bennett at [0029], [0030]; BProv at 8:16-9:20. The similarities in source resonators

between Cook and Bennett would have indicated to a POSA that the teachings of Bennett could be applied to the teachings of Cook, and vice versa.

b. Element 13[b][ii]: Resonant Frequency ω_1

137. This claim element requires that the first electromagnetic resonator “hav[e] a mode with a resonant frequency ω_1 .” The Cook/Bennett combination taught this claim element.

138. As discussed above with respect to the first electromagnetic resonator, Cook disclosed that its charger includes a coil and a capacitor. Cook at [0013]. The coil is an inductive component that would have a value L, and the capacitor is a capacitive component that would have a value C. Cook also explains that the LC circuit is “resonant,” indicating that it has a “resonant frequency.” Cook at [0001], [0013], cl. 6 (“applying power using a magnetically resonant antenna which includes an inductor and a capacitor”), cl. 13. Cook also refers to the fact that the Charging LC circuit is “resonant” when it explains that the vehicle’s “battery is automatically charged whenever the antenna 112 comes into range of a wireless charging circuit of appropriate type, e.g. the right frequency.” Cook at [0012].

139. Cook also explained this basic concept (that a resonant LC circuit has a resonant frequency) in Cook-086, which taught that “[a] capacitor [] is used with the loop inductive resonator” and “bring[s] the loop antenna to resonance.” Cook-086 at 5:12-13. It further explains how the resonant frequency (ω) is

mathematically related to the L and C values based on the “well known resonance equation: $\omega^2 = \frac{+1}{LC}$.” Cook-086 at 5:13-22. I note that this is the same inductance/capacitance/resonant frequency relationship taught in the ’687 patent. See ’687 patent at 25:58-67 (“The frequency at which this energy is exchanged may be called the characteristic frequency, the natural frequency, or the resonant frequency of the resonator, and is given by ω , $\omega = 2\pi f = \frac{1}{\sqrt{LC}}$.”).

c. Element 13[b][iii]: Intrinsic Loss Rate Γ_1

140. This claim element requires that the first electromagnetic resonator have “an intrinsic loss rate Γ_1 .” The Cook/Bennett combination taught this claim element.

141. A POSA would have understood that Cook’s resonator has an intrinsic loss rate Γ_1 . First, as I explained in the Overview of the ’687 Patent Section, a POSA would have understood generally that resonant frequencies and quality factors are properties of electromagnetic resonators and that the intrinsic-loss rate can be derived from the relationship recited in claim 1:

$$Q_1 = \frac{\omega_1}{2\Gamma_1} \quad \rightarrow \quad \Gamma_1 = \frac{\omega_1}{2Q_1}$$

See Section V.A.2.c above.

142. Second, and more specific to Cook, Cook’s charging circuit has a resonant frequency—which corresponds to the claimed ω_1 —as I explained in the

section for Element 13[b][ii] above, and has a quality factor corresponding to the claimed Q_1 , as I explain in the section for Element 13[b][iv] below. *See also, e.g.*, Cook cl. 6 (“magnetically resonant antenna which includes an inductor and a capacitor, and has a Q value greater than 1000”). A POSA would be able to determine the intrinsic loss rate of Cook’s charging resonator using the claimed formula. I note again that the ’687 patent does not claim any particular intrinsic loss rate. It only requires that it exist, which it would in Cook’s system.

143. Cook-086, which Cook incorporates by reference, disclosed that resonators used for wireless delivery of power in Cook’s system have a “half bandwidth” that is interchangeable with the value that the ’687 patent refers to as intrinsic loss rate. Specifically, Cook-086 taught that a “quality factor can also be used to define the bandwidth” according to the following equation:

$$\frac{\Delta\omega}{2} = \frac{\omega_0}{2Q}$$

Cook-086 at 13:1-8. Substituting Γ for $\frac{\Delta\omega}{2}$ yields the claimed equation as rearranged to express Γ .

144. A POSA would therefore have understood that Cook-086 is describing the same characteristics and that the intrinsic loss rate is simply another name for one half of the half power (3dB) bandwidth. *See* Cook-086 at 12:20-30 (“ $\Delta\omega$ corresponds to the 3dB-bandwidth”). In other words, the value “ $2\Gamma_1$ ” as

claimed in the '687 patent is equivalent to the metric more commonly known as the half power bandwidth, and " Γ_1 " is one half of that bandwidth, i.e., the frequency difference from the resonant frequency to the half-power point on either side of the resonant curve. Cook also taught that an inductor-capacitor resonant circuit would have a "loss resistance (R_l) and a radiation resistance (R_r)" and that under certain circumstances a "high resonance frequency increases losses and hence decreases the quality factor," which is similar to the discussion of intrinsic loss rates in the '687 patent. Cook-086 11:34-12:5; Cook [0001] (incorporating by reference Cook-086); '687 patent 17:12-25.

145. A POSA would have understood "intrinsic loss rate" and "resonance width" have the same meaning and are interchangeable. For example, in an earlier patent with common inventors as the '687 patent, Γ_1 and Γ_2 are referred to interchangeably as "intrinsic loss rate" and "resonance width" in its claims. *See* Joannopoulos at cl. 6 & cl. 60. Similarly, the specification there interchangeably refers to Γ_1 and Γ_2 as "resonance widths" (Joannopoulos at 2:19-21, 2:48-49, 4:54-56), "intrinsic loss-rates" (5:2-5), or "loss rates" (10:10-14).

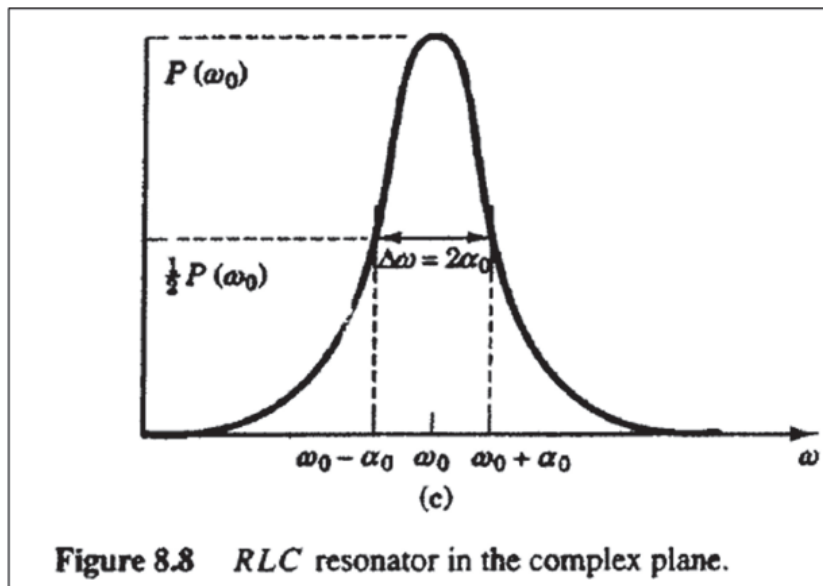
146. As I explained in my Background section, a POSA would have been familiar with the concept of the half power points and half power bandwidth of a resonator, and that those metrics were well known and commonly used metrics for

describing resonators like the ones in Cook.. For example, Staelin provides the following formula for Q in a discrete-element resonator:

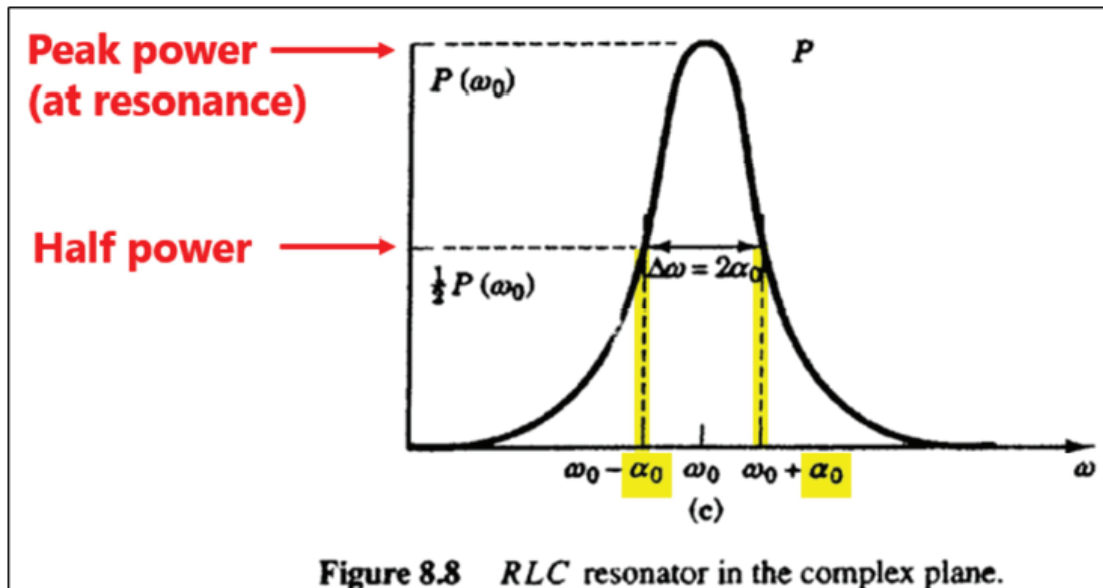
$$Q = \frac{\omega_0}{2\alpha_0}$$

Staelin at 359. Staelin explains that ω_0 is the resonant frequency of the resonator and can be defined by $\omega_0 = 1/\sqrt{LC}$, which is the same formula provided in both Cook-086 and the '687 patent. *See* Cook-086 at 5:13-22; '687 patent at 25:58-67. This formula is equivalent to the formula for Q recited in the '687 patent; it just uses the symbol α_0 rather than Γ .

147. As Staelin shows, $2\alpha_0$ can be represented graphically as the half-power bandwidth of a resonator. The frequency curve of a resonator can be shown graphically by plotting its frequency (on the X-axis) against its power (on the Y-axis):



Staelin at 360. The full vertical height of the plot, at its peak, represents the maximum power attainable at resonance. The horizontal dotted line represented half of that power, or the “half power” points of the frequency response. As seen in this figure, the half power height intersects the resonance curve two points, once on the left hand side of the peak ($\omega_0 - \alpha_0$) and once on the right hand side ($\omega_0 + \alpha_0$).



Staelin at 360 (annotated). The width between the left-hand half-power point and the right-hand half-power point on the frequency response is $2\alpha_0$ called the “half power bandwidth” of the resonator or the “full width at half maximum (FWHM).” Staelin at 361; *see also* Staelin at 337 (referring to same as the “bandwidth ... of a resonance”). Staelin further states that “the width of this resonance is closely related to its quality factor Q ,” which accords with the formula recited in the ’687 patent, substituting $2\alpha_0$ for the claimed 2Γ . Staelin at 362. Because the value of $2\alpha_0$ and its equivalent 2Γ are equal to the bandwidth, dividing by 2 shows that the claimed “intrinsic loss rate Γ_1 ” is equal to α_0 as shown above in Staelin’s Figure 8.8.

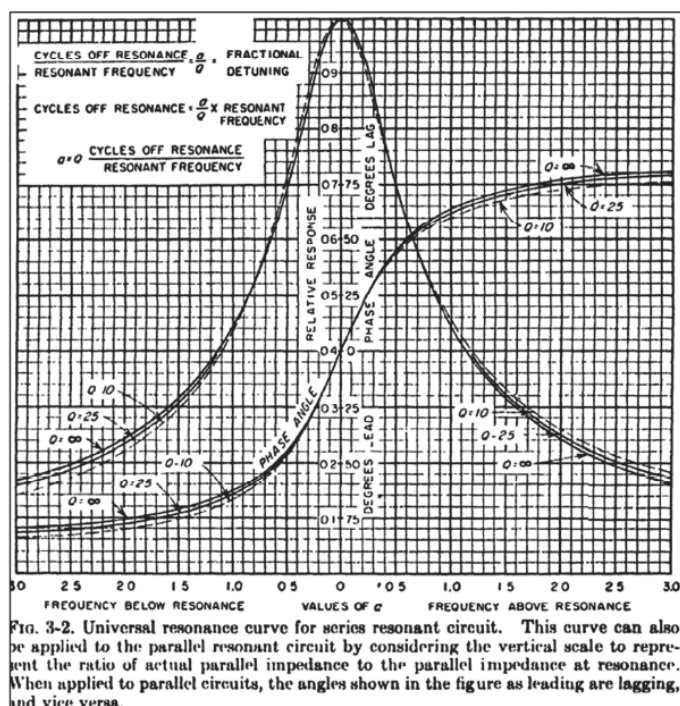
148. Other references similarly confirm, as a POSA would have understood, that the claimed “intrinsic loss rate Γ_1 ” is equivalent to the difference

between the resonant frequency and the half power point at either side of the resonant curve, i.e., one half of the half-power bandwidth of a resonator. For example, The Story of Q explained that, for a resonator, Q is “equal to the ratio of the resonant frequency to the bandwidth between those frequencies on opposite sides of resonance (known as ‘half-power points’) where the response of the resonant structure differs from 3db from that at resonance.” The Story of Q at 588. This can be shown to be equivalent to the claimed formula of the ’687 patent:

'687 patent (27:46-52)	The Story of Q at 588
$Q = \omega / 2\Gamma$	$Q = \frac{\text{resonant frequency}}{\text{bandwidth between ... half power points}}$

’687 patent at 27:46-52, cls. 1, 7, 13; The Story of Q at 588. As with Staelin, a POSA would have recognized that the value “2 Γ ” as described in the ’687 patent was just another way of expressing the “bandwidth between ... half power points,” also known as the half-power bandwidth. Therefore, the “intrinsic loss rate Γ ” for a given resonator is one-half of the half-power bandwidth.

149. Cook’s charger, because it is an LC resonant circuit, also has a half-power bandwidth. As Terman explained, the graphical plot of frequency to power is known as a “universal resonance curve” because it can be applied to any resonant circuit:



Terman at 48. As Terman explained,

The universal resonance curve is useful because it is independent of the resonance frequency of the circuit and of the relation of inductance to capacitance, and because it is substantially independent of circuit Q . It thus follows that *all resonance curves have the same relative shape irrespective of resonant frequency, Q , or ratio of inductance to capacitance of the circuit.*

Terman at 48. A POSA would therefore have understood that Cook’s resonator would have a resonance curve that could be drawn to have “the same relative shape” as the curves shown in Staelin and Terman. Those curves, as shown in Staelin and Terman, have a “half-power bandwidth”—displayed graphically as the width from one side of the resonant curve to the other at half of the peak power.

As explained above, one-half of that “half-power bandwidth” is equal to the claimed “intrinsic loss rate Γ_1 .”

d. Element 13[b][iv]: First Quality Factor $Q_1 = \omega_1/2\Gamma_1$

150. This claim element requires that the first electromagnetic resonator have “a first Q-factor $Q_1 = \omega_1/2\Gamma_1$.” The Cook/Bennett combination taught this claim element.

151. Cook taught “wirelessly supplying power” by “applying power using a magnetically resonant antenna which includes an inductor and a capacitor, and has a Q value greater than 1000.” Cook at cls. 6, 13. The inductor and the capacitor associated with the magnetically resonant antenna that supplies power correspond to the “coil 152” and “capacitor 154” of charger 150. *See* Cook at [0013]. So Cook’s first electromagnetic resonator had a Q-factor. And a POSA would have understood that Cook’s disclosed Q can be defined using the equation in claim 13 because Cook-086 taught that $Q = \frac{\omega_0}{\Delta\omega}$, and as explained above, $\Delta\omega = 2\Gamma_1$. *See* the Intrinsic Loss Rate discussion (Element 13[b][iii], Section VIII.B.3.c) above and Cook-086 at 12:20-27, 13:1-8.

152. More generally, a POSA also would have understood that Cook’s resonator had a Q because Q is a parameter that applies “to any resonant structure or device.” The Story of Q at 588. Terman confirms that “[c]oils intended for use in resonant circuits must have very low losses,” so “[i]t is convenient to express

the characteristics of a coil”—such as those disclosed in Cook—“in terms of Q.” Terman at 30. This Q-factor terminology was ubiquitous in resonator design by 1950, roughly corresponding to the “sharpness of resonance.” *The Story of Q* at 584, 586. I note that, as with ω and Γ , the ’687 patent does not claim a particular value of Q. Again, it only requires that some Q exist. A POSA would have understood that to be the case with Cook’s resonator

153. The ’687 patent itself is consistent with a POSA’s understanding that Cook’s resonator would have had a Q corresponding to the claimed “first Q-factor Q_1 .” According to the ’687 patent, the “Quality Factor, or Q, of [a] resonator ... characterizes the energy decay [and] is inversely proportional to the[] energy losses.” ’687 patent at 17:26-36. A POSA would have understood this statement to be describing an inherent property of all resonators, as *The Story of Q* shows, rather than revealing a new discovery. In fact, a POSA in 2008 would have known that Cook’s resonator would suffer from energy decay or losses because that is the case for all real-world resonators; it therefore would possess some quality factor Q.

154. I also note that the ’687 patent defines the quality factor as $Q = \omega * \frac{W}{P}$ (where P is the time-averaged power lost at steady state) or as “the number of oscillation periods, T, it takes for the energy in the resonator to decay by a factor of e.” ’687 patent at 17:26-36. As I said and explained above, any resonator having

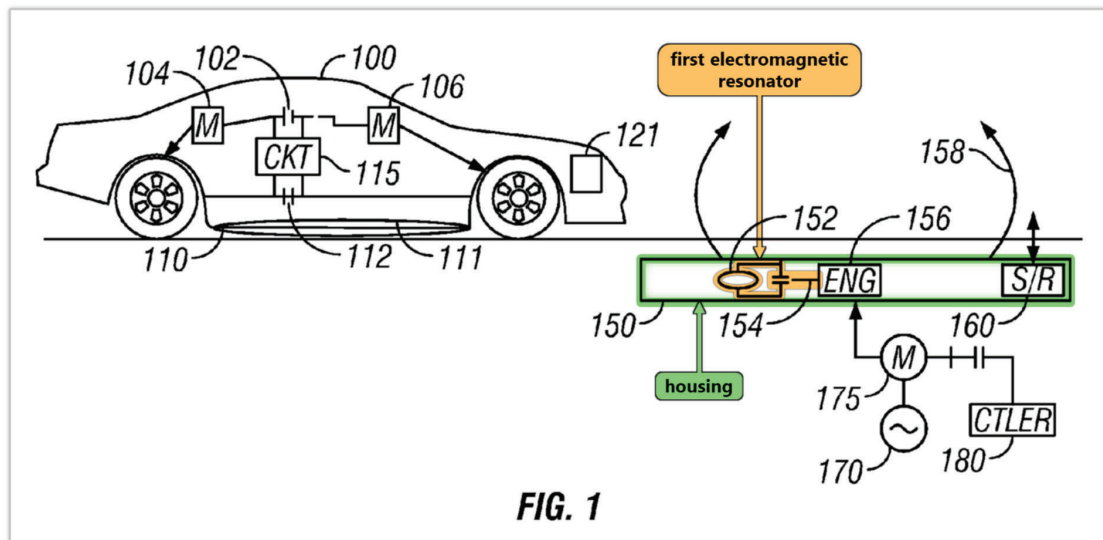
a resonant frequency and the potential to lose power over time, or any resonator that oscillates and has energy decay, will have a Q value.

155. As I showed above in my discussion of the Intrinsic Loss Rate element, Element 13[b][iii] in Section VIII.B.3.c, the relationship $Q_1 = \omega_1 / 2\Gamma_1$ is similarly a property of all real-world resonators. Accordingly, Cook's resonator has the claimed first quality factor $Q_1 = \omega_1 / 2\Gamma_1$.

e. Element 13[b][v]: Housed in a Housing

156. This claim element requires that “the first electromagnetic resonator [be] housed in a housing configured to be disposed in proximity to the vehicle.” The Cook/Bennett combination taught this claim element.

157. Cook described its charger 150 as including a variety of components performing different functions and stated that it can be “located within the ground near a parking space.” Cook at [0012]-[0013]. Cook showed that the charger 150 is a unitary structure (i.e., a “housing”) comprising all of its components in Figure 1, as I've annotated below.



Cook at Fig. 1 (annotated); *see also* Cook as [0012]-[0013] (describing charger 150).

Cook disclosed that “when the antenna 110 [associated with the automobile] comes into range of an appropriate transmitter, it receives a magnetic signal from that transmitter, and the receiving circuit 115 converts that power into output current.” Cook at [0011]; *see also id.* at [0012] (explaining that the vehicle charges when it “comes into range of a wireless charging circuit of appropriate type”). The vehicle charges when it “comes into range of a wireless charging circuit of appropriate type.” Cook at [0012].

158. If Patent Owner contends that charger 150 does not teach a “housing” for the first electromagnetic resonator, that would have been obvious to a POSA. First of all, it was ubiquitous in the art to house electronic components used in real-world devices in some sort of enclosure to prevent them from malfunctioning,

including for wireless charging of electric vehicles. Boys, for example, taught a transmitting “charging pad” that would produce “magnetic flux” to transmit power wirelessly to a vehicle, and the charging pad included an “outer housing” as shown in Figures 2 and 3 of Boys below. Boys at 8:19-42.

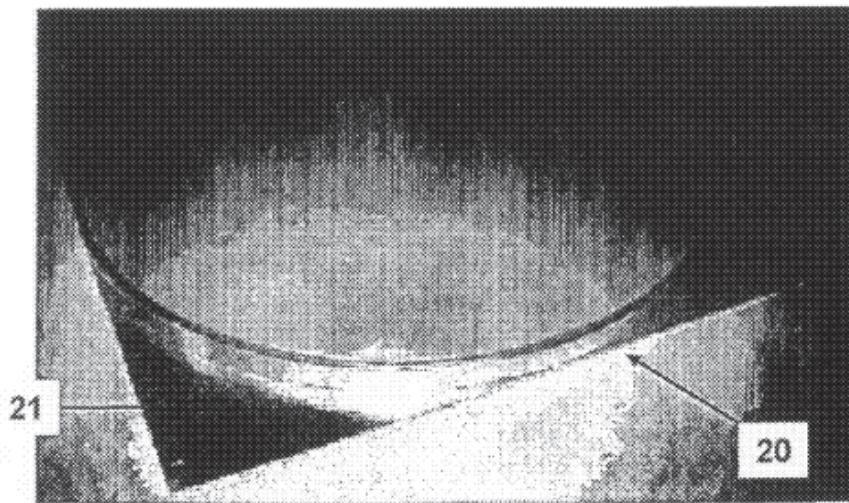


FIGURE 2

Boys at Fig. 2.

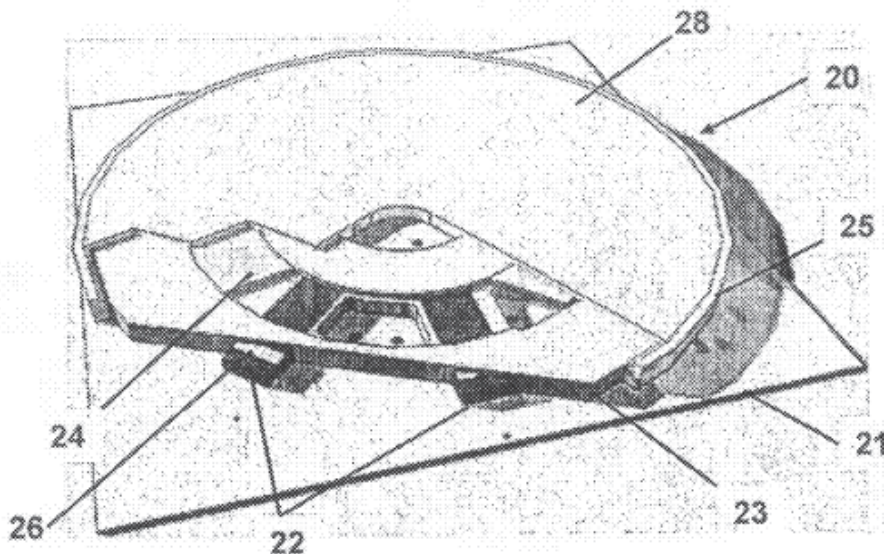


FIGURE 3

Boys at Fig. 3

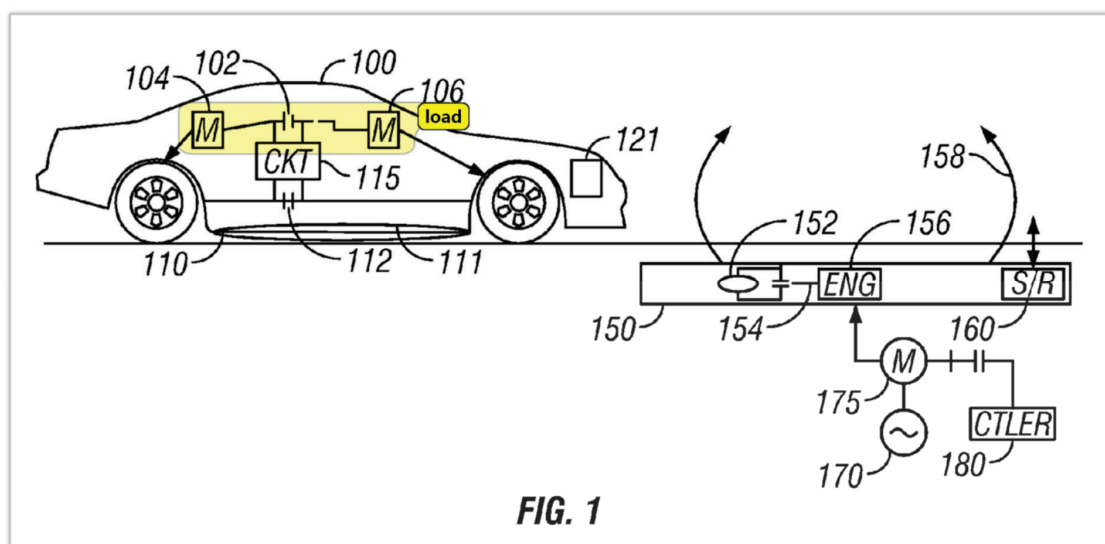
159. A POSA would have found it obvious that Cook's "charger 150" would include a similar outer housing as those shown above. In Cook, a POSA would have understood and found it obvious that a housing would be used to, for example, protect the coil and capacitor of Cook's resonator, along with the other circuitry making up the charger, from damage that could be caused by dirt, moisture, and animals when Cook's charger is placed under a parking spot enclosure. Cook at [0012]-[0013], Fig. 1. A POSA also would have been motivated to include a housing for the electrical components in Cook's charger 150 to allow its components, including *inter alia*, the "coil 152, a capacitor 154, and a charging circuit 156" and "send and receive portion 160" to be manufactured as a singular

unit and transported that way to where it would be installed, e.g., in a “parking space.” Cook at [0012]-[0013], Fig. 1.

4. Element 13[c]: Load Configured To Power The Drive System Of A Vehicle

160. This claim element recites “a load configured to power the drive system of a vehicle using electrical power.” The Cook/Bennett combination taught this claim element.

161. Cook described the process of delivering wireless power to an electric vehicle as “delivering power wirelessly to a load.” Cook at [0004]. In Cook, the “load” is the batteries and/or motors, which together power the drive systems of the car, as explained at Cook at [0011] and shown in my annotations to Cook’s Figure 1 below:



Cook at Fig. 1 (annotated); *see also* [0010] (“The battery 102 is shown driving an electric motor 104, 106 which may drive the vehicle wheels, for example.”), [0011] (“That power can be used for directly driving the motors 104, 106, but more preferably is used for charging the battery 102.”). Cook’s description of a “load” is consistent with the ’687 patent’s, which describes a “load” or “loading object” as any circuit element connected to or drawing power from a power-receiving resonator, as opposed to a generator, which generates power. *See* ’687 patent at 8:27-30, 17:61-18:10, Fig. 3.

5. Element 13[d]: Second Electromagnetic Resonator

162. This element in claim 13 recites:

[d][i] a second electromagnetic resonator adapted to be housed upon the vehicle and configured to be coupled to the load, the second electromagnetic resonator having

[ii] a mode with a resonant frequency ω_2 ,

[iii] an intrinsic loss rate Γ_2 ,

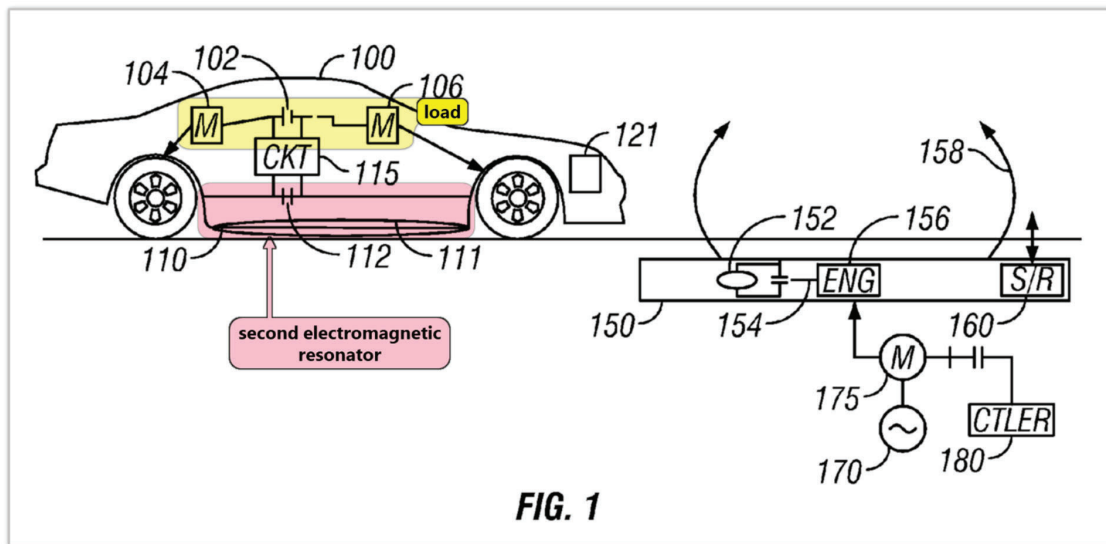
[iv] and a second Q-factor $Q_2 = \omega_2 / 2\Gamma_2$.

163. Like the first electromagnetic resonator in Element 13[b], the ’687 patent claims do not require the second electromagnetic resonator to have any particular resonant frequency ω_2 , intrinsic loss rate Γ_2 , or Q-factor Q_2 , so any values of those parameters will do. The Cook/Bennett Combination taught each part of this element for similar reasons as Element 13[b] and as detailed below.

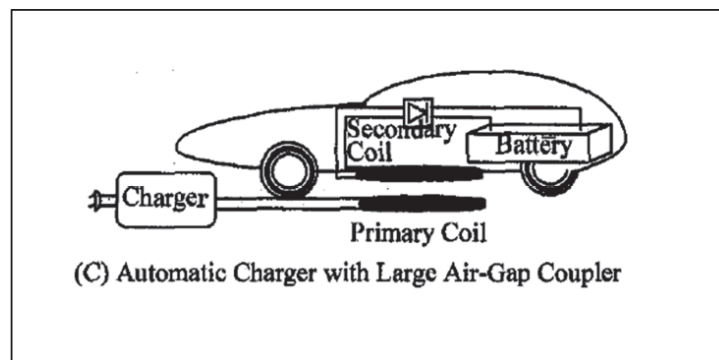
**a. Element 13[d][i]: Electromagnetic Resonator
Housed Upon the Vehicle and Coupled to the Load**

164. This claim element recites “a second electromagnetic resonator adapted to be housed upon the vehicle and configured to be coupled to the load.” The Cook/Bennett combination taught this claim element.

165. Cook taught that the receiving “magnetic resonant antenna,” which Cook identifies with element number 110 and which is “formed from an inductive loop 111 in parallel with a capacitor 112,” is located inside “the automobile.” Cook at [0011]. There, it is coupled to the battery, which serves as the primary power source for the vehicle and, together with the motors, corresponds to the claimed “load.” *See* Cook at [0009] (“An electrically powered automobile includes at least one battery 102 which may operate at least one electronic mobile system of the automobile.”), [0010] (“The battery 102 is shown driving an electric motor 104, 106 which may drive vehicle wheels for example.”), [0011] (“[W]hen the antenna 110 comes into range of an appropriate transmitter, it receives a magnetic signal from that transmitter, and the receiving circuit 115 converts that power into output current” that can be “used for charging the battery 102”). The magnetic resonant antenna therefore corresponds to the claimed “second electromagnetic resonator.” I illustrate this configuration with annotations to Cook’s Figure 1 below:



Cook at Fig. 1 (annotated). This configuration—placing the magnetic resonant antenna on the underside of the vehicle to provide power to the car’s battery—would have been familiar to a POSA and was, in fact, well known by 2008 because it allowed one to charge an electric car by simply driving the car over the transmitting pad and stopping there. Sakamoto’s Figure 2(C), for example, illustrates the same configuration:



Sakamoto (Ex. 1016) at Fig. 2(C). Likewise, other prior art references disclosing wireless car charging indicate that this configuration of the transmitting pad in the

ground and the receiving pad under the vehicle were typical. *See, e.g.*, Boys at 8:19-42 (describing a “charging pad 20 [that] is positioned on the underside of vehicle 10 so that it is substantially directly above charging pad 20 when vehicle 10 is parked”); Morita (Ex. 1014) at 7:52-61 (“The power receiving portion 2 is mounted in a mobile vehicle ... [m]eanwhile, the power feeding portion 1 is embedded in, for example, a track way for the mobile object or a floor surface of a garage, a repair firm or the like”), 5:56-67 (“The power receiving portion 2 is attached in the lower part of the mobile object at a position where the power receiving portion 2 is opposed to the power feeding portion 1.”); Wang (Ex. 1018) at 71 (“[T]he secondary winding is attached to the underside of an electric vehicle, while the primary winding is buried in the ground. Once an electric vehicle has stopped over the charging station, electric power is transferred to the vehicle across an air gap via magnetic coupling between the primary coil in the ground and secondary coil on the vehicle”).

b. Element 13[d][ii]: Resonant Frequency ω_2

166. This claim element requires that the second electromagnetic resonator “hav[e] a mode with a resonant frequency ω_2 .” The Cook/Bennett combination taught this claim element.

167. Cook taught that its “magnetic resonant antenna” 110 is “formed from an inductive loop 111 in parallel with a capacitor 112.” Cook at [0011]. The

inductive loop would have an inductance L , and the capacitor would have a capacitance C , meaning that (as I explained above in the resonant frequency section for the first electromagnetic resonator, and as Cook-086 taught) the magnetic resonant antenna has a resonant frequency $\omega = \frac{+1}{\sqrt{LC}}$. *See* Cook-086 at 5:13-22 (providing the “well known resonance equation”), 19:29-46 (modeling a circuit “as an equivalent representation as a parallel resonant circuit” and defining $\omega_0 = \frac{+1}{\sqrt{LC}}$).

c. Element 13[d][iii]: Intrinsic Loss Rate Γ_2

168. This claim element requires that the second electromagnetic resonator have “an intrinsic loss rate Γ_2 .” The Cook/Bennett combination taught this claim element.

169. As I explained above in the “Intrinsic Loss Rate Γ_1 ” section for the first electromagnetic resonator, the intrinsic loss rate Γ was a well-known metric of resonators, including those used in Cook. Cook-086 explained as much when it taught the interrelation between the quality factor and the bandwidth. *See* Cook-086 at 13:1-8. Thus, a POSA reading Cook and Cook-086 because it is incorporated by reference would have understood that Cook’s magnetic resonant antenna had a half-bandwidth that corresponds to the claimed “intrinsic loss rate.” *See also* Cook at [0001], [0011].

d. Element 13[d][iv]: Second Q-factor $Q_2 = \omega_2/2\Gamma_2$

170. This claim element requires that the second electromagnetic resonator have “a second Q-factor $Q_2 = \omega_2/2\Gamma_2$.” The Cook/Bennett combination disclosed this claim element.

171. Cook disclosed the use of a magnetic resonant antenna on an automobile that has “a relatively high Q, for example a Q that is higher than 1000.” Cook at [0011]. As I explained above with respect to the quality factor limitation of the first electromagnetic resonator, Element 13[b][iv], Cook’s disclosure of a “quality factor” or a “Q” is consistent with a POSA’s understanding that Q was a well-known property of resonators like those used in the Cook, Bennett, and ’687 patent systems.

172. I note here that because the ’687 patent does not require any specific values of Q, ω , or Γ , and because nothing in the ’687 patent requires that the values be different from one another, the subscripts 1 and 2 correspond to the first and second electromagnetic resonators rather than different values of Q. This is particularly so because a POSA would have understood that keeping the resonator’s frequencies the same would maximize power transfer. *See* Bennett at [0023]; BProv at 7:4-7; ’687 patent at 4:17-21.

6. Element 13[e]: Wirelessly Coupled

173. This claim element recites “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.” The Cook/Bennett combination disclosed this claim element.

174. Cook taught that “when the [magnetic resonant] antenna”—which, as I explained above, corresponds to the claimed second electromagnetic resonator—“comes into range of an appropriate transmitter”—in Cook, the “charger 150” that corresponds to the first electromagnetic resonator in the ’687 patent’s claims—“it receives a magnetic signal from that transmitter, and the receiving circuit 115 converts that power into output current.” Cook at [0011]. Cook confirms that the “appropriate transmitter” is the charger 150 two paragraphs later when it explains that “[w]hen an appropriate vehicle comes into range of the magnetic field 158,” which “charger 150 may produce,” “it may receive power from that magnetic field, and hence be charged thereby.” Cook at [0013].

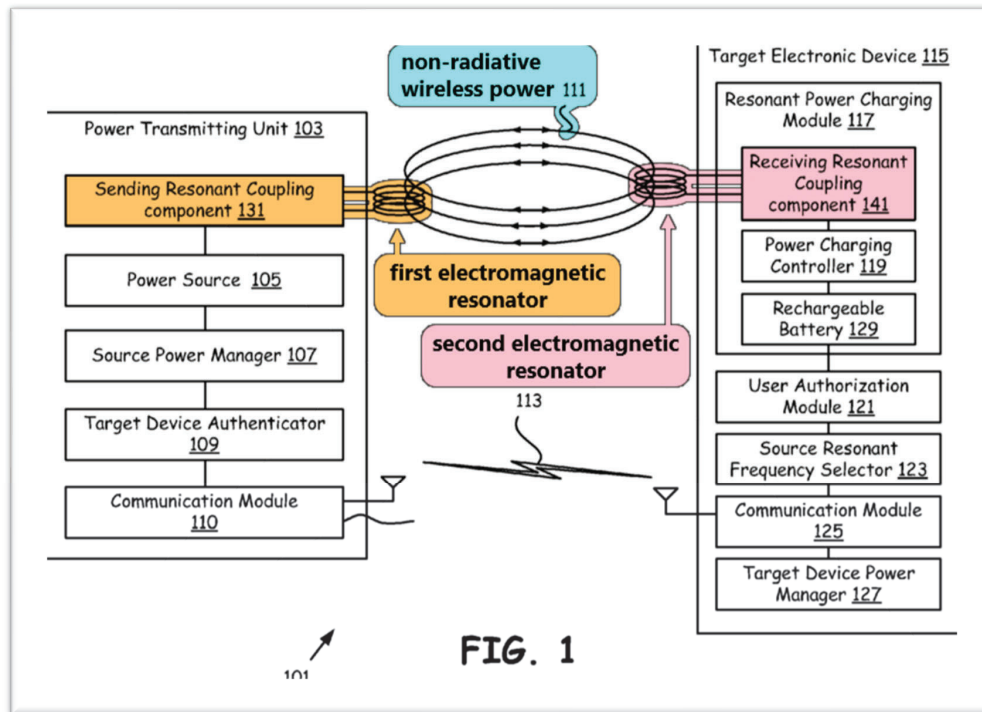
175. Cook therefore taught the claimed wireless coupling, whereby the first electromagnetic resonator (charger 150) provides wireless power to the second electromagnetic resonator (magnetic antenna 110) to charge the vehicle. The charger accomplishes this wireless power transfer by “forming a magnetic field

and receiving a magnetic field in a resonant antenna that is resonant with at least one characteristic of a magnetic field.” Cook at [0001]. As Cook-086 explained, “efficient power transfer between two antennas” uses “energy in the near field of the transmitting antenna, rather than sending the energy into free space in the form of a travelling electromagnetic wave.” Cook-086 at 2:61-64.

176. A POSA would have understood that the form of wireless coupling that Cook described was the same as taught in the '687 patent. The '687 patent stated that “near-field” and “non-radiative” wireless energy transfer is the same thing. '68 patent at 2:55-56 (“Energy or power may be transferred wirelessly using a variety of known radiative, or far-field, and non-radiative, or near-field, techniques.”), 3:12-13 (“A known non-radiative, or near field, wireless energy transfer scheme...”), 100:27-29 (“The systems and methods described herein may also use the near-field non-radiative resonant scheme for information transfer rather than, or in addition to, power transfer.”).

177. A POSA would have understood Bennett’s system is compatible with Cook’s wireless power transfer because it similarly taught the wireless power transfer through non-radiative magnetic waves at a target frequency. For example, Bennett “includes a power source 105 capable of generating power for power transmission and a sending resonant coupling component 131 capable of power transmitting employing magnetic waves 111, such as non-radiated magnetic field

waves of a specified target resonant frequency.” Bennett at [0029]; BProv at 8:16-9:5. Bennett also disclosed a target electronic device that “includes a resonant power charging module 117, a user authorization module 121, a source resonant frequency selector 123, a communication module 125, and a target device power manager 127.” Bennett at [0030]; BProv at 9:6-20. In operation, a “receiving resonant coupling component” of the resonant power charging module “is used to receive the power transmissions provided by the power transmitting unit 113 employing the target resonant frequency.” Bennett at [0030]; BProv at 9: 9:6-20. This results in a “resonant coupling effect” (Bennett at [0038]; BProv at 12:6-10) that provides “wireless power transmission.” Bennett at [0032]; BProv at 10:12-16. This is illustrated in Bennett’s Figure 1, annotated below:



Bennett at Fig. 1 (annotated); *see also* BProv at Fig. 1; *see also* Bennett at [0032] (“power to be transmitted in a non-radiated magnetic or radiated magnetic mode, employing an essentially ‘wireless means’ 111 ... the sending resonant coupling component 131 which transmits it, for example, creating a non-radiated magnetic field”), [0022] (“non-radiated magnetic fields” are used for “delivery of power” through “high frequency resonant magnetic coupling”), [0024] (“magnetic coupling between a power transmitting unit and target device enables the power transfer”); BProv at 7:8-15, 6:18-7:3 (“[T]he delivery of power is conducted through high frequency resonant magnetic coupling between a power source and a

target device, the target device being an electronic device that runs on a portable rechargeable battery embedded in it.”), 10:12-16, Fig. 1.

7. Element 13[f]: Authorization Facility

178. This claim element recites “an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.” The Cook/Bennett combination taught this claim element.

179. 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.” Cook at [0018]. Cook also envisioned that the automobile would house related authorization components in the wireless power receiver, including components used for transmitting an encrypted message indicating that “charging is enabled” for the vehicle indicating that it has a compatible resonator. Cook at [0015]. But beyond that basic explanation, Cook left the details for how to implement authorization between the charger and vehicle to the POSA.

180. As I explained above in the Motivation to Combine section, Bennett provided additional implementation details that a POSA would and could have looked to when building Cook’s system. Bennett taught that its power transmitting

unit (which, as I explained in the Motivation to Combine section, is the equivalent of Cook's charger 150) includes "a target device authenticator." Bennett at [0029]; BProv at 8:16-9:5. The target electronic device (which is the equivalent of Cook's automobile) includes a related "user authorization module 121." Bennett at [0030]; BProv at 9:6-20. These two authentication components, the target device authenticator and user authorization module, work together as part of an authorization facility, i.e., the "target device authenticator ... works in coordination with the user authorization module." Bennett at [0040]; BProv at 13:7-13. A POSA would therefore have understood 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.

181. In operation, "[t]he user authentication module 121 facilitates the authentication of the target electronic device 115, for resonant power delivery, with the target device authenticator 109 of the power transmitting unit 103." Bennett at [0037]; BProv at 11:18-12:5. Bennett specifically described authorizing power transfer only after verifying "identity information of the magnetic resonant target device" that confirms whether the user has subscribed to a power charging service. Bennett at [0037] ("If the match is determined, then resonant power delivery is initiated."), [0052], [0067] ("If the communicated information matches the database 507 contents then the resonant power delivery is initiated."), [0072]

(describing the authentication process), [0087] (“The target device power manager 127 of FIG. 1 ... authenticates with the power transmitting unit 103 of FIG. 1 for its subscription”; when authenticated, “the target device power manager 127 of FIG. 1 sends the power charging request for the power transmitting unit 103”); BProv at 11:18-12:5, 15:12-18, 20:4-10, 21:16-21, 26:4-10. In that process, “the user authorization module 121 exchanges the authentication information with the power transmitting unit 103,” which “compares the information (or a computed value thereof) with the subscriber’s information in its database by the target device authenticator 109.” Bennett at [0037], Fig. 3; BProv at 11:18-12:5, Fig. 3; *see also* Cook at [0017] (“The controller thereby 1) checks whether the value can be decrypted, and 2) checks whether the time is correct (to avoid reuse of a previously-sent message.”). Only if that information matches is “resonant power delivery [] initiated.” Bennett at [0039]; BProv at 11:18-24:5; *see also* Bennett at [0067] (“Typically the database information contains a pre-assigned identification number of the target device, relevant personal details of the user, a preferred magnetic resonant frequency for the target device, etc.”); BProv at 20:3-10. That is consistent with Cook’s objective with allowing power “to be dispensed only if an encrypted value properly agrees with the proper encryption code and proper token time.” Cook at [0018].

182. Bennett also taught that as part of the authorization process, the sending resonant coupling component (e.g., Cook's charger) will only initiate power transfer when it determines that there is a compatible nearby resonator (e.g., Cook's automobile), and also includes a step of adjusting the resonant frequency to improve power transfer compatibility between the resonators. First, Bennett taught that "[a] power control signal exchange operation is required for the authentication of the target electronic device 115 before a successful resonant power delivery." Bennett at [0039]; BProv at 12:11-20. 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]. A POSA would have understood that if the power signal exchange operation was successful, then the resonators were compatible, whereas if the power signal exchange failed (or was not initiated), they were not.

183. Second, Bennett taught that authorization includes a frequency compatibility check and adjustments as needed. In particular, a "source resonant frequency selector" on the target electronic device will check the "tuning voltage" that would be "automatically adjusted to achieve the optimum reception from an antenna/resonant coupling mechanism." Bennett at [0038], [0055] ("The assigned frequency value is configured into the magnetic resonant target device 211.

Sending of this information to power source 203 with a request for power helps in resonant locking/effective resonant coupling by the power source 203 with magnetic resonant target device 211”); BProv at 12:6-10, 16:7-15. In this way, “[t]he target device authenticator 109 authenticates the resonant power requests made by the target electronic device 115, and works in coordination with the user authorization module 121 of the target electronic device” to “facilitate the authentication of the target electronic device [] for resonant power delivery.” Bennett at [0037], [0041]; BProv at 11:18-12:5, 13:7-13. As explained in the Motivation to Combine Section above, a POSA would have been motivated to include these compatibility checks as part of the authorization process to improve the efficiency and accessibility of Cook’s charger that is contemplated to be used for multiple vehicle types. *See* Section VIII.A.

C. Bennett and Cook Render Obvious Independent Claims 1 and 7

184. As I explained above in the Challenged Claims section of my Overview of the ’687 Patent, Section V.B, independent claims 1 and 7 include substantially the same elements found in claim 13. Claims 1 and 7 recite a subset of the components in claim 13 in order to describe the same system from different perspectives, the receiver (claim 1) and power source (claim 7). It is my opinion that independent claims 1 and 7 are unpatentable for substantially the same reasons as independent claim 13 as I explain below.

1. Independent Claim 1: Wireless Receiver

185. As explained above, independent claim 1 recites “[a] vehicle powering wireless receiver for use with a first electromagnetic resonator coupled to a power supply” and then lists a subset of the elements in claim 13 regarding the structure and characteristics of the wireless power system. As the table in Section V.B above illustrated, Element 1[a][i] maps to Element 13[b][i], 1[a][ii] to 13[b][ii], 1[a][iii] to 13[b][iii], 1[a][iv] to 13[b][iv], 1[b] to 13[c], 1[c][i] to 13[d][i], 1[c][ii] to 13[d][ii], 1[c][iii] to 13[d][iii], 1[c][iv] to 13[d][iv], 1[d] to 13[e], and 1[e] to 13[f].

186. It is my opinion that the Cook/Bennett combination taught or suggested each and every element of claim 1 in the same way and for the same reasons as discussed above with respect to claim 13. The only portion of claim 1 that is not substantively the same as an element of claim 1 is the preamble, which recites a “vehicle powering wireless receiver.” The Cook/Bennett combination taught this claim element. As I explained in the Overview of Cook and Claim 13 Preamble sections above, Cook taught a wireless car charger in which a magnetic resonant antenna is placed on the underside of a vehicle so that power can be transmitted wirelessly from a charger to the vehicle, where it charges the battery, which powers the vehicle’s motors. *See* Elements 13[pre], 13[d] (second electromagnetic resonator), and 13[e] (wireless coupling).

187. The Cook/Bennett combination taught the remaining elements of claim 1 for all the same reasons as discussed above with respect to claim 13. In sum, the Cook/Bennett combination taught a vehicle powering wireless receiver (Cook's "magnetic resonant antenna" 110 that is mounted on a vehicle coupled to the battery and motors (together the "load")) that is for use with a first electromagnetic resonator (together the "coil 152" and "capacitor 154" in Cook's "charger 150"). *See* Element 13[b][i]. The charger resonator is coupled to a power supply ("charging circuit 156") and has a resonant frequency ω_1 , an intrinsic loss rate Γ_1 , and a first Q factor $Q_1 = \omega_1 / 2 \Gamma_1$. *See* Elements 13[a][i], 13[b][i], 3[b][ii], 13[b][iii], 13[b][iv], and 13[b][v]. The receiving vehicle includes a load (motors and batteries) configured to power the vehicle's drive system; it also includes a second electromagnetic resonator ("magnetic resonant antenna") that has a resonant frequency ω_2 , an intrinsic loss rate Γ_2 , and a second Q factor $Q_2 = \omega_2 / 2 \Gamma_2$. *See* Elements 13[c], 13[d][i]-[iv]. The two electromagnetic resonators are coupled to each other to wirelessly provide power through a non-radiative magnetic field. *See* Element 13[e]. And the receiving vehicle comprises an authorization facility (Bennett's "user authentication module," and related components for power exchange operation and resonant frequency selection) to confirm compatibility of the resonators and provide authorization for transfer of power. *See* Element 13[f].

2. Independent Claim 7: Power Source

188. As explained above, independent claim 7 recites “[a] power source for wirelessly providing power to a wireless receiver” and then lists all of the same elements as are in claim 13 regarding the structure and characteristics of the wireless power system. As the table in Section V.B above illustrated, Element 7[a] maps to Element 13[a], 7[b][i] to 13[b][i], 7[b][ii] to 13[b][ii], 7[b][iii] to 13[b][iii], 7[b][iv] to 13[b][iv], 7[b][v] to 13[b][v], 7[c] to 13[c] and 13[e], 7[d][i] to 13[d][i], 7[d][ii] to 13[d][ii], 7[d][iii] to 13[d][iii], 7[d][iv] to 13[d][iv], and 7[e] to 13[f].

189. It is my opinion that the Cook/Bennett combination taught or suggested each and every element of claim 7 in the same way and for the same reasons as discussed above with respect to claim 13. The only portion of claim 7 that is not substantively the same as claim 13 is the preamble, which recites a “power source for wirelessly providing power to a wireless receiver.” The Cook/Bennett combination taught this claim element. As I explained above, Cook’s “charging circuit” generates a magnetic field that provides power to vehicles that come into range. *See* Elements 13[pre], 13[b] (first electromagnetic resonator), and 13[e] (wireless coupling). Cook’s “automobile” is at least “partially electrically powered,” as claim 7 requires, because the “primary source of the automobile” is a “battery 102.” Cook at [0009]. Cook also explains that the vehicle

can be a “hybrid vehicle” that operates on both “electric power” and “gas power,” i.e., is “partially electrically powered.” Cook at [0010]-[0011].

190. The Cook/Bennett combination taught the remaining elements of claim 7 for all the same reasons as discussed above with respect to claim 13. In sum, the Cook/Bennett combination taught a power source (“charger 150” with “a charging circuit 156”) for wirelessly providing power to a wireless receiver of an at least partially electrically powered vehicle (Cook’s automobile). *See* Elements 13[pre], 13[b] (first resonator), 13[e] (wireless coupling). The charger 150 contains a power supply (“charging circuit 156”) that supplies power at a rate sufficient to charge the electric vehicle. *See* Element 13[a]. It further contains a first electromagnetic resonator (together the “coil 152” and “capacitor 154”) that has a resonant frequency ω_1 , an intrinsic loss rate Γ_1 , and a first Q factor $Q_1 = \omega_1 / 2\Gamma_1$. *See* Elements 13[b][i], 13[b][ii], 13[b][iii], 13[b][iv]. The charger 150 is wirelessly coupled to a second electromagnetic resonator (“magnetic resonant antenna ... formed from an inductive loop 111 in parallel with a capacitor 112”), which has a resonant frequency ω_2 , an intrinsic loss rate Γ_2 , and a second Q factor $Q_2 = \omega_2 / 2\Gamma_2$ and which is coupled to a load (motors and batteries) associated with the drive system of the vehicle. *See* Elements 13[c], 13[d]. And, in combination with Bennett, the charger includes an authorization facility (including Bennett’s “target device authenticator,” power manager and communication modules) to confirm

compatibility of the resonators and provide authorization for transfer of power. *See* Element 13[f].

D. Dependent Claims

191. Dependent claims 2 through 6, 8 through 12, and 14 through 18 would have been obvious over the combination of Cook and Bennett for the same reasons as claims 1, 7, and 13 and for the additional reasons that follow. Because each independent claim in the '687 patent has the same dependent claims—in other words, dependent claims were repeated to depend from each of the independent claims, as I illustrated above in Section V.B—I group overlapping dependent claims together in my analysis.

1. Claims 2, 8, and 14: Public Key Infrastructure

192. Claims 2, 8, and 14 respectively depend from claims 1, 7, and 14 and further recite “the authorization facility uses public key infrastructure.” The Bennett/Cook combination rendered this claim element obvious.

193. The '687 patent does not describe “public key infrastructure” other than to state that “[t]hose skilled in the art will appreciate” that “any known security and cryptography algorithms” can secure a communication channel between the charger and the vehicle, including “a public key infrastructure (PKI).” '687 patent at 184:16-23.

194. As discussed below, Cook and Bennett describe security and cryptography algorithms, including based on “tokens” and “keys,” but do not expressly use the phrase “public key infrastructure.” A POSA would have found a “public key infrastructure” obvious, however, because “public key infrastructures” were one a limited number of well-known systems for security and encryption for secure identification and authorization of multiple devices (e.g., Cook’s vehicles and Bennett’s target electronic device) to a common central system (e.g., Cook’s charger and Bennett’s transmitting unit).

195. While not described in the ’687 patent, a POSA would have understood that a “public key infrastructure” is a “set of policies” that use “cryptographic keys in a manner that allows users to reliably determine the identity of the owner of each public/private key pair.” Aull (Ex. 1008) at [0004]; Ward at 1:25-28 (“a technology known as Public Key Infrastructure (PKI) [] enables users to be authenticated to each other by confirming identities”). That is what Cook and Bennett taught.

196. Cook described a “real-time token type system” that can be used to encrypt a “vehicle’s private encryption key.” Cook at [0017]. Power is only authorized when the “controller” in the charger can “decrypt the encrypted message” using a “decryption key.” Cook at [0017]. Power is “allowed to be dispensed only if an encrypted value properly agrees with a proper encryption

code.” Cook at [0018]. Put another way, Cook taught the use of “cryptographic keys” that would allow the charger “to reliably determine the identity of the owner of” an automobile, corresponding to PKI. Aull at [0004]; Ward at 1:25-28.

197. A POSA implementing the Cook/Bennett combination would have understood Bennett’s system to also be consistent with PKI. Bennett taught that “[t]he rechargeable electronic device authenticates with the power transmitting unit 103 and receives a token that is used for subsequent communication and power charging (in one or more charging sessions).” Bennett at [0041]-[0042]; BProv at 13:7-22. Bennett explains:

The power transmitting unit may also include a token generator that generates a token for delivery to the target device during a target device registration operation. The power transmitting unit is then operable to authenticate the target device during subsequent power transmission operations based partially on the token. The token generator may include a pseudorandom number generator operable to generate the token. With these operations, the power transmitting unit may be operable to deliver power to the target device only after authenticating the target device.

Bennett at [0046]; *see also* Bennett at [0086] (explaining that the system includes “encryption/decryption of digital data”); BProv at 18:6-16 (“During the resonant power delivery session the power source 203 and an individual target device, such as the magnetic resonant target device 211, synchronize token and related authentication information to authenticate a target device as a legitimate power receiver.”), 25:19-26:3, 31:20-22 (claiming a “token generator [that] employs a

pseudorandom number generator”). As Bennett explains, generated tokens provide “security, confidentiality and non-repudiation” because decryption of the generated tokens requires a “key.” Bennett at [0062]; BProv at 18:17-23. Bennett taught that the transmitting unit identifies the target device by “comparing the identity data received with the subscription data stored in the database.” Bennett at [0072]; BProv at 21:17-21. Thus, Bennett taught cryptographic keys used “to reliably determine the identity of the owner of” a target electronic device, corresponding to a PKI-based system. *See* Aull at [0004]; Ward at 1:25-28. Both Cook and Bennett also specifically taught that the use of cryptographic keys and secure identification of a wireless power receiver was part of the process of initiating power transfer as claimed. In Cook, power transfer is only initiated when the “controller” in the charger can “decrypt the encrypted message” using a “decryption key.” Cook at [0017]. Similarly, in Bennett, power transfer is initiated only after the “power transmitting unit” authenticates with the “rechargeable electronic device.” Bennett at [0042], [0055] (“On confirming the identity of the magnetic resonant target device 211 the power source 203 delivers the resonant power signal.”); BProv at 13:14-22, 16:7-15.

198. To the extent Patent Owner or its expert contend the Cook/Bennett combination does not disclose a public key infrastructure, claims 2, 8, and 14 also would have been obvious in view of the knowledge of a POSA. As an initial matter,

the '687 patent correctly admits that PKI was well known to a POSA, stating that “[t]hose skilled in the art will appreciate” that “any known security and cryptography algorithms” can secure a communication channel, including “a public key infrastructure (PKI).” ’687 patent 184:16-23. Indeed, systems using PKI for encryption and security were widely used by, and known to POSAs by 2008. *See, e.g.*, Muftic (Ex. 1024) at Abstract (“The certification system with its multiple certification and its policies constitute a public key infrastructure facilitating secure and authentic transactions over an unsecure network.”), 18:13-15 (“In addition, the problems and shortcomings of the prior art are eliminated using the disclosed public key infrastructure described herein.”); Johnson (Ex. 1025) at 14:41-43 (“It is assumed that a public key infrastructure exists which is capable of providing certificates of public keys and for certificate management at client devices.”); Moses (Ex. 1027) at 1:6-9 (“The present invention relates generally to public key infrastructure and more particularly to obtaining status information relating to public key management certificate updates.”); Lewis (Ex. 1026) at cl. 12 (“wherein said replacement public key and replacement private key are used to encode data according to the Public Key Infrastructure for secure communications over a network”); Adams (Ex. 1028) at 1:62 (“Several types of public key infrastructure systems exists [sic].”), 5:5-10 (“The public key certificate containing the privilege test criteria data 110 may be stored in a local storage device or a centralized

repository accessible by the subscriber unit 200 in the same way that other public key certificates are available in known public key infrastructure systems.”).

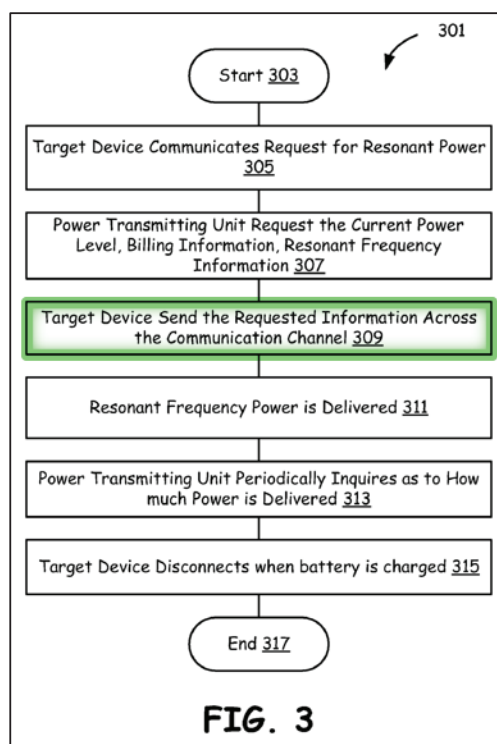
199. The Cook/Bennett combination taught, as discussed above, “encryption/decryption” of digital data on a communication channel used to authorize a target device before wireless power delivery. Bennett at [0086]; BProv at 25:19-26:3; Cook at [0017]-[0018]. A POSA would have recognized that public key infrastructure (PKI) was one of the predictable ways to do such encryption/decryption of the communication channel, and would have been motivated to implement a PKI system because it was so well known.

2. Claims 3, 9, and 15: Secure Communication Channel

200. Claims 3, 9, and 15 respectively depend from claims 1, 7, and 13 and further recite “the authorization facility uses a secure communication channel.” The Cook/Bennett combination disclosed this claim element.

201. Cook taught that authorization of power transfer included sending and receiving ID’s “wirelessly,” indicating a “communication channel,” and also taught “encryption” and “decryption” of the wirelessly transferred information to “cryptographically determine[] whether the power delivery is accurate.” Cook at [0017]-[0018]. A POSA would have understood this to mean that the “communication channel” used in Cook for authorization was secure.

202. Bennett also taught that a power transmitting unit (e.g., Cook's charger) and the target electronic device (e.g., Cook's vehicle) communicate with each other on a secure communication channel: the power transmitting unit's communication module includes a "digital processing module" that "performs the digital signal processing functionality, which includes encryption/decryption of the digital data, etc." Bennett at [0086]; BProv at 25:19-26:3. A POSA would have understood that encryption/decryption of digital data means the communication channel between the two devices was secure. As described in Bennett's Figure 3 flowchart, which I reproduce below with annotations, the target electronic device sends information relating to billing information across the secure "communication channel" at step 309:



Bennett at Fig. 3 (annotated); *see also* BProv at Fig. 3. Bennett explains that “FIG. 3 is a flowchart illustrating resonant power transfer operations performed using the power system of FIG. 1.” Bennett at [0057]; BProv at 4:8-10; 16:20-17:6.

203. The communication channel is “secure” because it uses encryption/decryption. Bennett at [0062] (tokens are exchanged for “security, confidentiality and non-repudiation”), [0086] (“communication module ... includes encryption/decryption of the digital data”); BProv at 18:17-23, 25:19-26:3; Cook at [0018] (“Power is allowed to be dispensed only if an encrypted value properly agrees with the proper encryption code and proper token time.”). The ’687 patent confirms a POSA’s understanding that the use of encryption/decryption for

digital data in Cook and Bennett would mean that the channel was secure, as it acknowledges that a “secure” channel is one that uses any type of “encryption,” “authentication” or “security.” ’687 patent at 184:10-13 (“[t]hose skilled in the art will appreciate a signaling and communication channel capable of transmitting messages may be secured with any number of encryption, authentication, and security algorithms.”).

3. Claims 4-5, 10-11, and 16-17: In-Band and Out-of-Band Communication

204. Claims 4, 10, and 16 respectively depend from claims 3, 9, and 15 and further recite “the channel is an in-band communication channel.” Claims 5, 11, and 17 also respectively depend from claims 3, 9, and 15 and further recite “the channel is an out-of-band communication channel.” Because these claims recite two alternatives, I discuss them together.

205. The Cook/Bennett combination taught these claims elements. Again, as I stated in the Motivation to Combine section and elsewhere, a POSA implementing Cook’s charger would have been motivated to implement Bennett’s security features to protect communications between the car and the charger. *See* Sections VIII.A, VIII.B.7.

206. Bennett taught that resonant coupling between the sending resonant coupling component and the receiving resonant coupling component “is achieved wirelessly using a ‘wireless field’ 111.” Bennett at [0031]; BProv at 9:21-10:11. In

some embodiments, Bennett said, “communicating the power and a control signal are conducted employing the same frequency, or in other words, on the same channel.” Bennett at [0031]; BProv at 9:21-10:11. In such embodiments, an “antenna 831 is used for both resonant power charging and normal communication operation.” Bennett at [0084]; BProv at 25:9-15.

207. Cook also taught in incorporated-by-reference Cook-086 that information and wireless power transfer can be transmitted on the same (in-band) frequency. For example, “the (predominantly) magnetic field of the transmitter is modulated or impressed with information so as to transfer information, along with power.” Cook-086 at 18:39-42. The information might “comprise[] control signaling between the receiver and transmitter, thereby obviating any separate data or communications link (and hence simplifying the system and making it more robust).” Cook-086 at 18:43-46. A POSA would expect Bennett’s in-band communication channel to be compatible with Cook’s resonators based on incorporated-by-reference Cook-086.

208. Bennett and Cook-086’s disclosure of same-frequency communication and power transfer corresponds to in-band communication as described in the ’687 patent. The ’687 patent describes “in-band communication channel” as using “at least some part of a magnetic resonator used to exchange power is also used to exchange information, and the carrier frequency of the

information exchange is close to the resonant frequency used in the power exchange.” ’687 patent at 180:44-49.

209. Bennett taught that other embodiments could use “out-of-band” communication, i.e., communication on a different frequency from the wireless field. For example, Bennett stated that “the power link (such as the magnetic field), the control signal, and the normal communication (i.e. the normal function) operation takes place in separate channels.” Bennett at [0031]; BProv at 9:21-10:11. Indeed, Bennett said that this method may be preferable because in-band channels can lower resonator Q factors. *See* Bennett at [0084]; BProv at 25:9-15 (noting that an in-band communication configuration “will disturb the resonant tuning of target device by lowering the quality factor”). In this alternative configuration, the coil/antenna used for wireless power transfer is separate from “another antenna 833 with the wireless link 835 [that] is employed exclusively for communication purposes.” Bennett at [0085], Fig. 8; BProv at 25:16-18, Fig. 8.

210. Cook taught the same in Cook-086, which contemplated that power and communication could be on separate channels. Cook-086 at 18:43-46. A POSA would therefore have understood this alternative in Bennett as describing the use of an “out-of-band” communication channel because Bennett and Cook-086’s disclosure of different frequencies used to transmit power and communications is the same as how the ’687 patent describes out-of-band communication: “[a]n out-

of-band communication channel may use an antenna and a signaling protocol that is separated from the energy transfer resonator and magnetic fields.” ’687 patent 180:49-53. A POSA would have been motivated to implement an out-of-band communication channel in Cook when designing a more sensitive system where Q should be preserved. *See* Motivation to Combine section above; Bennett [0084], 25:9-15.

4. Claims 6, 12, and 18: Safety Condition

211. Claims 6, 12, and 18 respectively depend from claims 1, 7, and 13 and further recite “the authorization facility further determines a safety condition for initiation of transfer of power.” The Cook/Bennett combination disclosed this claim element.

212. As I explained above in the Motivation to Combine section, a POSA would have been motivated to implement Cook’s electric car charger consistently with the principles described in Bennett. This would have included Bennett’s battery monitoring functionality, which, for the safety reasons outlined below, the POSA would have incorporated into the authorization facility in the combined Cook/Bennett system as a precondition for transfer of power.

213. Bennett taught that the power transmitting unit only initiates power transfer after a “target device power manager 127” in the target electronic device determines that the battery is at a safe level for charging. Bennett at [0039] (“The

target device power manager 127 manages the battery level of the rechargeable battery 129 by regulating the battery discharge and by initiating resonant power charge operation.”), [0041] (“The target device power manager 127 tracks the total charging time, amount of charge delivered, etc.”); BProv at 12:11-20, 13:7-13. A POSA would have understood that this safe battery level for charging corresponds to the claimed “safety condition.” In operation, a “low voltage sensor” in Bennett’s target electronic device determines when a target device’s battery level “falls below a threshold limit” or a “preset value,” indicating that power transfer should be initiated. Bennett at [0075]; *see also* [0076] (“The low voltage sensor 621 monitor the low voltage limit of the rechargeable battery and the high voltage sensor 623 monitor the high voltage limit.”), [0077] (describing the components of the “target device magnetic resonant power charging module,” including “a magnetic resonant target device authentication module” and “a magnetic resonant battery charging circuit”), [0082] (describing operation of low- and high-voltage limits); BProv at 11:9-17 (“The high voltage limit protects the battery”), 22:10-14 (“When the voltage falls below a preset value the power request module 611 communicates with the power source 203”), 22:15-19 (“The low voltage sensor 621 monitor the low voltage limit of the rechargeable battery and the high voltage sensor 623 monitor the high voltage limit.”), 22:20-23:5 (“a magnetic resonant

target device authentication module 707, a magnetic resonant frequency seeking module 709, a magnetic resonant battery charging circuit 711”).

214. Bennett’s system also only initiates power transfer when the battery level is below the “maximum allowable battery voltage,” which is the level where the system will “initiate[] a termination of power delivery.” Bennett at [0026], [0076], [0087]-[0090] (“high voltage limit” is monitored and there is “resonant power cutoff” when it is exceeded); BProv at 8:1-9 (“Once the battery is charged to a maximum level, the high voltage sensing circuitry initiates a termination of power delivery”), 22:15-19 (“The power charging controller 619 helps in maintaining the rechargeable battery charge at a safer limit”), 26:15-19 (“[T]he target device power manager 127 of Fig. 1 monitors the high voltage limit corresponding to the full battery charge condition and sets the high voltage flag.”).

215. As stated, a POSA would have understood that Bennett’s determination of the target electronic device’s battery level before initiating power transfer is a “safety condition.” Overcharging could cause explosions or fires, so a POSA would have been motivated to implement Bennett’s battery monitoring to “maintain the rechargeable battery at a safer limit for a smooth functioning of the target device.” Bennett at [0076]; BProv at 22:15-19.

* * *

Declaration for *Inter Partes Review* of USP 8,912,687

216. For the reasons set forth above, it is my opinion that the prior art renders obvious claims 1 through 18 of the '687 patent.

CONCLUSION

All statements made herein of my own knowledge are true, and all statements made on information and belief are believed to be true. Further, I am aware that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001. I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 16, 2023, in Philadelphia, PA.


Mark Allen