

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re *Inter Partes* Review of:)
U.S. Patent No. 8,461,719)
Issued: Jun. 11, 2013)
Application No.: 12/567,716)
Filing Date: Sep. 25, 2009)

For: **Wireless Energy Transfer Systems**

DECLARATION OF MARK ALLEN

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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. 8,461,719 (“the ’719 patent”) (Ex. 1001). The ’719 patent relates to near-field wireless energy transfer between a “source resonator” and a “second” (or “device”) resonator. ’719 patent at 2:14-37.

2. I understand that InductEV is petitioning for IPR of claims 16-17 of the ’719 patent and requests that the United States Patent and Trademark Office (“PTO”) cancel those claims.

3. In preparing this Declaration, I have reviewed the ’719 patent and considered the documents identified in Section III in light of the general knowledge in the relevant art. In forming my opinions, I relied on my education, knowledge, and experience (including my extensive research and development experience with wireless power transfer) and 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. At the beginning of my academic career in 1989, I founded my 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 that time. Although the composition as well as 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.

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 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 its wireless aneurysm pressure monitor was highlighted by the FDA 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 receiving FDA approval for its hemodynamic monitor, CardioMEMS was acquired by St. Jude Medical (now Abbott) 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. EnaChip was launched in 2017 and is focused on exploiting electroplatable, nanoengineered materials for the realization of ultracompact power supplies. In particular, Enachip 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 field of MEMS. Together with

this group, I have published approximately 400 technical articles in the field of MEMS. I hold approximately sixty U.S. patents in the MEMS area.

16. The work of my research group 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 a Fellow of the IEEE, 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 "For 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 (*e.g.*, ¶ 3) and elsewhere in this Declaration, in forming my opinions, I have considered the following documents:

Ex. No.	Description
1001	U.S. Patent No. 8,461,719 B2 (“719 patent”)
1002	File History for U.S. Patent No. 8,461,719 B2 (“719 FH”)
1005	U.S. Patent No. 8,855,554 B2 (“Cook-554”)
1006	File History for U.S. Patent No. 8,855,554 B2 (“Cook Provisional” or “CProv”)
1007	U.S. Patent No. 8,378,523 B2 (“Cook-523”)
1008	U.S. Patent Application Publication No. US 2007/0145830 A1 (“Lee”)
1009	International Patent Publication No. WO 2007/101902 A1 (“Pohjonen”)
1010	Estill I. Green, <i>The Story of Q</i> , in 43 Am. Scientist 584 (W.J. Cunningham et al ed., (1955)) (“Story of Q”)
1011	U.S. Patent No. 8,143,844 B2 (“Tamura”)
1012	Frederick Emmons Terman, <i>Electronic and Radio Engineering</i> (4th ed. 1955) (“Terman”)
1013	U.S. Patent No. 7,773,041 B2 (“Wang-041”)
1014	U.S. Patent No. 7,623,078 B2 (“Wang-078”)
1015	U.S. Patent No. 8,138,977 B2 (“Zhang”)
1016	U.S. Patent No. 9,223,345 B2 (“Dabov”)

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Ex. No.	Description
1017	U.S. Patent Application Publication No. 2002/0153531 (“Levine”)
1018	C. Yeh et al., <i>Dielectric Ribbon Waveguide--An Optimum Configuration for Ultralow-Loss Millimeter/Submillimeter Dielectric Waveguide</i> , prepared for Space Systems Division Airforce Command, by The Aerospace Corporation (Apr. 14, 1991) (“Yeh”)
1019	U.S. Patent No. 9,774,086 B2 (“Cook-086”)
1020	U.S. Patent No. 7,741,734 B2 (“Joannopoulos”)
1021	U.S. Patent Application Publication No. 2009/0299918 A1 (“Cook-918”)
1023	Kathleen O’Brien, <i>Inductively Coupled Radio Frequency Power Transmission System for Wireless Systems and Devices</i> (2007) (Ph.D. dissertation, Technische Universität Dresden (“O’Brien”))
1024	File History for Patent Application No. 12/649,635 (“12/649,635 FH”)
1025	File History for Patent Application No. 12/639,963 (“12/639,963 FH”)
1027	U.S. Patent No. 7,599,743 B2 (“Hassler”)
1028	U.S. Patent No. 8,446,045 B2 (“Smith”)
1029	<i>Flat</i> , The American Heritage Dictionary of the English Language (4th ed. 2000)
1030	<i>Flat</i> , Concise Oxford American Dictionary (2006)

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.

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 '719 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 16-17 of the ’719 patent, and prior art relating thereto, from the perspective of such a person at the time of the alleged inventions. I understand that the ’719 patent was filed on September 25, 2009, 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 September 27, 2008, I would have qualified as at least a POSA, and 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 '719 patent are directed to common wireless power transfer techniques using coupled resonators that were well-known in the art and 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 '719 PATENT

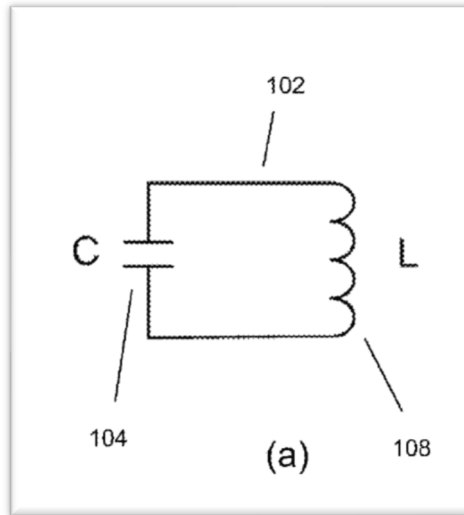
A. The '719 Patent

42. The '719 patent is generally directed to near-field “wireless energy transfer, also referred to as wireless power transmission.” '719 patent at 1:30-31; *see also* '719 patent at 2:14-17 (“disclosed herein [is] 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.”). More particularly, the '719 patent discusses wireless energy transfer from a “source resonator” to a “second” resonator (the “second” resonator is also referred to interchangeably as a “device” resonator). '719 patent at Abstract (“Described herein are improved capabilities for a source resonator...and a second resonator... where the source resonator and the

second resonator are coupled to exchange energy wirelessly among the source resonator and the second resonator.”), 3:48-64 (describing “wireless energy transfer” where a “[d]evice resonators may receive energy from a source resonator”). The ’719 patent also contemplates that there can be “intermediate” resonators that are used to “extend the range of the wireless energy transfer system by allowing energy to hop, transfer through, be temporarily stored be partially dissipated, or for the transfer to be mediated in any way, from a source resonator to any combination of other device and intermediate resonators.” ’719 patent at 3:52-60, 15:64-66. Intermediate resonators can also be a “device and source resonator simultaneously,” for example when they “relay power from a source in one location to a device in another location.” ’719 patent at 15:62-66, 4:4-12, 76:60-61 (“intermediate relay source coil”).

43. As the ’719 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.” ’719 patent at 11:37-40. 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. '719 patent at 18:63-19:8.



'719 patent at Fig. 6(a).

44. As explained by the '719 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 the magnetic field energy stored in the inductor,” “which in turn transfers energy back into the electric field energy stored in the capacitor.” '719 patent at 19:1-8. 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.” '719 patent at 20:61-21:2.

45. A resonator has a “characteristic, natural, or resonant frequency determined by its physical properties,” which is 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, and a resonator is defined in part by this “resonant frequency,” ’719 patent at 20:31, 20:61-21:32. Energy in the resonators may be lost by intrinsic losses such as “absorptive losses” and “radiative losses.” ’719 patent at 20:61-63. The absorptive losses are caused by “the finite conductivity of the conductor used to form the inductor” and “losses in other elements, components, [and] connectors” in the resonator. ’719 patent at 20:66-21:2. The “Quality Factor” of a resonator, which “characterizes its energy decay, is inversely proportional” to those losses. ’719 patent at 20:64-66. The quality factor Q of a resonator may be – absent significant radiative or component losses – calculated by the equation below:

$$Q_{abs} = \frac{\omega L}{R_{abs}},$$

where ω is the resonant frequency, L is the total inductance of the resonator, and R is the resistance of the conductor used to form the inductor. ’719 patent at 21:9-23.

46. A POSA would have known that this Q factor is a dimensionless constant that has been used for decades to measure the “quality,” or relative level of losses of resonators. A POSA would have also known that the relationship provided by the equation above was well known: a high Q value corresponds to low losses 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). Thus, it was commonly understood to POSAs that “[i]n a majority of situations the desired value of Q is the highest one economically attainable.” The Story of Q at 592.

47. The '719 patent states that, a “high-Q resonator may be defined as one with $Q > 100$ ” and provides examples where the quality factor of the source and device resonators can be greater than 100, or where the source and device resonators have a “geometric mean of the resonator Q’s [that] is greater than 100, $\sqrt{Q_s Q_d} > 100$.” '719 patent at 15:42-48. However, the '719 patent does not explain how the “geometric mean” relates to the performance of the disclosed system. For example, the '719 patent does not explain any significant or unexpected difference in performance in a system that has a “geometric mean” of quality factors that are greater than 100 as compared to a system having a “geometric mean” of quality factors that are less than 100. Similarly, the '719 patent does not impute any particular or unexpected benefit to a single resonator Q factor that is greater than 100 as compared to, for example, the same resonator having a quality factor of 99 (or less). The '719 patent acknowledges that “measurements of a wider variety of coil shapes, sizes, materials and operating frequencies than described above show that $Q's > 100$ may be realized for a variety of magnetic resonator structures using commonly available materials.” '719 patent at 24:61-65. In addition to providing examples of Q factors of above 1000, the '719 patent further acknowledges that “a

number of practical examples yield qualify factors of $Q \approx 1000-1500$.” ’719 patent at 24:59-61.

48. The ’719 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.” ’719 patent at 13:17-24. As the ’719 patent explained, “[t]here are a variety of physical pictures and models that may be employed to understand, design, optimize and characterize this energy exchange,” including the “coupled mode theory” which follows a set of linear equations. ’719 patent at 13:20-30.

49. Indeed, a POSA would have understood that electromagnetic resonators and the way that they interact and exchange energy was well understood and described in various introductory textbooks on AC theory. 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) and described the “elementary voltage, current and impedance relations of series resonant circuits [that] are discussed in every book on alternating currents”:

Analysis of Series Resonant Circuit. The elementary voltage, current, and impedance relations of series resonant circuits are discussed in every book on alternating currents. The basic quantitative relations are listed below for convenient reference.

$$\text{Resonant frequency} = f_0 = \frac{1}{2\pi \sqrt{LC}} \quad (3-2)$$

$$Z_s = R + j \left(\omega L - \frac{1}{\omega C} \right) \quad (3-3a)$$

$$|Z_s| = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C} \right)^2} \quad (3-3b)$$

¹ The circuit Q can also be defined as

$$Q = 2\pi \frac{\text{energy stored in circuit}}{\left\{ \begin{array}{l} \text{energy dissipated in circuit} \\ \text{during one cycle} \end{array} \right\}} \quad (3-1)$$

This relation follows from the fact that the energy stored in the inductance L when the current I is maximum (i.e., when all the stored energy is in the inductance) is $I^2 L/2$, where I is the peak current. At the same time, the energy lost per cycle in the circuit resistance R is $I^2 R/2f$, where f is the frequency.

$$\tan \theta = \frac{\omega L - (1/\omega C)}{R} \quad (3-4)$$

$$I = \frac{E}{Z_s} = \frac{E}{R + j[\omega L - (1/\omega C)]} \quad (3-5)$$

$$\text{Current at resonance} = I_0 = \frac{E}{R_0} \quad (3-6)$$

$$\text{Voltage across inductance} = j\omega L I \quad (3-7a)$$

$$\text{Voltage across capacitor} = \frac{-j}{\omega C} I \quad (3-7b)$$

where E = voltage applied to circuit

I = current flowing in circuit, amp

f = frequency, cycles

$\omega = 2\pi f$

$Q = \omega L/R$

R = total series resistance of tuned circuit

L = inductance, henrys

C = capacitance, farads

Z_s = impedance of series circuit

θ = phase angle of impedance

Subscript ₀ denotes values at resonant frequency

Terman 45-46; *see also generally* 44-50 (providing further information on series resonant circuit behavior).

50. Dr. Terman similarly described the related “fundamental relations” for parallel resonant circuits, where an inductance branch is formed in parallel with a capacitance branch:

The fundamental relations of a parallel resonant circuit are derived in every introductory book on a-c circuit theory, and are listed below for convenient reference.

$$\text{Parallel impedance} = Z = \frac{Z_c Z_L}{Z_c + Z_L} = \frac{Z_c Z_L}{Z_s} \quad (3-9)$$

$$\text{Line current} = \frac{E}{Z} \quad (3-10)$$

$$\text{Inductive branch current} = \frac{E}{Z_L} = \frac{E}{R_L + j\omega L} \quad (3-11)$$

$$\text{Capacitive branch current} = \frac{E}{Z_c} = \frac{E}{R_c - (j/\omega C)} \quad (3-12)$$

where E = voltage applied to circuit

$Z_c = R_c - (j/\omega C)$ = impedance of capacitive branch

$Z_L = R_L + j\omega L$ = impedance of inductive branch

$Z_s = Z_c + Z_L$ = series impedance of circuit

Z = impedance of circuit when connected in parallel

$R_s = R_c + R_L$ = total series resistance of circuit

$\omega = 2\pi$ times frequency

$Q = \omega L/R_s$ = circuit Q

These equations are fundamental to every parallel circuit, irrespective of the circuit Q , the frequency, or the division of resistance between the branches.

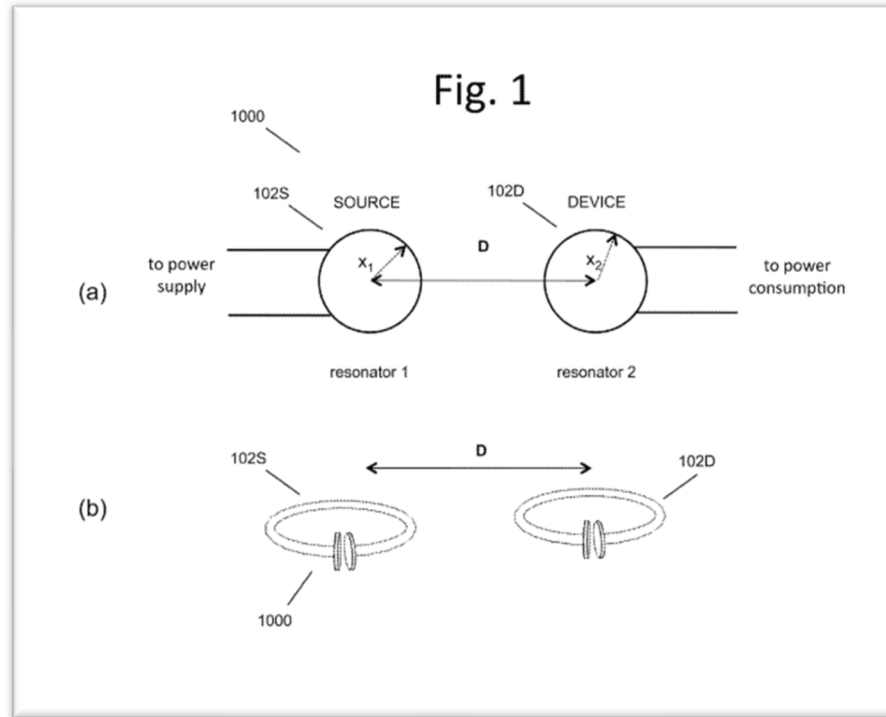
Terman at 51-52; *see also* Terman at 53-57 (providing further information on parallel resonant circuit behavior).

51. Dr. Terman also provided the physics and equations relating to mutual coupling of coils that are in separate circuits (*see generally* Terman at 19-21, 53-77)

as well as more specifically the “Behavior of systems Involving Resonant Primary and Resonant Secondary Circuits.” *See generally* Terman at 63-72.

52. As explained in the '719 patent, one way that energy between two resonators could be exchanged is by having the “source” resonator generate an oscillating magnetic field. This induces a current in the inductor of the second resonator, and “[w]ork may be extracted from the [second resonator] by a power consuming drain or load,” further causing energy to be wirelessly transferred to the second resonator over a distance D. '719 patent at 28:26-30. The source resonator may be driven by a power supply or generator that “constantly driv[es] the source resonator at a constant driving frequency.” '719 patent at 13:24-36. Thus, if the “source” resonator is connected to an appropriately configured power supply or generator to replenish the energy transferred from the “source” resonator to the

second resonator, continuous power can be transferred from the power supply to the second resonator, as demonstrated in Figure 1, which is reproduced below.



'719 patent at Fig. 1, 14:24-27.

53. The '719 patent states that it is directed to “electromagnetic resonators,” which include “magnetic resonators” and “electric resonators.” '719 patent at 18:43-19:7. A resonator is a “magnetic resonator” when the “electric field” is confined to the resonator and the “magnetic field” is primarily “in the region surrounding the resonator,” such that the “energy exchange is mediated primarily by the resonant **magnetic** near-field.” '719 patent at 18:43-49. An “electric resonator” has the opposite behavior, with the “magnetic field” confined to the resonator and the “electric field” primarily “in the region surrounding the resonator,” with the “energy

exchange [that] is mediated primarily by the resonant electric near field.” ’719 patent at 18:50-56. Put another way, a system with resonators that primarily transmit and receive energy through “magnetic fields” is a system using “magnetic resonators,” whereas a system with resonators that primarily transmit and receive energy through “electric fields” is a system using “electric resonators.”

54. The ’719 patent focuses almost entirely on “magnetic resonators” in its embodiments because they are “preferred in wireless energy transfer applications in populated environments because most everyday materials including animals, plants, and humans are non-magnetic (i.e., $\mu_r \sim 1$), so their interaction with magnetic fields is minimal and due primarily to eddy currents induced by the time-variation of the magnetic fields, which is a second-order effect.” ’719 patent at 19:9-20.¹ Indeed, this was well known. Cook-523 similarly described that “magnetic field coupling” is advantageously used for wireless power transfer over “electric field coupling” due to “relatively weak influence from extraneous objects” for magnetic field coupling.

¹ The only diagram of an example “electric resonator” in the ’719 patent is in Figure 6(e), which “shows a diagram of one example of an electric resonator.” ’719 patent at 7:20-21. Figure 6(e) is not otherwise discussed in the ’719 patent. *See* ’719 patent at 18:63-20:28 (discussing Figures 6(a)-6(d), but not 6(e)).

Cook-523 at 3:35-39. As I explain in more detail below, the resonators that I discuss from the prior art references in Grounds 1-4 below, including from Cook-554, Cook-523 and Lee, are also “magnetic” resonators that transmit energy primarily through magnetic field coupling.

55. The ’719 patent also explained that while resonators can have different geometries and coupling orientations, “planar resonators may be preferable for some applications.” ’719 patent at 28:40-42, *see also* ’719 patent at 28:19-39 (describing a “single planar resonator structure”). The inductive component in a planar resonator is “flat” and its “low profile” (i.e. a small thickness) makes it easier to integrate into “many electronic devices that are relatively flat and planar” like typical “mobile devices,” including by making it easier to integrate “into or as part of a complete side of a device.” ’719 patent at 28:40-60; *see also* ’719 patent at 30:65-31:9 (“The structures and configuration may be useful for a large number of applications where electronic or electric devices and a power source are typically located, positioned, or manipulated in substantially the same plane and alignment. Some of the possible application scenarios include devices on walls, floor, ceilings or any other substantially planar surfaces.”).

56. The ’719 patent also explains that in applications where high Q resonators are subject to environmental variations, i.e., “where the low-loss inductive element or the external circuit, may exhibit variations,” tuning the

capacitance of the circuit “dynamically to match the inductive element to the external circuit impedance” may be necessary to preserve the high Q. ’719 patent at 45:54-63. This tuning can be done, for example, by connecting the inductive component to “networks of variable capacitors.” ’719 patent at 45:64-46:5, 46:37-44 (explaining that the “topology of the circuit matching a variable inductive element to an impedance, Z_0 , may include appropriate combinations and placements of fixed and variable elements, so that the voltage/current requirements for the variable components may be reduced and the desired tuning range may be covered with finer tuning resolution.”).

57. The ’719 patent discloses that “source and device resonators” may be “enclosed in an enclosure, container, sleeve or housing” that may be composed of “almost any kind of material.” ’719 patent at 59:40-43. The ’719 patent states that “[l]ow loss tangent materials such as Teflon, REXOLITE, styrene, and the like may be preferable for some applications.” ’719 patent at 26:17-24, 59:43-45. Besides providing these examples, the ’719 patent states that “low loss tangent materials” may have a “negligible impact on the losses of a magnetic resonator” whereas materials with “moderate to high loss tangents” may have “relatively high dissipative losses.” *See* ’719 patent at 34:61-35:6. The ’719 patent does not provide any definitive bounds for what constitutes a material with a “low”— as compared to

a “moderate to high”—loss tangent. I note that the ’719 patent does not provide the numerical value for the loss tangent of these materials.

58. A POSA, based on his or her understanding of the art, would have understood that the loss tangents of the exemplary materials with “low loss tangents” have loss tangents in the range from 0.0002 to 0.001 at a frequency of approximately 10GHz, which is the top end of the operating frequencies that the ’719 patent states its systems will use. *See* ’719 patent 3:39-43 (“Disclosed herein are electromagnetic resonators and systems of coupled electromagnetic resonators, also referred to more specifically as coupled magnetic resonators and coupled electric resonators, with *operating frequencies below 10 GHz.*”), 62:27-30. In particular, Teflon (PTFE) has a loss tangent of 0.0002, Rexolite has a loss tangent of 0.001, and polystyrene has a loss tangent of 0.0003. *See* Yeh at 10, Levine at ¶¶ 113, 122.

B. The Challenged Claims

59. The ’719 patent recites three independent claims, claims 1, 16 and 17, and fourteen dependent claims, claims 2-15, all of which depend from claim 1. I understand that Petitioner is challenging claims 16 and 17, which I address below.

60. Claim 16 recites the following requirements, with designations I’ve added in brackets for reference to different parts of the claim:

[16pre] A system, comprising:

[16a] a source resonator having a Q-factor Q_1 and a characteristic size x_1 , and

[16b] a second resonator having a Q-factor Q_2 and a characteristic size x_2 , and located a distance D from the source resonator;

[16c] wherein the source resonator and the second resonator are coupled to exchange energy wirelessly among the source resonator and the second resonator; and

[16d] wherein $\sqrt{Q_1 Q_2}$ is greater than 100, and

[16e] wherein at least one of the resonators is enclosed in a low loss tangent material

61. Similarly, Claim 17 recites the following elements with designations

I've added in brackets for reference to different parts of the claim:

[17pre] A system, comprising:

[17a] a source resonator having a Q-factor Q_1 and a characteristic size x_1 , and

[17b] a second resonator having a Q-factor Q_2 and a characteristic size x_2 , and located a distance D from the source resonator;

[17c] wherein the source resonator and the second resonator are coupled to exchange energy wirelessly among the source resonator and the second resonator, and

[17d] wherein $\sqrt{Q_1 Q_2}$ is greater than 100; and;

[17e] wherein at least one of the resonators includes a coil of a plurality of turns of a conducting material connected to a network of capacitors, wherein the plurality of turns are in a common plane,”

[17f] and wherein a characteristic thickness of the at least one of the resonators is much less than a characteristic size of the at least one of the resonators.

62. As referenced above, the preamble and first four parts of claims 16 and 17 are identical, i.e., [16pre] is the same as [17pre], [16a] is the same as [17a], [16b] is the same as [17b], [16c] is the same as [17c], [16d] is the same as [17d].

C. Prosecution History

63. During prosecution, the Examiner rejected claims 1, 3-4 and 17 as anticipated by Joannopoulos and claims 1, 5-6, 18 and 21 as anticipated by Cook-492. *See* '719 FH at 577-578. As shown below, the Examiner found that each reference disclosed (1) a source resonator having a first Q-factor and a characteristic size, (2) a second resonator having a second Q-factor and a characteristic size, (3) the resonators coupled to exchange energy wirelessly over a distance D, and (4) wherein the square root of the product of the Q-factors is greater than 100:

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As to claim 1, Joannopoulos discloses a system comprising: a source resonator (1) having a first Q-factor and a characteristic size, coupled to a power generator (power supply) with direct electrical connections; and a second resonator (2) having a second Q-factor and a characteristic size, coupled to a load with direct electrical connections, and located a distance D from the source resonator (1), wherein the source resonator (1) and the second resonator (2) are coupled to exchange energy wirelessly among the source resonator (1) and the second resonator (2) in order to transmit power from the power generator to the load, wherein the square root of the product of the Q-factors is greater than 100 (if both Q-factors are greater than 100, the square root of their product will be greater than 100) (see column 1, lines 54-60; column 2, lines 30-33 and 58-61; column 4, lines 37-40; and Figure 1).

As to claim 1, Cook discloses a system comprising: a source resonator (112) having a first Q-factor and a characteristic size, coupled to a power generator (102) with direct electrical connections; and a second resonator (155) having a second Q-factor and a characteristic size, coupled to a load with direct electrical connections, and located a distance D from the source resonator (112), wherein the source resonator (112) and the second resonator (155) are coupled to exchange energy wirelessly among the source resonator (112) and the second resonator (155) in order to transmit power from the power generator to the load, wherein the square root of the product of the Q-factors is greater than 100 (e.g. the first Q-factor may be 1400 and the second Q-factor may be 300) (see paragraphs [0020]-[0021], [0025], and [0034], and Figure 1).

'719 FH at 577-578.

64. These limitations were also in pending claims 22 and 23 (now challenged claims 16 and 17), but the Examiner allowed these claims in view of their additional limitations:

Claim 22 is allowed because none of the prior art of record discloses or suggests the square root of the product of the first and second Q-factors being greater than 100, and at least one of the resonators being enclosed in a low loss tangent material, in combination with the remaining claimed features.

Claim 23 is allowed because none of the prior art of record discloses or suggests at least one of the resonators including a coil of a plurality of turns of a conducting material connected to a network of capacitors, wherein the plurality of turns are in a common plane, and wherein a characteristic thickness of the at least one of the resonators is much less than a characteristic size of the at least one of the resonators, in combination with the remaining claimed features.

'719 FH at 681. In response and without addressing the merits of the Examiner's rejections, the Applicant either canceled the pending claims rejected by the Examiner or amended them to depend on claims the Examiner stated would be allowable. '719 FH at 718-719. The Examiner then allowed the remaining claims for the same reasons set forth in the original Office Action.

65. I note that Cook-492 names the same inventors as Cook-523 and Cook-554 discussed in greater detail below. Cook-492 also appears to share similar Figures with Cook-523, such as Figure 14 of Cook-554 and Figure 7 of Cook-492, but Cook-523 also includes a number of additional disclosures that do not appear in Cook-492

including its Wireless Power Bridge embodiment which is discussed in more detail below. Cook-492 is even less similar to Cook-554 in providing details regarding its control system and tuning.

VI. CLAIM CONSTRUCTION

66. I have been informed by counsel that the words of a claim are generally given their ordinary and customary meaning, but if the specification defines a claim term, then that definition governs. The '719 patent defines two terms that are used in claims 16 and 17, “characteristic size” (both claims) and “characteristic thickness” (claim 17 only), which I address below.

1. “characteristic size”

67. Claims 16 and 17 recite source and second resonators with a “characteristic size.” See Elements [16a] (“characteristic size x_1 ”), [16b] (“characteristic size x_2 ”), [17a] (“characteristic size x_1 ”), [17b] (“characteristic size x_2 ”), [17f] (“characteristic size of the at least one of the resonators”). The '719 patent “defines” the “characteristic size” of a resonator depending on whether it is a “magnetic resonator” or an “electric resonator.” '719 patent at 23:27-33 (“It is to be understood that the characteristic sizes 802 of resonators 102 may be **defined** in terms of the size of the conductor and the area circumscribed or enclosed by the inductive element in a magnetic resonator and the length of the conductor forming the capacitive element of an electric resonator.”).

68. Magnetic resonators, i.e., resonators where energy is primarily exchanged by “the resonant magnetic near field,” have a “characteristic size” “equal to the radius of the smallest sphere that can fit around the **inductive** . . . element.” ’719 patent at 23:33-37, 18:43-49 (explaining that resonators are “magnetic resonators” when energy is primarily exchanged by “the resonant magnetic near field”).

69. Similarly, for electric resonators, i.e., resonators where energy is primarily exchanged by the “resonant electric near-field”, the “characteristic size” is equal to the “radius of the smallest sphere that can fit around the **capacitive** element.” ’719 patent at 23:33-37, 18:50-56 (resonators are “electric resonators” when energy is primarily exchanged by the “resonant electric near-field”).

2. “characteristic thickness”

70. Claim 17 of the ’719 patent requires that one or more resonators have a “characteristic thickness.” Just as with the characteristic size, the “characteristic thickness” as defined in the ’719 patent depends on whether the resonator is “magnetic” or “capacitive” (i.e., electric). ’719 patent at 23:38-42 (defining characteristic thickness based on whether the resonator is magnetic or capacitive); For a “magnetic” resonator, the “characteristic thickness is the “highest point of the inductive . . . element . . . measured from a flat surface on which it is placed.” ’719 patent at 23:38-42. For a “capacitive” resonator, the characteristic thickness is “the

smallest possible height” of the “capacitive element,” i.e., the thickness is measured using the height of the “capacitive element” rather than the inductive element as used for the magnetic resonator. ’719 patent at 23:38-42.

71. To the extent that the foregoing descriptions of “characteristic size” and “characteristic thickness” are not construed according to their definitions, my opinion as to the invalidity of claims 16 and 17 would not change as my opinions would also apply under any reasonable construction, including the plain meaning.

VII. OVERVIEW OF THE PRIOR ART

72. I have been informed that the documents described in this section constitute prior art to the ’719 Patent. I am not a lawyer, and I do not purport to be an expert in determining whether a document constitutes prior art.

A. Cook-554

1. Prior Art Status

73. Cook-554 was filed on March 4, 2009, and also claims priority to the Cook Provisional that was filed on March 5, 2008. I understand that Cook-554 was also previously published as U.S. Pat. Publ. No. 2009/0243397, which appears on the face of the ’719 patent along with hundreds of other references. Based on my review of the file history, it does not appear that the Examiner considered Cook-554’s disclosures in any office action.

2. Overview

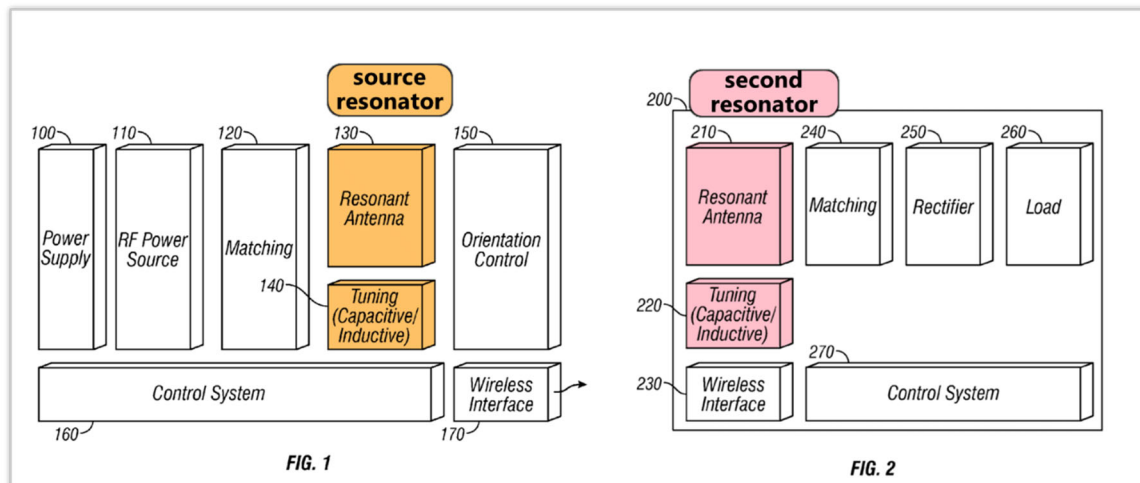
74. Cook-554, like the '719 patent, describes the “use and applications of wireless power,” including the “tuning of wireless antennas, and packaging of those antennas.” Cook-554 at 2:11-14; Cook Provisional at Title, 25. Specifically, Cook-554 discloses “wireless energy transfer” that is “based on coupled magnetic resonance using magnetic field antennas,” where wireless power is transmitted from a “resonant” transmitting antenna to a “resonant” receiving antenna. Cook-554 at 8:54-57 (further describing “a loop or coil operating either in the LF or HF frequency range”); 10:32-34 (describing a “Wireless Power Bridge” that is “based on magnetic-field inductive coupling between a resonant transmit antenna and a resonant receive antenna.”); *see also* Cook Provisional at 34.

75. Figures 1 and 2 of Cook-554, reproduced with annotations below, provide a block diagram of a “generic wireless energy source” and generic “receiver,” where the receiver “includes similar parts to those of the transmitter in Fig. 1, in essentially reverse order.” Cook-554 at 3:21-29 (describing the “generic wireless energy source”), 4:26-34, 6:14-32 (describing a “receiver” that is “shown generically in Fig. 2”); *see also* Cook Provisional at Figs. 3-1,3-2 (same). The wireless energy source “produces power at a specified RF frequency” and contains a matching circuit that “matches the RF output to the resonant antenna,” where the antenna may have

a tuning and orientation “control” that can control characteristics of the transmission.”

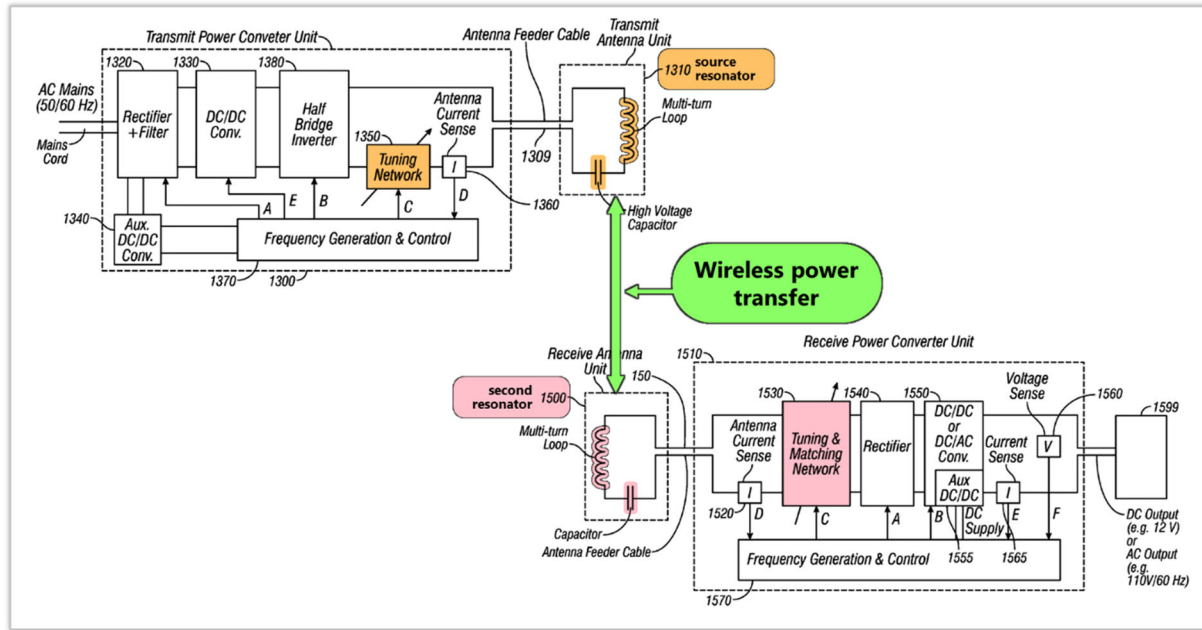
Cook-554 at 3:21-29.

76. As shown in the annotated figure below, the energy source and receiver each include a resonator that includes a resonant antenna connected to a capacitive/inductive tuning system.



Cook-554 at Figs. 1 and 2 (annotated); Cook Provisional at Figs. 3-1, 3-2.

77. Cook-554 details the “transmit and receive subsystem[s]” for a wireless power device as shown in Figures 13 and 15, respectively, which can be used with “any of the wireless power embodiments” that are disclosed in Cook-554:



Cook-554 at Figs. 13, 15); *see also* Cook-554 at 11:20-24 (Fig. 13 shows a block diagram of a transmit subsystem”), 13:46-49 (“The receive subsystem is shown in FIG. 15.”); Cook Provisional at 40-43 (transmit subsystem), 43-45 (receive subsystem), 59, Figs. 4-11, 4-12.

78. As shown in the annotations in the figure above, the transmit subsystem includes a source resonator that includes an inductive component (a “multi-turn loop”), a capacitive component (i.e., a “capacitor”), and an inductive or capacitive tuning network. Cook-554 at 13:12-20 (“The transmit antenna unit includes a multi-turn loop (coil) and a high voltage capacitor forming a principal part of a series tank circuit.”), 13:30-32 (“The antenna 1400 is formed of a coil part 1405 and a high voltage capacitor 1410”), 11:31-35 (explaining that the “tuning network” can be powered “to maintain precise resonance maximizing antenna current”). The tuning

network can “adjust parameters to maintain the antenna operated at resonance.” Cook-554 at 12:19-38; Cook Provisional at 42.

79. Similarly, the receive subsystem includes a second resonator, also with a multi-turn loop and capacitor as part of the “receive antenna unit” further connected to a “tuning & matching network” within the receive power converter unit. Cook-554 at Fig. 15, 13:46-54; Cook Provisional at 43. Cook-554 states that the resonators have high Q-factors and provides Qs ranging in the hundreds or thousands. Cook-554 at 13:35-41 (discussing high Q-factor), 13:50-51 (explaining that the “receive antenna unit” “may be identical to the transmit antenna unit”), 10:32-44 (explaining that its “Wireless Power Bridge” can be accomplished “through use of two resonant antennas applying coupled resonance with a high Q-factor (typically >200); 2:4-7 (“In one embodiment, two high-Q antennas are placed such that they react similarly to a loosely coupled transformer, with one antenna inducing power into the other. The antennas preferably have Qs that are greater than 1000.”); ; Cook Provisional at 17 (§5), 26, 32, 40.

80. Cook-554 also disclosed wireless energy transfer used for various applications. For example, in some embodiments, the receiving resonant antenna may be “integrated” in a portable device for wireless charging of, for example, cellular phones. Cook-554 at 9:29-46 (describing embodiments with “integrated” antennas in a cellular phone that “uses magnetically coupled resonance to transfer

the power from source to receiver”), 8:65-9:4 (providing examples of various types of wireless power enabled devices); Cook Provisional at 34, 36-39.

81. In these configurations, the receive antennas are “internal” to (i.e., inside) the mobile device housing and are integrated into parts that have “lower losses” and “better penetration of magnetic fields” so that a higher Q-factor of the integrated resonator is maintained. Cook-554 at 9:15-50 (“... internal antenna 705 in the portable device 710. In this embodiment, the internal antenna 705 is a ferrite rod antenna. Since the device and its internal antenna 705 ... in FIG. 7, both the wireless charging station 699 and the portable device 720 integrate a resonant magnetic antenna”), 19:24-50 (explaining that “”a high Q resonant loop/coil antenna should” “ideally” “be separated from the device main body” (as in a “clamshell style phone) and further explaining that “[a]nother embodiment integrates the antenna into a part, causing lower losses and providing better penetration of magnetic fields because it contains less metallic and/or dielectric structure.”); Cook Provisional at 58.

82. In another embodiment labelled a “Wireless Power Bridge,” the transmit and receive antennas are not integrated into devices to be charged but instead formed as planar “flat panels” that “transmit power through walls or windows” for example, in situations where it would be inconvenient to place a wire or typical wired plug. Cook-554 at 10:8-11 (explaining that a “wireless power bridge”

is used when “it may be convenient to transmit power through walls or windows.”), 10:25-31 (“The transmit subsystem may also produce an invisible local power hot spot that enables easy access to electric power from the other side of a wall using a compatible receiving devices.”); *see generally* Cook-554 at 10:8-11:19, Figs. 10-11; Cook Provisional at 40-42, Fig. 4-8.

83. Like other embodiments, the Wireless Bridge uses “magnetic-field inductive coupling between a resonant transmit antenna and a resonant receive antenna.” Cook-554 at 10:32-34, 10:61-65 (explaining that the system includes, among other things, a “[t]ransmit antenna unit (flat panel) that is resonant on the operating frequency” and a “[r]eceive antenna unit (flat panel) that integrates a multi-turn loop (coil) and a capacitor to achieve resonance at the desired operating frequency”); *see also* Cook-554 at Figs. 10-11; Cook Provisional at 40.

3. Cook-554 Claim 17 is supported by Cook Provisional

a. 17[pre] Preamble

84. To the extent the preamble is limiting, the Cook Provisional supports the preamble of claim 17 of Cook-554 requiring “a method comprising” because it discloses methods that support the limitations as I discuss below. *See also* Cook Provisional at 17 (disclosing a “method to match to the impedance of the antenna”), 18 (“tuning methods”), 20 (“methods of tuning”), 43 (Receive antenna tuning “methods”); Cook Provisional at 29 (“method to match to the impedance of the

antenna”), 30 (“tuning methods”), 32 (“methods of tuning”), 55 (Receive antenna tuning “methods”).

b. 17[a] Receiving Power

85. Cook-554 claim 17 recites: “receiving power via a resonant circuit from a non-modulated wireless magnetic field at an operating frequency and at a receive power level.” The Cook Provisional supports this first step in claim 17.

86. Specifically, the Cook Provisional discloses “magnetic-field (inductive) coupling between a resonant transmit antenna and a resonant receive antenna and uses an [sic] non-modulated carrier frequency.” Cook Provisional at 28 (“The proposed Wireless Power Bridge is based on magnetic-field (inductive) coupling between a resonant transmit antenna and a resonant receive antenna and uses a[] non-modulated carrier frequency” ... appropriate for wireless transmission through a wall or window.... The system is capable of efficiently transferring power through a non-metallic wall of thickness in the range of a few mm up to 40 centimeters also depending on the size of the antenna. This is accomplished through use of two resonant antennas applying the principle of coupled resonance with high Q-factor (typically > 200)); 63 (“wireless power systems produce essentially non-modulated radiation fields), Figs. 4-11, 4-12. The “receive antenna unit” includes a “multi-turn loop (coil) and a capacitor” (a “resonant circuit”) that “achieve[s] resonance at the desired operating frequency.” Cook Provisional at 40 (“Receive

antenna unit (flat panel) that integrates a multi-turn loop (coil) and a capacitor to achieve resonance at the desired operating frequency”), Figs. 4-11, 4-12; *see also* Cook Provisional at 40-48 (describing transmit and receive subsystems as shown in Figs. 4-12 and 4-13), Fig. 4-12, 4-13. The Cook Provisional states that the “preferred frequency is in the range from 20 kHz to 135 kHz.” Cook Provisional at 40; *see also* Cook Provisional at 36 (“The operating frequency is preferably either in the LF or HF frequency range.”).

c. 17[b] Converting Power

87. Claim 17 of Cook-554 next recites: “converting the received power, so as to charge a battery, with a power converting circuit having an impedance value that is variable.” The Cook Provisional supports this second step in claim 17.

88. Specifically, the Cook Provisional discloses a “receive power converter unit” for a target load, e.g., a “battery of a device.” Cook Provisional at 40 (describing a “receive power converter unit”); 30 (“the target load that consumes the transferred energy (e.g. battery of a device, device circuitry”), 31-32 (describing “Receive power converter unit” and its subunits, including, among subunits, a “Antenna current sense,” a “tuning and matching network,” “[r]ectifier generating the raw DC voltage required in the following stages,” a “DC/DC or DC/AC converter”), Fig. 4-12. The receive power converter unit “integrates an AC/DC [] frequency converter, which reconverts the frequency used for wireless transmission

into the required DC voltage.” Cook Provisional at 40. As explained above, the receive power converter unit can vary impedance by using a variable inductor or variable capacitors, as described above. *See* Cook Provisional at 55-57 (describing “Receive antenna tuning” including through “techniques to create antenna load impedance that can be varied”), Figs. 5-5, 5-6, 5-7.

d. 17[c] Varying Impedance

89. Claim 17 of Cook-554 next recites “varying the impedance value of the power converting circuit to tune the resonant frequency of the resonant circuit based on the received power level.” The Cook Provisional supports this final step in claim 17.

90. The Cook Provisional explains that because “[h]igh Q-factor means low bandwidth thus little tolerance for variations of L and C values due to” “manufacturing tolerances,” “ageing,” “environmental effects,” and non-linear and memory effects (e.g., in conjunction with the use of permeable magnetic materials)”, in “practical high-Q designs[,] readjusting (tuning) of the resonance frequency is often compulsory.” Cook Provisional at 51. In turn, the Cook Provisional discloses techniques for tuning the resonance frequency, including the use of variable capacitance, inductance, or both, to “create antenna load impedance that can be varied in terms of both resistive (real) part and reactive (imaginary) part.” Cook Provisional at 55; *see also* Cook Provisional at 44 (“The tuning and matching

network is generally needed to ensure that the receive antenna is operated at resonance...This is particularly true for all applications requiring maximum transmission range and efficiency”), 57 (discussing a method for “fine tuning a receive antenna” as shown in Fig. 5-7 using a “Tuneable load impedance”), Fig. 4-12.

91. In addition to fully supporting and enabling claim 17 of Cook-554 as I explained above, the Cook Provision provides the same teachings as in Cook-554, as I demonstrate further below through citations to both Cook-554 and the Cook Provision in my discussion on Grounds 1A and 1B.

B. Pohjonen

92. Pohjonen does not appear as a reference cited during prosecution of the '719 patent.

93. Pohjonen concerns the “selection of cover materials and structures for” a portable radio device that includes an internal antenna to “enhance antenna efficiency.” Pohjonen at 1. Pohjonen explains that POSAs knew and understood that in order to maintain antenna efficiency, the “outer cover should naturally cause as little attenuation of radio waves as possible, so that it would allow the antenna to freely receive and transmit radio frequency transmissions” and further discloses prior art disclosing a “combined antenna and cover structure.” Pohjonen at 1.

94. Pohjonen explains that a known problem with integrated antennas in portable radio devices is the “effect of radio frequency losses in the cover materials” that has a known solution, namely, using materials with “as low losses as possible” for the outer cover. Pohjonen at 2 (citing WO 2005/034286 and US 5,455,596). However, that solution, Pohjonen states, was only described in the form of “abstract statements” in the prior art literature. Pohjonen at 2.

95. Thus, Pohjonen is directed “present[ing] an antenna structure for portable radio devices, which has low losses and good reliability in operation” and “increases the convenience of use to a human user” and evaluates commonly used materials used for the outer covers of these devices. Pohjonen at 2-3. Pohjonen achieves its objectives of “low loss,” “good reliability, and therefore increased convenience by “making the outer cover of a portable radio device” from a “very low loss thermoplastic material,” which has a “loss tangent value of which is less than 0.005.” Pohjonen at 2-3. With values less than 0.005, Pohjonen concludes that the outer cover’s loss tangent value “becomes acceptable in terms of [having] only very little additional loss caused to the antenna.” Pohjonen at 6. Pohjonen, however, notes that [t]his value is not an exact limit, but merely serves to illustrate the order of magnitude at which the loss value becomes acceptable.” Pohjonen at 6.

96. Pohjonen provides exemplary materials that have acceptable loss tangent values, including polyolefin based thermoplastic resins, polycarbonate and polystyrene, which are “well suited for injection molding and other large-scale methods of precision manufacturing of plastic components.” Pohjonen at 7.

Pohjonen also states as background that polycarbonate and polystyrene were two of the “most common materials used for injection moulding” and that “[a] vast majority of outer covers for portable radio devices are manufactured by injection moulding:”

lected on other grounds than low RF losses. A vast majority of outer covers for portable radio devices are manufactured by injection moulding. The material used for an injection moulded outer cover must naturally have properties that are advantageous in the process. Also, the completed outer cover must have sufficient mechanical stiffness and durability as well as dimensional accuracy, and it must serve as a good basis for surface treatments such as decorative painting.

Pohjonen at 2.

The most common materials used for injection moulding are acrylonitrile-butadiene-styrene (ABS), polycarbonate (PC), high-density polyethylene (HDPE), poly-methyl-methacrylate (PMMA), polypropylene (PP), polystyrene (PS), and polyvinyl chloride (PVC). Loss tangent values for these materials in their pure forms are found in B. Riddle, J. Baker-Jarvis, J. Krupka: “Complex Permittivity Measurements of Common Plastics Over Variable Temperatures”, IEEE Transactions on Microwave Theory and Techniques, Vol. 51, No. 3, pp. 727-733, March 2003. Approximate values for frequencies around 10-11 GHz and room temperature are the following: ABS 0.006-0.009, PC 0.0004-0.0006, HDPE 0.0001-0.0002, PMMA 0.006-0.01, PP 0.00007-0.0001, PS 0.0004-0.0006, and PVC 0.005-0.008.

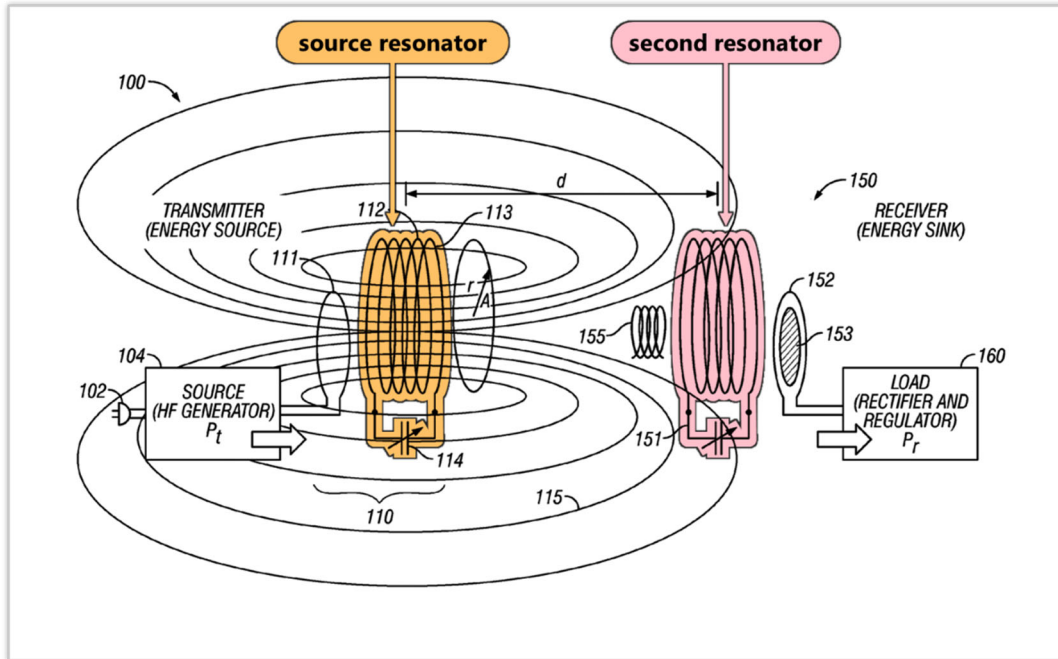
Pohjonen at 2.

C. Cook-523

97. Cook-523 is a U.S. patent filed on September 16, 2008.

98. I note that the disclosures of Cook-523 described in the ground below were not considered during prosecution because Cook-523 is a continuation-in-part of application No. 12/018,069 that is cited on the face of the '719 patent, but that application (to the extent it was considered by the Examiner, as it does not appear to be discussed in any office action) did not include the additional teachings of Cook-523. In particular, and as I address in more detail below, Cook-523's Figures 12-13 embodiments where a second resonator is "integrated" in a mobile device that was not included in the applications considered by the Examiner during prosecution of the '719 patent.

99. Like the '719 patent and Cook-554 described above, Cook-523 generally relates to wireless power transfer through the use of magnetically coupled resonators. Cook-523 Title, Abstract. Specifically, Cook-523 describes energy transferred wirelessly from a transmitting "resonant antenna" to a receiving "resonant antenna," where each is a resonator comprising an inductive coil and a capacitor, as shown below in Figure 1. Cook-523 at 3:24-26, 3:33-35, 2:49-53.



Cook-523 at Fig. 1 (annotated); *see also* Cook-523 at 2:33-45.

100. Cook-523 explains “magnetic field coupling” is advantageously used over “electric field coupling” due to “relatively weak influence from extraneous objects” for magnetic field coupling. Cook-523 at 3:33-39. Cook-523 further teaches that its “antennas preferably have Qs that are greater than 1000” and are “preferably of a small size to allow it to fit into a mobile, handheld device where the available space for the antenna may be limited.” Cook-523 at 1:31-45. And Cook-523 teaches that “wireless power may be integrated into portable devices” by, for example, having the antenna coil “formed on the insulator” that is adjacent to the external surface of the portable device. Cook-523 at 13:17-39; Figs. 12A-C, Figs. 13A-B. The disclosed layouts allow the “magnetic field 1226 created by the

antenna [to pass] through” a gap as well as “minimize[] eddy current effects.”

Cook-523 at 13:17-39.

D. Lee

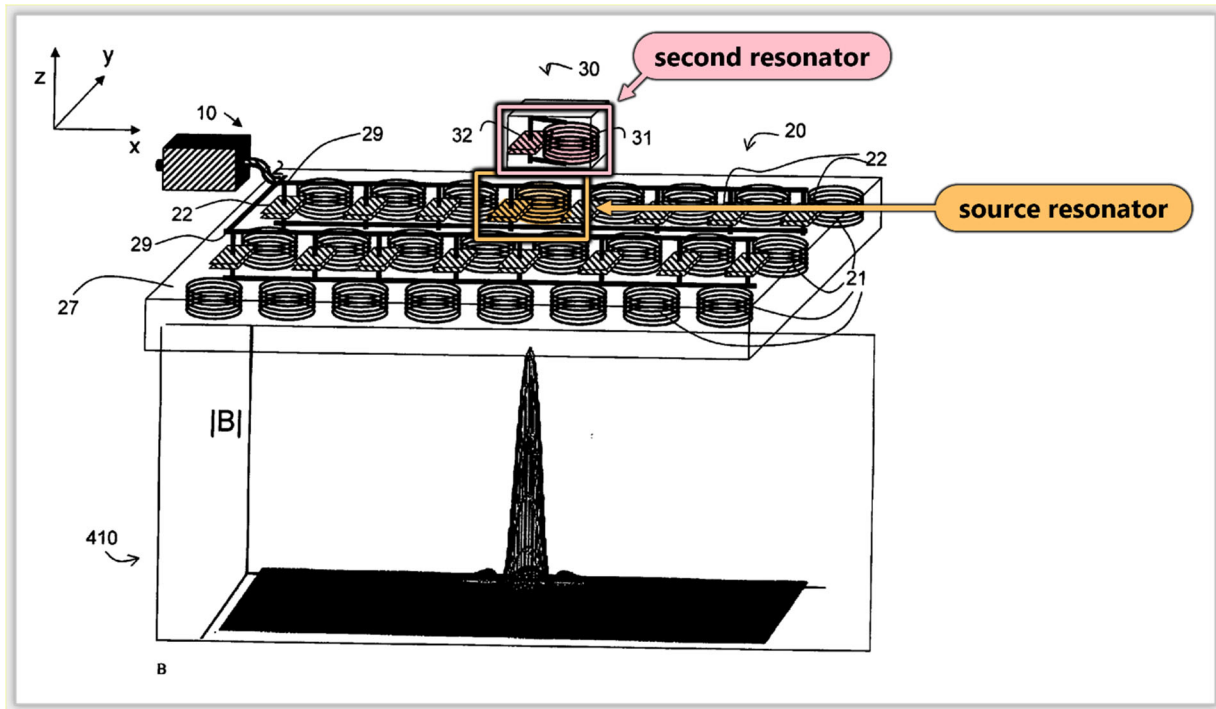
101. Lee does not appear as a reference cited during prosecution of the '719 patent.

102. Like the '719 patent and Cook-523, Lee generally relates to wireless power transfer using resonators, e.g., a “system and method for efficient and safe transfer of electrical power without needing conductive contacts.” Lee at ¶ 1; Abstract (“A system and method is provided for the inductive transfer of electric power between a substantially flat primary surface and a multitude of secondary devices in such a way that the power transfer is localized to the vicinities of individual device coils.”).

103. Lee states that “[c]ontact free power transfer has been around for a long time,” including, for example, a “transformer which converts high Voltage AC power into low voltage AC power and vice versa through a shared inductive magnetic field.” Lee at ¶ 2 (further explaining that a modern example of this transformer is the “Braun Oral B toothbrush, which relies on the external casing of the toothbrush base to guide the toothbrush to mate with the internal shape of the charger module, thus allowing the primary coil, the secondary coil, and the high permeability cores to align perfectly so that charging can take place.”). Lee further

explains that resonant power transfer” from a source resonator to a device resonator was known and provides as a “prime” example a “Passive RFID tag” that contains no internal power supply. *Id* at ¶ 5 (further explaining that the “minute RF current induced in the antenna of the tag by the incoming RF signal provides the power for the tag.”). Lee, however, states that prior art techniques failed to provide an adequate method to “localize the magnetic field around the secondary devices.” Lee at ¶ 8.

104. Addressing that localization problem, Lee is directed to designing the source of wireless power (i.e., a “primary unit”) as a two-dimensional array of planar coils that are connected in parallel with a matching capacitor. Lee at ¶¶ 54-56. Each coil/capacitor pair forms a “local parallel LC (inductance-21-capacitance 22) architecture,” to create the array of source resonators. Lee at ¶ 55. A second resonator to be placed in a device that receives power (such as, for example, a mobile phone) is similarly configured as a “parallel LC” circuit with a planar coil and capacitor. Lee at ¶¶ 54-56. Lee explains that Figure 3, annotated and reproduced below, shows an exemplary source resonator for wirelessly transmitting power and an adjacent second resonator for receiving that power:



Lee at Fig. 3 (annotated).

105. Lee states that “Graph 410” at the bottom of Figure 3 shows the magnetic field intensity from the array of source resonators of. Lee at ¶ 57. In this figure, Lee shows the source resonator closest to the “compatible secondary unit 30” having the largest magnetic field intensity. Lee states that this magnetic field intensity is achieved using the well-known impedance characteristics of “parallel LC” resonators. Lee at ¶ 56; Terman at 51 (explaining that “one of the most important properties of parallel resonance” is that they can develop “very high impedances”).

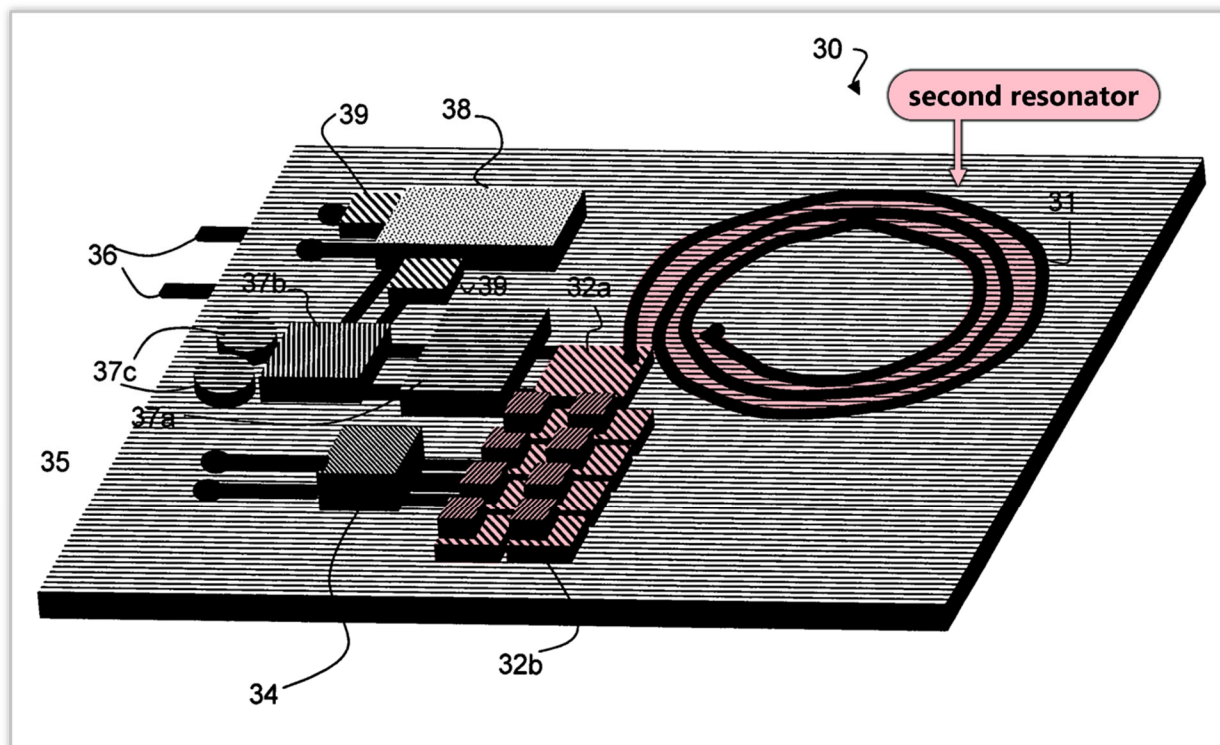
106. To explain, and as was well known in the art, a parallel LC circuit will have maximum impedance (and minimum current flow from the source) when it is

tuned to resonance, and lower impedance (and larger current flow from the source) away from resonance. *See* Terman at 51 (“The fundamental relations of a parallel resonance circuit are derived in every introductory book on a-c circuit theory”). In Lee’s array, each parallel LC resonant circuit in the transmitting array is tuned to have a resonant frequency at the operating frequency of the source. Lee at ¶¶ 55-56. Thus, under normal operating conditions at the operating frequency, Lee states the impedance of each source resonator is sufficiently high that little to no current flows from the power source to each resonant circuit. Lee at ¶ 56.

107. However, Lee states that when a “compatible” second resonator—a parallel LC resonant circuit tuned to have a resonance frequency at the same frequency as the source resonator and operating frequency— is placed near a source resonator in the array, the secondary resonator may “strongly shift” the source resonator away from resonance causing a corresponding “drastic” decrease in impedance. Lee at ¶ 55 (further explaining that “[w]hen a secondary unit 30 is placed anywhere on the top surface 27 of the primary unit 20, the resonance circuitry within the secondary unit 30 couples to the local LC circuit of the primary unit 20, and together, they form a new local resonance substructure”); Terman 63-67 (describing how impedance of primary resonator is altered by a nearby second resonator). Lee explains that the “the parallel LC resonance frequency is shifted away from the driving frequency of the RF source 10, which, in turns, causes the

effective local LC impedance to decrease sufficiently to enable the load current to flow into the local LC network.” Lee ¶ 57. Then, “the increase in the local load current in turns results in the increase in the local magnetic field intensity which is shown in Graph 410.” Lee ¶ 57. The current flowing in the source resonant circuit generates a magnetic field that couples with and transfers energy wirelessly to the second resonator. Lee at ¶ 55.

108. Lee teaches that its second resonator includes a planar, multi-turn coil that is connected to a main capacitor and a tunable capacitive element. Lee at ¶¶ 55-57, 75. For example, as Figure 12 below shows, the second resonator can include a “bank of switched capacitors 32b which are also in parallel with the main capacitor 32a” that are connected to the planar coil element 31.



Lee at Fig. 12 (annotated), ¶¶ 23, 26, 75.

109. Lee further describes in its Background section that prior art techniques that did not localize the magnetic field had “energy conversion efficiency issues.” Lee at ¶ 12. For example, Lee explains that because the “Q factor” (quality factor) of a “primary coil is not infinity in practice” there will be losses caused by stray flux from the non-localized field that is not coupling into a receiving device. Lee at ¶ 12 (“presence of nonlocalized field which does not couple to client devices drastically reduces the energy conversion efficiency since the Q factor of the primary coil is not infinity in practice hence the portion of the current that is responsible for the generation of such stray flux will always have a resistive component.”). Although Lee acknowledges that Q is not infinite for resonators, Lee does not expressly use the term “Q” in the context of describing the resonators in his embodiments. However, as discussed more below in Ground 4, Lee describes characteristics of his resonators indicating that the Q factors should be “nearly infinite,” or as a POSA would understand, as high as possible.

VIII. GROUND 1: CLAIM 16 IS OBVIOUS OVER COOK-554, ALONE OR IN VIEW OF POHJONEN

110. For the reasons discussed below it is my opinion that Cook-554, alone or with Pohjonen, teaches and renders obvious each and every claim element as arranged in claim 16 of the '719 patent.

A. Motivation to Combine Cook-554 and Pohjonen

111. To the extent Patent Owner argues that Cook-554 alone does not render obvious that limitation, a POSA would have and could have had Cook-554's second resonator enclosed in Pohjonen's low loss tangent material.

112. As an initial matter, Cook-554 and Pohjonen are analogous art. Cook-554 describes the integration of "antennas" for receiving wireless energy at radio frequencies (e.g., 13MHz) into portable electronic devices, and Pohjonen describes "the technology of antennas for portable radio devices and devices including radio functionality." Cook-554 at 3:51-54 (wireless power transmission at 13.56 MHz), 6:31-35, 9:25-65, 10:3-7, 19:15-35, Figs. 7, 10, 22A-22D; Cook Provisional at 25, 29, 62, Figs. 4-4, 4-6; Pohjonen at 1-2 (describing frequencies in the "range from 1MHz to 10GHz"). The '719 patent is similar, integrating magnetic (inductive) resonators operating at frequencies up to 10 GHz in "cell phones." '719 patent 59:40-53, 47:51-56 (resonators use "magnetic (inductive) coupling"); 3:39-43 ("Disclosed herein are electromagnetic resonators and systems of coupled electromagnetic resonators, also referred to more specifically as coupled magnetic resonators and coupled electric resonators, with operating frequencies below 10 GHz."), 62:27-30. Further, Cook-554 and Pohjonen both describe antennas that have both non-radiative (near-field) and radiative (far field) components to their magnetic field, and both references are directed to reducing losses in the area around

the antenna. Cook-554 at 2:2-3, 6:29-32 (“Eddy currents and dielectric losses in the surrounding of a receive antenna will deteriorate its Q-factor. This is particularly true if the antenna is integrated into a device.”), 16:18-29 (“Another effect often overlooked degrading Q-factor is energy absorption in lossy materials in the antenna’s surrounding”), 19:30-35 (“integrates the antenna into a part causing lower losses”), 22:7-10; Cook Provisional at 17-18 (¶4), 29, 50, 58, 63; Pohjonen at 1, 9. This is similar to the problem that the ’719 was purporting to address with its “low loss tangent material” that was intended to have a “negligible impact” on losses of a magnetic resonator. ’719 patent 34:53-35:6 (“low loss tangent materials and objects may have a negligible impact on the losses of a magnetic resonator”).

113. A POSA would have enclosed Cook-554’s portable device with an integrated resonator in Pohjonen’s low loss tangent material for at least two reasons. First, it would protect Cook-554’s second resonator from damage during manufacturing or use. Second, it would improve the efficiency of Cook-554’s second resonator while protecting the resonator. A POSA could and would have enclosed Cook-554’s second resonator in a low loss tangent material, and would have done so with a reasonable expectation of success because it would be easy and cost-effective to make the enclosing using common, well-known injection molding plastics. See Cook-554 at 16:53-58 (“enabling wireless power ... should not significantly increase overall manufacturing costs”); Cook Provisional at 50;

Pohjonen at 2 (“A vast majority of outer covers for portable radio devices are manufactured by injection moulding”), 6-7 (outer cover material with “suitably low loss tangent value” and “well suited for injection moulding”), 11.

114. Further, using a low loss tangent material enclosure would be advantageous for protecting Cook-554’s integrated resonator during manufacturing and use. *See* Cook-554 at 1:59-61 (receiving antennas are “preferably of a small size to allow it to fit into a mobile, handheld device”), 9:16-28; Cook Provisional at 16 (¶2), 34, 36; Dabov at 10: 43-50 (describing use of “antenna chassis” to “protect the antenna from mechanical damage”). As Pohjonen and others explained, it was typical for portable radio devices to have an integrated antenna that is “enclosed inside an essentially continuous outer cover of the device,” and that the “most common materials” used for creating those covers included materials having low loss tangents. Pohjonen at 1-2, 7, 9; *see also, e.g.*, Tamura at 2:19-20, 4:24-27 (identifying low loss tangent materials including poly vinyl chloride (PVC) to “physically protect[] the antenna circuit”); Wang-041 at 5:67-6:2 (“plastic housing material as is normally used in portable electronic devices (e.g., ABS, polycarbonate, polystyrene or the like).”); Pohjonen at 2 (identifying polycarbonate and polystyrene as some of “the most common materials used for” outer covers of portable electronic devices, with the following loss tangents: PC 0.0004-0.0006, PS 0.0004-0.0006,); Dabov 10:27-50 (“[s]uitable materials” for enclosing antennas have “low loss

tangent” such as “polycarbonate”); Hassler 2:57-64 (stating that it has “traditionally been necessary to enclose” a wireless power transfer receiver in a “non-metallic material, such as a ceramic outer casting”). In particular, Pohjonen identifies seven materials that were the “most common materials used for injection moulding,” and five of those (PC, HDE, PMMA, PP, and PS) had loss tangents equal to or less than the exemplary “low loss tangent” materials in the ’687 patent. Pohjonen 2;’719 patent at 26:17-24, 59:43-45; Yeh at 10, Levine at ¶¶ 113, 122.

Pohjonen “most common materials used for injection moulding”	Loss tangent	’719 patent “low loss tangent materials”	Loss tangent
Acrylonitrile-butadiene-styrene (ABS)	0.006-0.009	Teflon (PTFE)	0.0002
Polycarbonate (PC)	0.0004-0.0006	Rexolite	0.001
High-density polyethylene (HDPE)	0.0001-0.0002	Styrene	0.0003.
Poly-methyl-methacrylate (PMMA)	0.006-0.01		
Polypropylene (PP)	0.00007-0.0001		
Polystyrene (PS)	0.0004-0.0006		
Polyvinyl chloride (PVC)	0.005-0.008		

115. Using a low loss tangent enclosure for Cook-554's second resonator would have been obvious because it involves nothing more than the use of a known technique (i.e., low loss tangent covers) to known prior art that is ready for the improvement.

116. In addition, a POSA would have enclosed Cook-554's second resonator in a low loss tangent outer cover specifically in order to maintain Cook-554's antenna efficiency while it remains physically protected. Indeed, Cook-554 taught that its resonators were designed to transmit and receive power at radio frequencies, and "lossy" materials near the antenna should be avoided because they "deteriorate its Q-factor." Cook-554 at 6:27-35, 16:18-25; Cook Provisional at 29, 50; Terman at 3.

117. Therefore, a POSA looking to implement Cook-554's integrated resonator would have looked to a non-lossy enclosure like Pohjonen's to preserve the Q and efficiency of Cook-554's second resonator. *See* Pohjonen at 1-2, 6-7, 9-10. In particular, Pohjonen "advise[d] that if a portable telephone device has a radiating antenna element attached to or close to an outer cover part," i.e. what Cook-554 taught (*see* Cook-554 at Figs. 7, 10, 22A-22D; Cook Provisional at Figs. 4-4, 4-7, 5-8), "it is advisable to make said outer cover part of a material with a loss tangent value less than about 0.005." Pohjonen at 6. For values less than approximately

0.005, Pohjonen explains that “the loss tangent value becomes acceptable in terms of only very little additional loss caused to the antenna.” Pohjonen at 6.

118. In addition, a POSA would have had a reasonable expectation of success in using Pohjonen’s outer cover material to enclose Cook-554’s second resonator because Pohjonen’s cover is not limited to any “form or operating principle of the radiating antenna elements” and was designed to enclose antennas “made of good [] conductor materials,” like the inductive component of Cook-554’s second resonator. Pohjonen at 9; Cook-554 at 4:39-46 (“Copper tube or silver plated copper tube”), 13:12-20 (“multi-turn loop is made of well insulated copper wire”); Cook Provisional at 29, 42.

119. In similar vein, Cook-554 disclosed that its second resonator could be integrated into a portion of a mobile phone that is “in a part that can be folded out for the purpose of wireless charging” which Pohjonen’s outer cover material is “equally well applicable to.” Cook-554 at 19:15-35, Fig. 22A; Cook Provisional at 58, Fig. 5-8; Pohjonen at 12. And it was well known to POSAs that portable electronic devices (like those that Cook-554’s secondary resonator was intended to “fit into” (Cook-554 at 1:59-61, 19:15-19; Cook Provisional at 16, 36)) already and commonly used low loss tangent materials for their outer covers. Pohjonen at 1-2. Therefore, a POSA would have known and understood that Pohjonen’s low loss

tangent outer cover could and would be implemented in Cook-554 using well-known techniques.

120. At most, “modifying” Cook-554 with Pohjonen’s material selection involves merely combining known prior art elements (i.e., antenna structures used in portable electronic devices and common plastic housings) according to known methods that yield predictable results (i.e., enclosures that protect an antenna while minimizing radio frequency losses in the cover materials).

B. Independent Claim 16

1. Element [16pre]: Preamble

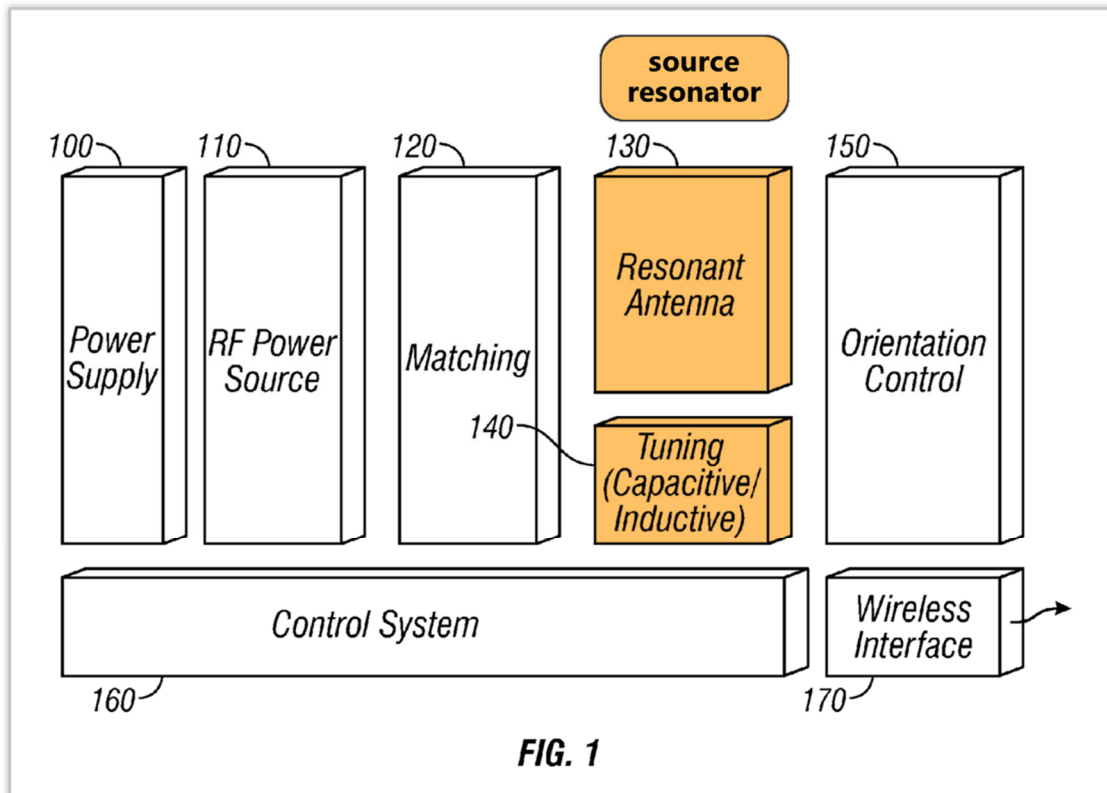
121. Claim 16’s preamble recites “A system, comprising.” To the extent that the preamble is limiting, Cook-554 discloses various “systems” for wireless power transfer as explained for the following elements. *See also, e.g.*, Cook-554 at 4:26-34 (“The system also uses...”), 6:13-32. (describing a “magnetically/inductively coupled system...”); Cook Provisional at 26, 29.

2. Element [16a]: Source Resonator

122. Claim 16 first recites: “a source resonator having a Q-factor Q_1 and a characteristic size x_1 .” I note that claim 16 does not recite any particular characteristic size for the source resonator, only that the resonator has a characteristic size. Cook-554 taught this element.

123. Cook-554 discloses a “transmit antenna unit” and an associated “tuning network,” as shown in annotated Figure 1 below, which disclose to a person of

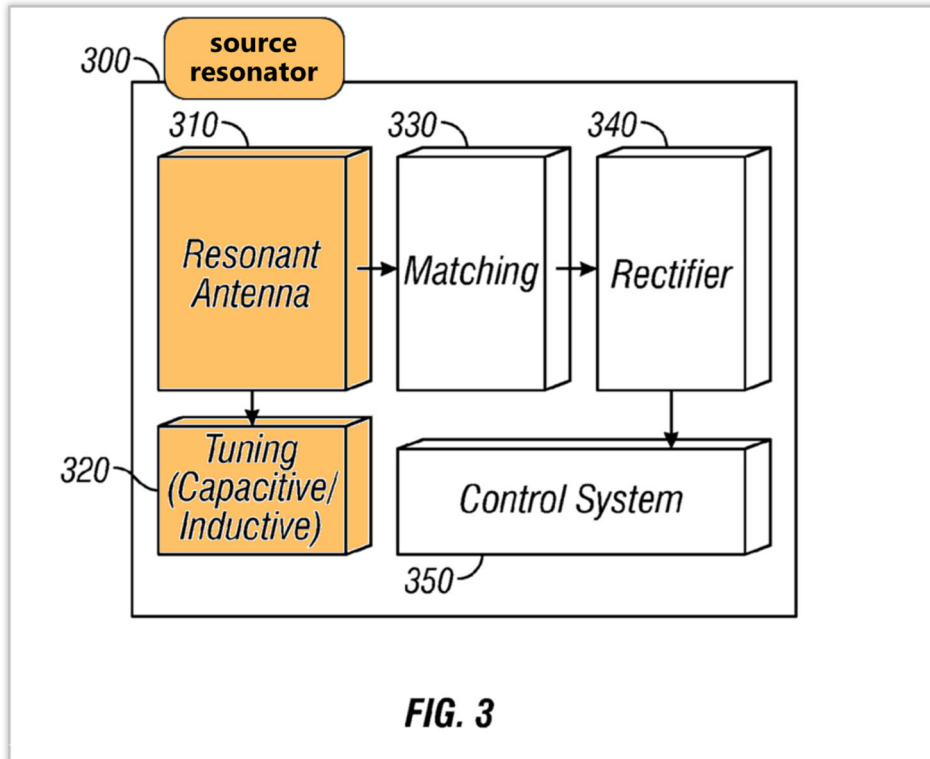
ordinary skill the claimed “source resonator.” The transmit antenna unit “includes a multi-turn loop (coil) and a high voltage capacitor forming a principal part of a series tank circuit,” and the “tuning network” can include a “capacitor bank” used for “tuning of the antenna’s resonance frequency.”



Cook-554 at Fig. 1 (annotated) (same as Cook Provisional Fig. 3-1), 3:21-32 (Figure 1 is a block diagram of the “generic wireless energy source” including “resonant antenna” and “tuning (capacitive/inductive)), 13:12-20, 13:30-32 (“The antenna 1400 is formed of a coil part 1405 and a high voltage capacitor 1410”), 11:31-35, 12:19-38; *see also, e.g.*, Cook-554 at 3:21-32, 4:61-67 (“Tuning can be capacitive . . . It can be a capacitor bank”), Fig. 13 (same as Cook Provisional Fig. 4-11), 11:12-24

(“Fig. 13 shows a block diagram of a transmit subsystem that can be used with any of the wireless power embodiments”), 13:12-20; Cook Provisional at 23, 25-28, 41-43, . The tuning network forms part of the “resonator” because it provides additional capacitance or inductance that would exchange energy (resonate) with the primary coil or capacitance forming the antenna.

124. Cook-554 also describes an optional “energy relay” that includes a “resonant parasitic antenna” as well as associated tuning. A “generic” block diagram of the wireless energy relay is shown in annotated Figure 3 below. Like the transmitting unit discussed above, the energy relay includes a “resonant antenna” and associated tuning, which together form a “source resonator” that “repeat[s] wireless power in an area.” Cook-554 at 8:4-34; Cook Provisional at 32-33. Indeed, Cook explains that the energy relay antenna can be “the same or similar to those used in an energy transmitter.” Cook-554 at 8:28-30; Cook Provisional at 32.

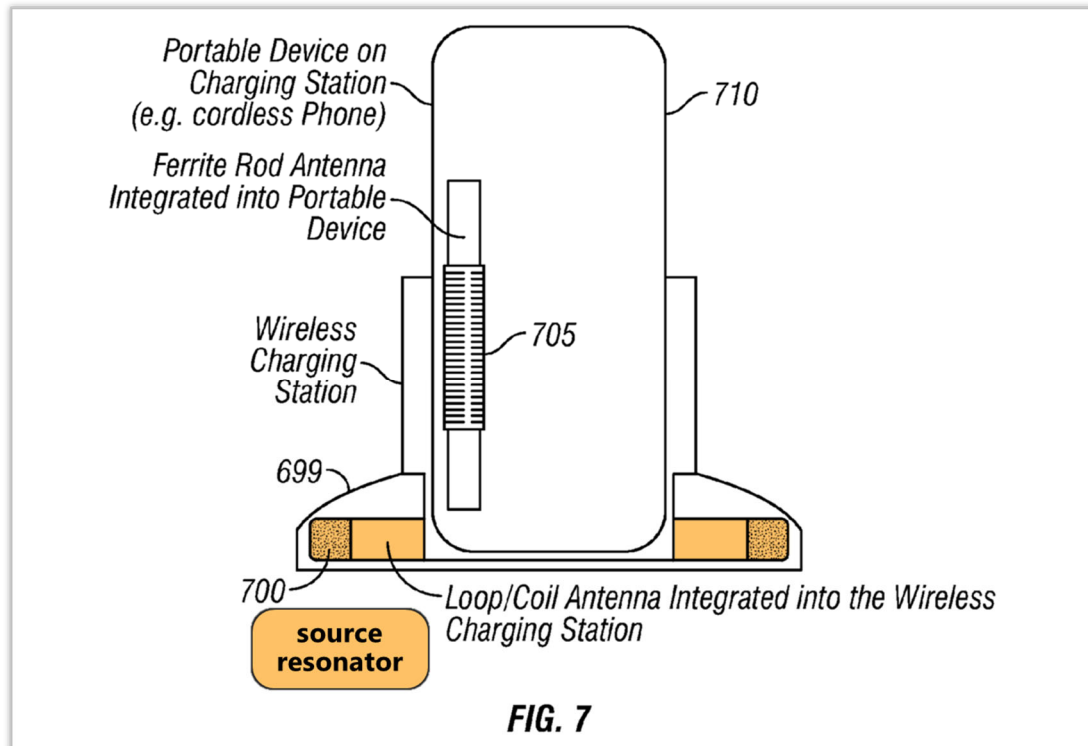


Cook-554 at Fig. 3 (annotated), 8:16-18 (“The antenna 310 is generally a multi-turn loop (coil) in series with a capacitor”); Cook Provisional at 32-33, Fig. 3-3 (same as Cook-554 Fig. 3). That a POSA would have understood Cook’s energy relay unit as including a “source resonator” as claimed is also confirmed by the ’719 patent, which similarly explained that a resonator used to “relay power from a source in one location to a device in another location” can “alternatively or simultaneously” be referred to as a source resonator or device resonator. ’719 patent at 15:62-66, 76:60-61 (describing an “intermediate relay source coil”), 83:28-35.

125. Cook-554 explains that the transmit subsystem shown in Figure 13 can be “used with any of the wireless power embodiments in this application.” Cook-554 at 11:20-24; Cook Provisional at 28. For example, the source resonator –

whether as an energy relay or a transmit antenna – can be integrated in a wireless charging station in substantially the same way.

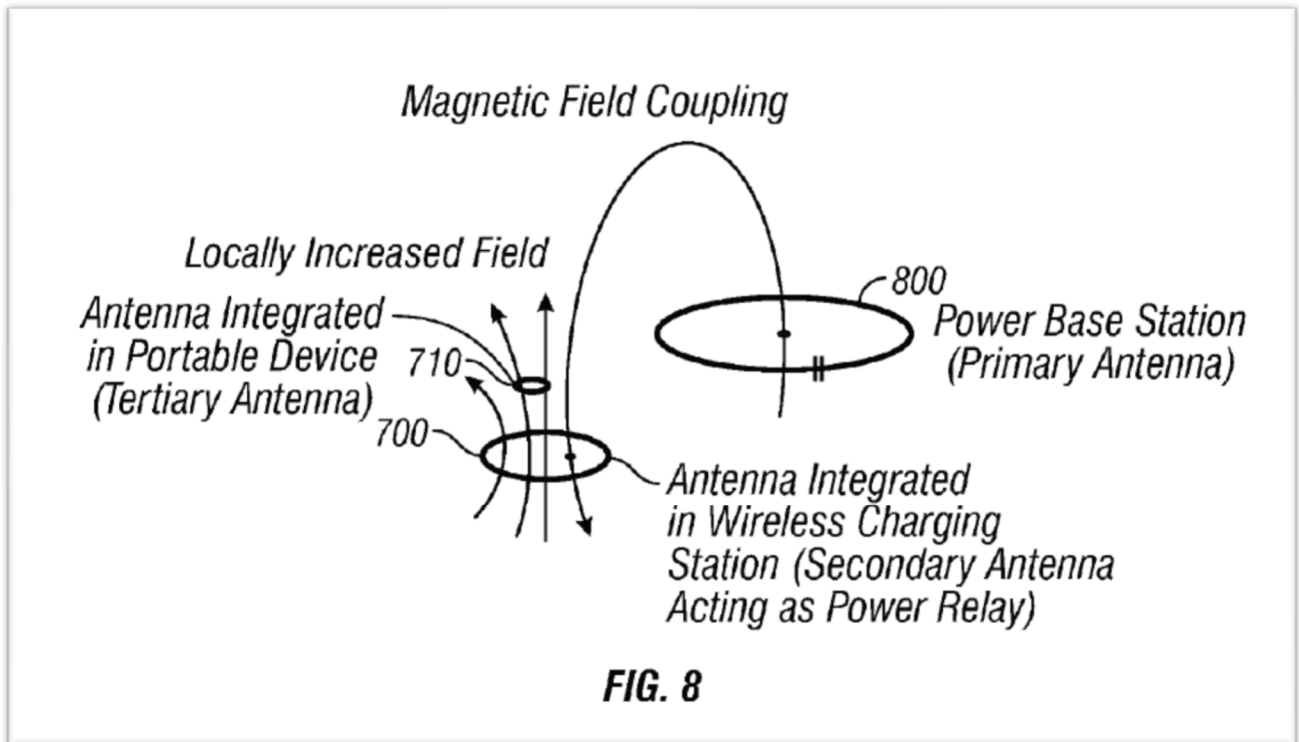
126. Annotated Figure 7 below shows an energy relay resonator integrated into the wireless charging station.



Cook-554 at Fig. 7 (annotated), 9:16-65 (describing embodiments of “variants of a wireless powering or charging station” that use “magnetically coupled resonance to transfer the power from source to receiver”); *see also* Cook Provisional at Figs. 4-4 (same as Cook-554 Fig. 7), 36.

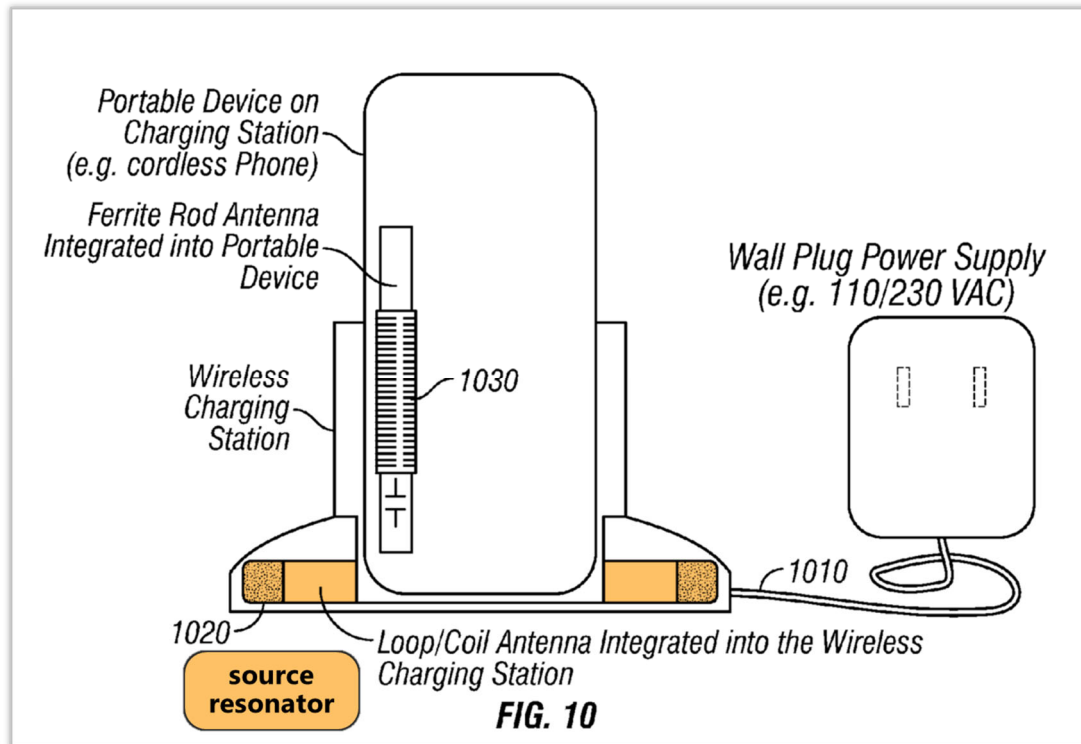
127. As explained in Cook-554, the “wireless charging station antenna 700” receives energy wirelessly from the “power base station primary antenna” and then relays that energy to the “antenna 705 of the portable device 710.” Cook-554 at 9:41-

46; Cook Provisional at 36. The energy relay antenna thus acts as a “source” for the antenna 705 of the portable device 710, which is illustrated in Cook-554’s Figure 8 below:



Cook-554 at Fig. 8; Cook Provisional at Fig. 4-5 (same as Fig. 8).

128. Cook’s Figure 10 integrates an antenna into the wireless base station in the same way as Figure 7, but instead of receiving power wirelessly (as in Figure 7) the antenna in Figure 10 “receives power through a wired connection e.g., directly from the 110/230 V AC source over wire 1010.” Cook-554 at 10:3-5; Cook Provisional at 36. The base station antenna 1020 (source resonator) forwards the power “to the portable device based on magnetic coupled resonance between transmit antenna 1020 and receive antenna 1030.”



Cook-554 at Fig. 10 (annotated), 10:3-7 (describing the embodiment in Fig. 10 with “a wired connection, e.g., directly from the 110/230 V AC source” where “power is forwarded to the portable device based on magnetic coupled resonance between transmit antenna 1020 and receive antenna 1030”); Cook Provisional at Fig. 4-7 (same as Cook-554 Fig. 10), 36. The transmit antenna 1020 thus acts as a “source resonator” because it is the source of the magnetic field that transmits energy wirelessly based on magnetic coupled resonance.

129. Cook-554’s base station antenna, whether implemented as an energy relay or a transmitting antenna, corresponds to the claimed “source resonator.” More particularly, a POSA would have understood that Cook’s transmit/energy relay antennas are “magnetic resonator[s]” as used in the ’719 patent because they provide

wireless energy transfer “based on magnetic coupled resonance.” *See also* at Cook-554 at 15:23-26 (describing “[e]fficient wireless energy transfer based on magnetic coupled resonance”), 8:16-25 (explaining that “[i]n a magnetically/inductively coupled system, the antenna 310 is generally a multi-turn loop (coil) in series with a capacitor.”), 8:54-57 (further describing wireless energy transfer based on coupled magnetic resonance using “a loop or coil”), 9:29-34 (“An embodiment uses magnetically coupled resonance to transfer the power from source to receiver”), Fig. 8 (same as Cook Provisional Fig. 4-5); Cook Provisional at 26, 32-34, 36, 49. As a magnetic resonator, it has a “characteristic size x_1 ” according to the ’719 patent that is equal to the radius of a sphere that can enclose the coil element. *See* Claim Construction Section above. I note that claim 16 does not recite any particular value of the source resonator’s characteristic size but rather only requires the existence of a characteristic size. Cook-554’s source resonators have inductive elements — the “loop” or “coil” —which has a size.

130. Cook-554 discloses that its transmit and energy relay antennas have a “high quality factor,” which corresponds to the claimed “ Q_1 .” Cook-554 at 4:26-38 (transmit antenna should “provide a Q-factor as high as possible” with practical systems having Q ranging from 300 to 600 or higher), 8:3-32 (same for energy relay antenna), 9:20-34 (“coil antennas, preferentially of high quality factor, are used for energy transfer”); *see also* Cook-554 at 2:4-7 (describing an embodiment with “two

high-Q antennas” with “one antenna inducing power into the other” where the “antennas preferably have Qs that are greater than 1000.”); Cook Provisional at 28, 31.

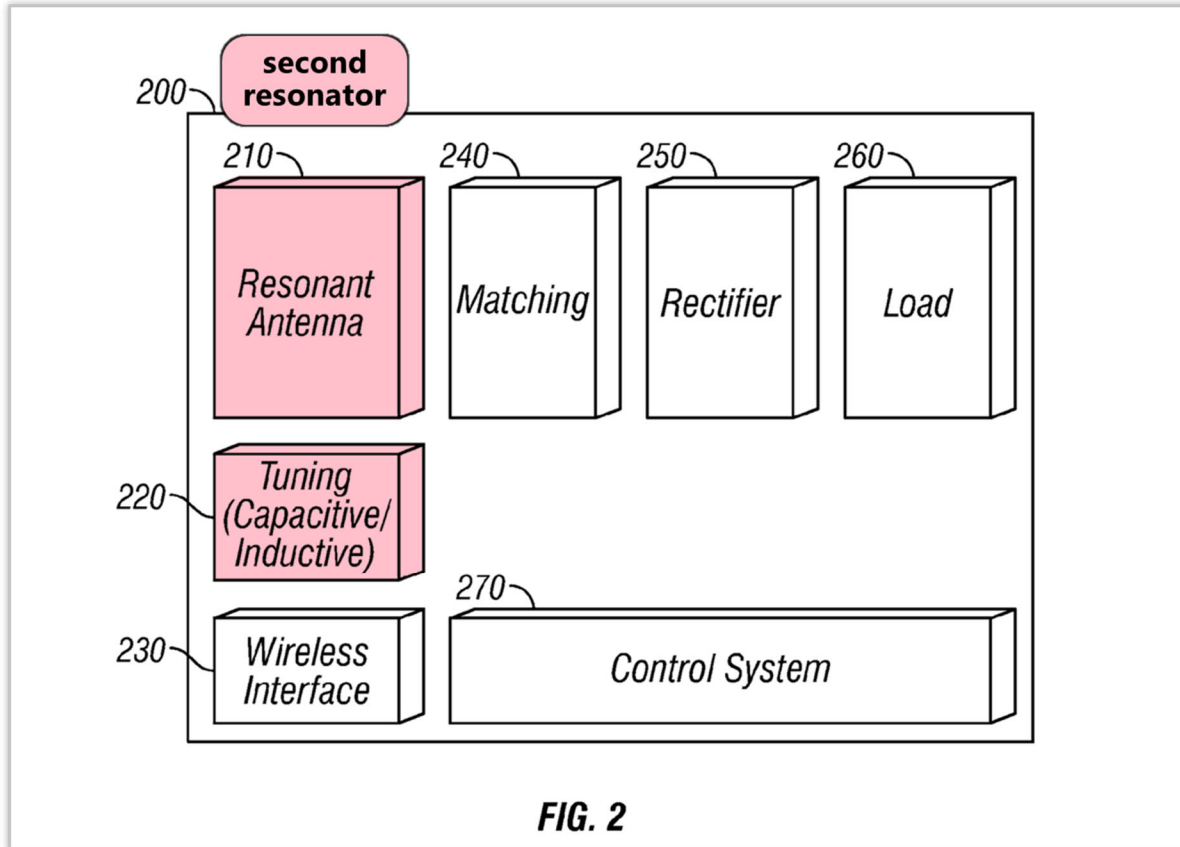
131. As described above with respect to Cook-554’s Figures 1 and 3, Cook-554’s transmitting and energy relay resonators also include tuning circuits, which aren’t shown in Figures 7 and 10. Those tuning circuits “help keep a high Q” for the antenna and does “not impair the antenna’s Q-factor.” Cook-554 at 17:34-40 (explaining that “in practical high-Q designs[,] readjusting tuning of the resonance frequency may help keep a high Q” and “tunable capacitor(s)” “do not impair the antenna’s Q-factor”); Cook Provisional at 51-52.

3. Element [16b]: Second Resonator

132. Claim 16 next recites: “a second resonator having a Q-factor Q_2 and a characteristic size x_2 , and located a distance D from the source resonator.” I note that claim 16 does not recite any particular characteristic size for the second resonator, only that the resonator has a characteristic size.. Cook-554 taught this element.

133. Cook-554 taught a receiver, shown generically in Figure 2 below, that includes a “second resonator” comprising a “receive antenna unit” and its related “tuning and matching network.” The receive antenna unit includes a multi-turn loop (coil) and a capacitor, and the tuning and matching network can include a “capacitor

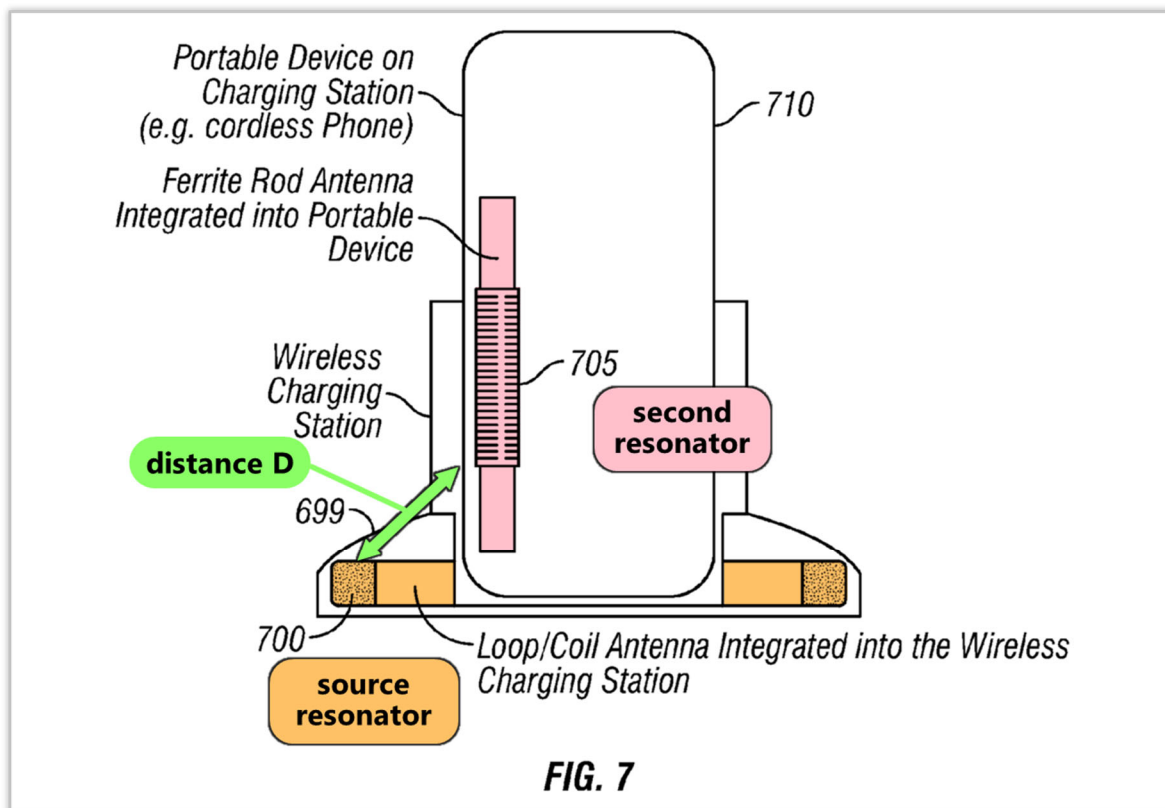
bank” used for “tuning of the antenna’s resonance frequency.” Cook-664 at 6:40-44, 6:56-67 (explaining how “[c]apacitive tuning may be accomplished”).



Cook-554 at Fig. 2 (annotated), 6:14-19 (“receiver is shown generically in Fig. 2 and includes similar parts to those of the transmitter of Fig. 1”), 6:40-62 (describing tuning of receiver); *see also* Cook-554 at Fig. 15, 13:46-54 (describing the “receive subsystem” shown in Fig. 15 that includes a “receive antenna unit, and a receive power converter unit” that are “very similar” to those described for the transmit subsystem); Cook Provisional at 43, 50-51, Figs. 3-1, 3-2 (same as Cook-554 Fig. 2), 4-1, 4-3, 4-4, 4-5, 4-6, 4-8, 4-12 (same as Cook-554 Fig. 15), 5-1.

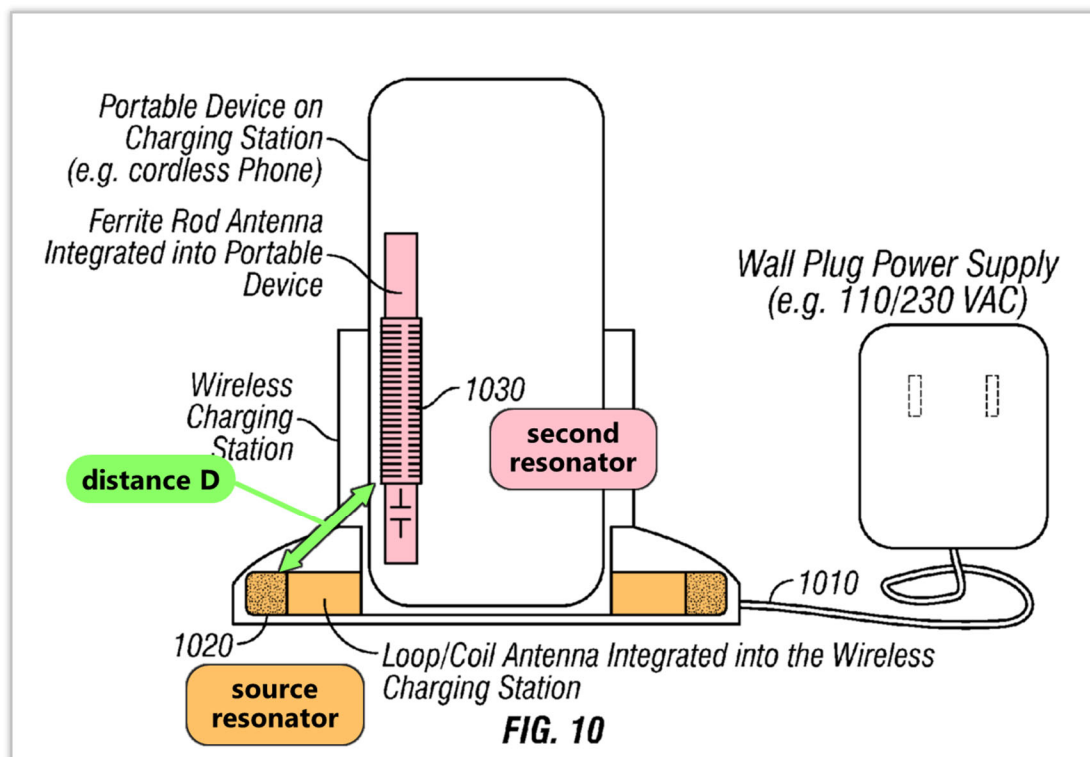
134. Cook further taught to a person of ordinary skill in the art that its second resonator can be “integrated into” a portable device to receive energy transferred wirelessly over a distance D from a source resonator integrated in a wireless charging station.

135. As one example, Cook-554 shows in Figure 7, annotated below, a second resonator that is integrated in a “Portable Device on Charging Station (e.g., cordless phone),” where the second resonator is located a distance D from an energy relay (source) resonator.



Cook-554 at Fig. 7 (annotated), 9:20-46, 6:20-32, Fig. 6; Cook Provisional at 24, Figs. 4-3, 4-4.

136. As another example, Cook-554 shows in Figure 10, annotated below, a second resonator similarly integrated in a Portable Device, such that the second resonator is located a distance D from a transmitting (source) resonator.



Cook-554 at Fig. 10 (annotated), 9:20-46, 6:20-32, 10:3-7; *see also* Cook-554 at Fig. 6; Cook Provisional at 24, 36, Figs. 4-3, 4-4, 4-7.

137. Figures 7 and 10 above show the second resonator depicted as a Ferrite rod antenna,” with multiple turns of a conductive coil around a ferrite core.” Cook-554 at 9:37-41, 15:38-47. However, Cook-554 explains that “another loop/coil

structure with suitable form factor” can also be used. Cook-554 at 9:37-41, 6:20-32; *see also* Cook-554 at Figs. 22A-22D (alternative ways to integrate antenna in mobile device); Cook Provisional at 36, Fig. 5-8 (same). In addition to Figures 7 and 10, Cook describes alternative ways to integrate a second resonator into a mobile device in Figures 22A-22D. The same alternative figures are also disclosed in the Cook Provisional at Figure 5-8.

138. Cook-554’s second resonator receives wireless energy using “magnetically coupled resonance.” Cook-554 at 9:29-34 (explaining this is in “contrast with to ordinary inductive coupling”), Figs. 7-8, 10; Cook Provisional at 36, Figs. 4-4, 4-5, 4-7; *see also* Cook-554 at 3:6-13, 3:45-51, 8:54-57, 10:3-7. Thus, it is a “magnetic resonator” with a “characteristic size x_1 ” as used in the ’719 patent that is equal to the radius of a sphere that can enclose the inductive element. *See* Cook-554 at 15:23-26, 8:16-25, 8:54-57, 9:29-34; Cook Provisional at 22, 26, 36, 49. In Cook-554’s second resonator, the “inductive element” is the “loop” or “coil.”

139. Cook-554 explains that its receiving antenna unit has a “quality factor,” corresponding to the claimed “ Q_2 .” Cook-554 at 9:30-34, 6:33-35, 2:4-7; Cook Provisional at 28, 31. Cook also describes its second resonator as typically being further connected to a tuning circuit, not shown in Figures 7 and 10, which would “not impair the antenna’s Q-factor.” Cook-554 at 6:33-7:2, 17:34-40, 18:65-67 (also explaining that ferrite rod antennas can be tuned without “requiring any additional

components in the tank circuit thus maintaining the Q-factor”); Cook Provisional at 51-52.

4. Element [16c]: Wireless Energy Transfer

140. Claim 16 next recites: “wherein the source resonator and the second resonator are coupled to exchange energy wirelessly among the source resonator and the second resonator.”

141. Cook-554 teaches this to a POSA through its explanation of the use of “wireless energy transfer based on magnetic coupled resonance ... using resonant antenna circuits ... in both energy transmitter and energy receiver.” Cook-554 at 9:29-34, 15:23-26; Cook Provisional at 36, 49.

142. As discussed above, the resonator in the wireless charging station (i.e., the energy source) transfers power to a portable device using an integrated second resonator (i.e., energy receiver) that “receives electrical energy.” Cook-554 at 9:35-65, 10:3-7, Figs. 7-8, 10 (same as Cook Provisional Figs. 4-4, 4-5, 4-7); *see also* Cook-554 at 3:6-10, 3:21-31, 4:26-34 (transmitter), 6:14-32 (receiver), 8:16-25 (energy relay), Figs. 1-3 (same as Cook Provisional Figs. 3-1, 3-2, 3-3); Cook Provisional at 25-26 (transmitter), 28-29 (receiver), 32-33 (energy relay), 36, Figs. 3-1, 3-3, 3-4, 4-3, 4-4, 4-5, 4-7.

5. Element [16d]: High Quality Factor

143. Claim 16 next recites: “wherein $\sqrt{Q_1 Q_2}$ is greater than 100.” Cook-554 taught this.

144. As I discussed above, Cook-554 taught transmitting and energy relay (i.e., source) resonators with a “high Q-factor,” i.e., Q_1 , and a second receiving resonator also having a “high Q-factor,” i.e. Q_2 . *See* Ground 1 Elements 16[a], 16[b].

145. Cook-554 generally taught that Q-factors for both the transmitter and receiver should be as high as possible for efficiency and to improve the distance of power transfer. Cook-554 at 15:23-26 (“wireless energy transfer” is “more efficient when using resonant antenna circuits with highest possible quality factor in both energy transmitter and energy receiver”), 2:6-7, 4:26-34, 6:27-29 (“The Q-factor sets the transfer efficiency, and higher Q factors improve the distance over which the power can be received.”), 8:23-25, 9:30-34, 12:25-27; Cook Provisional at 17, 22, 26, 28, 29, 32, 43; *see also generally* Cook-554 at 15:23-17:40 (describing considerations for designing high Q resonators); Cook Provisional at 49-52.

146. Cook-554 further taught that its transmitting resonators in “practical system implementations” would have high Q factors “up to 300” at low frequency (LF) and “up to 600 in the HF frequency range (13.6 MHz).” Cook-554 at 4:35-38; Cook Provisional at 26, 32. Similarly, Cook-554 quantifies the Q factor in the second resonator and explained that a second resonator that is “integrated” in a

device will, in practical system implementations, have “Q-factors up to 150 may be typical at LF and up to 200 in the HF frequency range (13.6 MHz).” Cook-554 at 6:20-35; Cook Provisional at 29.

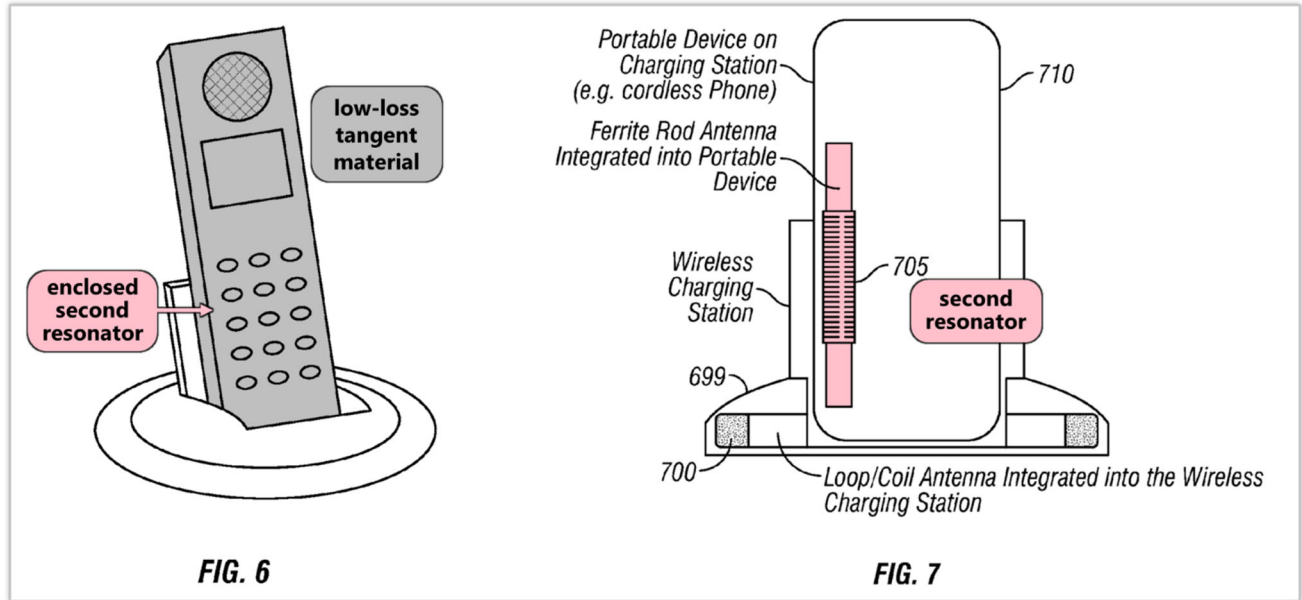
147. Because Cook-554 taught source resonators having Q_1 up to 300 or up to 600, second resonators integrated into devices having Q_2 up to 150 or up to 200, and also taught that the highest quality factors should be used in both the transmitter and receiver, Cook-554 taught wherein the “ $\sqrt{Q_1 Q_2}$ is greater than 100,” as claimed. I also understand from Counsel that because the ranges disclosed in Cook-554 overlap with the claimed range of Q_1 and Q_2 , the claimed range is *prima facie* obvious, and that the Patent Owner would need to provide evidence that the overlapping range would not have been obvious. I am not aware of any evidence that the overlapping range would not have been obvious and reserve the right to respond to any such evidence if Patent Owner or its expert identifies any.

6. Element [16e]: Low Loss Tangent Material Enclosure

148. Claim 16 next recites “and wherein at least one of the resonators is enclosed in a low loss tangent material.” A POSA would have found this element obvious in view of Cook-554 alone or in combination with a POSA’s knowledge and/or Pohjonen.

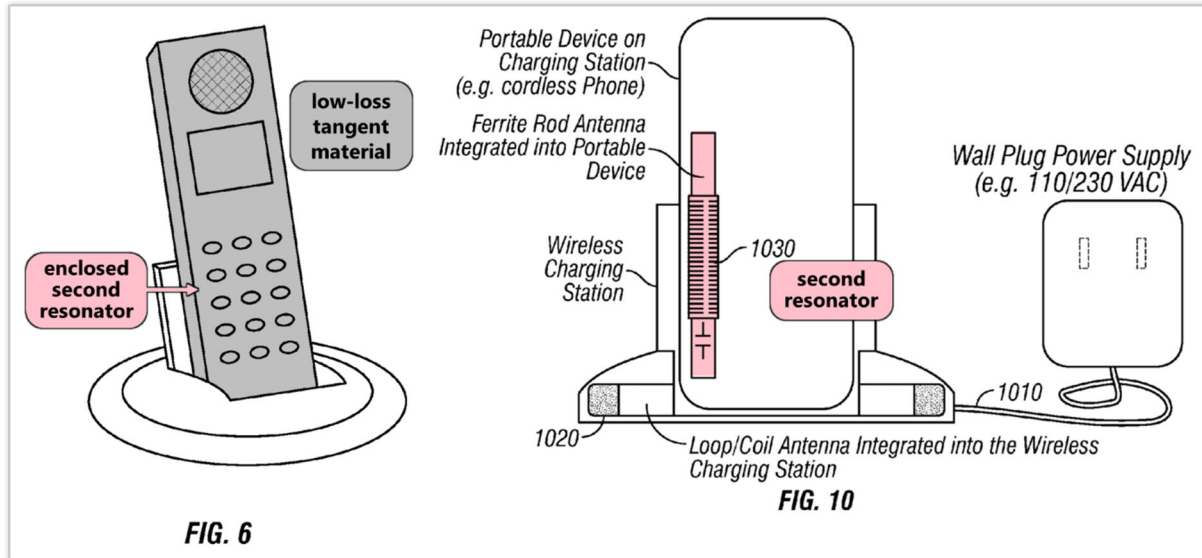
149. Enclosing Cook-554’s second resonator in a material with a low loss tangent would have been obvious to a POSA in view of Cook-554’s teachings. As

discussed above, Cook-554 discloses that its second resonator can be “integrated” into a “mobile, handheld device.” Cook-554 at 1:59-61, 9:29-10:10, Figs. 7-8, 10; Cook Provisional at 16, 57, Figs. 4-4, 4-5, 4-7. In this context, a POSA would have understood that “integrated” means “enclosed” in the mobile device’s external housing, as shown in Cook-554 Figures 6 and 7 of Cook-554, reproduced below. *See also* Cook-554 at 9:20-28 (“*internal* antenna 705 in the portable device 710”); Cook Provisional at Figs. 4-3, 4-4. Specifically, Cook-554 discloses that Figures 6 and 7 depict the same “cellular phone” on a charging station, but with the outer cover visible in Figure 6 and removed in Figure 7. The second resonator is not visible because the outer cover encloses it. A POSA would have understood that the outer cover would be a low loss tangent material—such as a low density plastic commonly used for the outer cover of portable devices at the time—for the reasons discussed below.



Cook-554 at Figs. 6 & 7 (annotated), 9:16-28 (“An example of a wireless powering . . . with a portable electronic device (e.g., a cordless phone) is shown in FIGS. 6 and 7”); Cook Provisional at 36, Figs. 4-3, 4-4 (same as Cook-554 Figs. 6 & 7, respectively); *see also* ’719 patent at 59:40-53 (device resonators can be “enclosed in an enclosure” made from “low loss tangent materials,” including that the “device resonator may be integrated into . . . cell phones”).

150. Figure 10 would be similarly understood as showing the cellular phone with the low loss tangent cover removed.



Cook-554 at Figs. 6 & 10 (annotated) (Cook Provisional Figs. 4-3 and 4-7). Cook-554's disclosure of the antennas integrated into low loss tangent mobile phone enclosures is consistent with the '719 patent, which similarly states that device resonators can be "enclosed in an enclosure" made from "low loss tangent materials," including that the "device resonator may be integrated into ... cell phones." '719 patent at 59:40-53.

151. Cook-554 taught that when integrating a resonator into a portable device, one should "avoid a metallic housing" and "integrate[] the antenna into a part, causing lower losses and providing better penetration of magnetic fields." Cook-554 at 17:1-2, 19:30-35; Cook Provisional at 51, 58. These teachings would have led a POSA to low-loss tangent materials, which were materials that were non-metallic and caused lower losses and better penetration of magnetic fields than other types of materials. Dabov, for example, explained that exemplary materials for

enclosing antennas within portable phones included “low loss tangent materials” made from “low density plastic” because those materials were “suitable for allowing electromagnetic waves (e.g., from the antenna) to pass.” Dabov at 10:27-32 (describing an “antenna chassis and antenna cap 930” for enclosing an integrated antenna within a mobile device); *see also* Wang-078 at 7:16-20. Pohjonen similarly explained that the problem of “losses” caused by the outer cover of a portable device was a known problem with a known solution—making the outer cover from a material with “lower losses.” Pohjonen at 2 (also explaining that “dielectric loss tangent” is a “better measure of the actual losses” caused by an outer cover).

152. Cook-554 further explains that “lossy materials in the antenna’s surrounding” degrade Q-factors of its antennas. Cook-554 at 16:18-24, 19:36-50; Cook Provisional at 50, 58. Thus, a POSA would have known to use low loss tangent materials for the portable device enclosure to maintain the Q factors as high as possible because those known materials had “very little additional loss caused to the antenna.” Pohjonen at 6-7.

153. It is also my opinion that Cook-554’s disclosures of enclosing a device resonator in a non-metallic mobile phone housing that provides “lower losses” and “better penetration of magnetic fields” is at the same level of detail as the ’719 patent’s description of enclosing a resonator in a “low loss tangent material.” *Compare* Cook-554 at 17:1-2, 19:30-35 (described above) *with* ’719 patent at 34:53-

64 (explaining how “electromagnetic fields” cannot significantly penetrate “metallic materials,” whereas “low loss tangent materials” have a “negligible impact on the losses of a magnetic resonator”), 59:40-53 (device resonators can be “enclosed in an enclosure” made from “low loss tangent materials,” including that the “device resonator may be integrated into . . . cell phones”).

154. A POSA would have found it obvious to enclose Cook-554’s second resonator in a low loss tangent material based on their general knowledge regardless of Cook-554’s disclosures. Indeed, at the time of the ’719 patent, it was known that “[a] vast majority of outer covers for portable radio devices [were] manufactured by injection molding,” and commonly used plastics for injection molding had “suitably low loss tangent value[s].” Pohjonen at 2, 7; *see also* Cook-554 at 17:1-2, 19:30-35; Cook Provisional at 51, 58. As one example, by September 2008 a POSA would have been familiar with low loss tangent enclosures for antennas used in portable electronic devices, like those disclosed in Cook-554, because “housing material” like polycarbonate (PC), and polystyrene (PS) that was “normally used in portable electronic devices” had low loss tangents. Wang-041 at 5:67-6:2 (“plastic housing material as is normally used in portable electronic devices (e.g., ABS, polycarbonate, polystyrene or the like).”); Pohjonen at 2 (identifying polycarbonate and polystyrene as some of “the most common materials used for” outer covers of portable electronic devices and having following loss tangents: PC 0.0004-0.0006, PS 0.0004-0.0006,);

Dabov at 10:27-50 (explaining that “[s]uitable materials” for an antenna enclosure will have a “low loss tangent” such as a “low density plastic such as polycarbonate”). And those low loss tangent materials were used because they were known to allow radio waves to be “readily transmitted from and received by the antenna structures” in a device. Wang-078 at 7:16-20.

155. Therefore, it would have been obvious to a POSA to form the outer cover of Cook-554’s mobile device from a “low loss tangent material” because it was one of a finite number of known, predictable solutions that would not cause significant loss to Cook-554’s second resonator. *See Pohjonen* at 6-7. Indeed, a POSA could have and would have enclosed Cook-554’s receiving antenna in a low loss tangent outer cover in view of Pohjonen because a low loss tangent material would protect Cook-554’s second resonator from damage during manufacturing or use and would provide increased durability and enable surface treatments like decorative painting (at least one purpose of any housing), all the while improving the efficiency of Cook-554’s second resonator. *See Pohjonen* at 1-2, 6-7; *see also* Ground 1 Motivation to Combine.

* * *

156. For these reasons, claim 16 of the ’719 patent is unpatentable in view of Cook-554 alone or with Pohjonen.

IX. GROUND 2: CLAIM 17 IS OBVIOUS IN VIEW OF COOK-554

157. In analyzing claim 17, I focus on Cook-554's "Wireless Power Bridge" embodiment, which taught each element of that claim as it is arranged in the claim. As I explain in further detail below, the Wireless Power Bridge includes both source and second resonators for transmitting energy wirelessly over a distance D , with each resonator having a Q-factor that is greater than 200. Further, the source and second resonators are "flat panel[s]" that include including planar multi-turn coils connected to a plurality of capacitors and that have a thickness that is less than their characteristic size. A POSA would have understood or found obvious based on Cook-554's disclosures that because the resonators are "flat panels," the panels' "characteristic thickness" as defined by the '719 patent would be much smaller than their "characteristic size." Therefore, claim 17 is unpatentable over Cook-554.

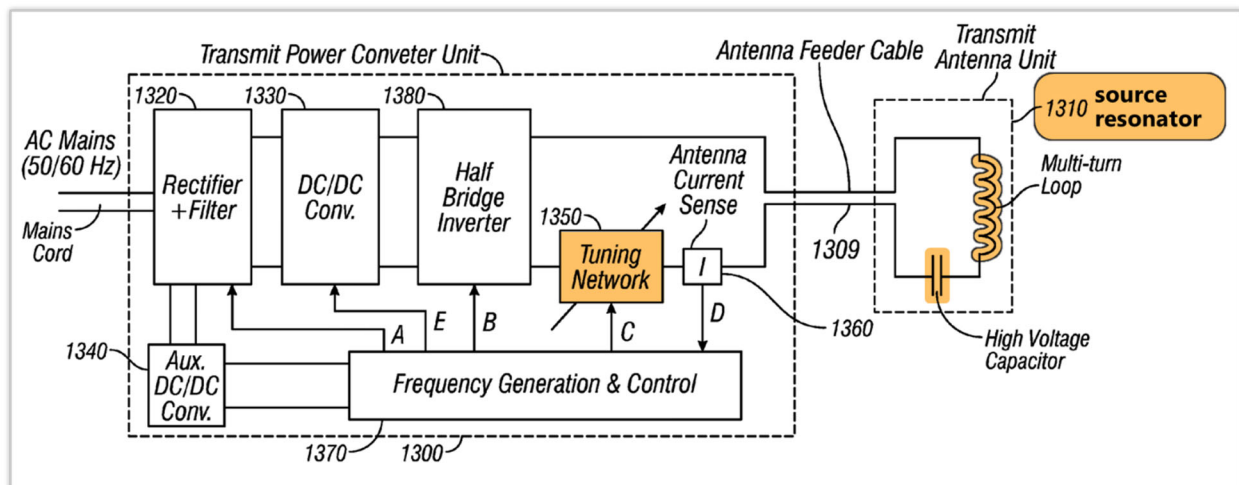
A. Element [17pre]: Preamble

158. Claim 17's preamble recites a "system." To the extent that the preamble is limiting, it is disclosed by Cook-554 as I explain below in the following sections. *See also, e.g.*, Cook-554 at 4:26-34 ("The system also uses..."), 6:13-32 ("magnetically/inductively coupled system..."); Cook Provisional at 40, 60.

B. Element [17a]: Source Resonator

159. Claim 17 recites "a source resonator having a Q-factor Q_1 and a characteristic size x_1 ," which is the same as element 16[a] above.

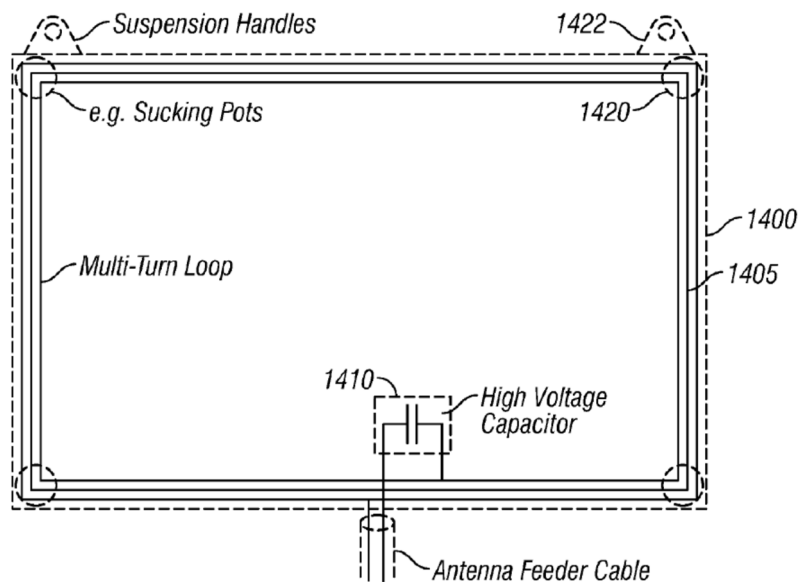
160. As I explained above with respect to element 16[a], Cook-554's "transmit antenna unit" and its associated "tuning network" correspond to the claimed "source resonator." Cook-554's "Wireless Power Bridge" embodiment, which is shown below in annotated Figure 13, has a source resonator that "includes a multi-turn loop (coil) and a high voltage capacitor forming a principal part of a series tank circuit," and a "tuning network" which can include a "capacitor bank" used for "tuning of the antenna's resonance frequency":



Cook-554 at Fig. 13 (annotated) (same as Cook Provisional Figure 4-11), 13:12-20, 13:30-32 ("The antenna 1400 is formed of a coil part 1405 and a high voltage capacitor 1410"), 11:31-35, 12:19-38, 19:51-64 ("block diagrams of the Wireless Power Bridge as shown in FIGS. 13 and 15"); *see also, e.g.*, Cook-554 at Fig. 1 (block diagram of the "generic wireless energy source" including "resonant antenna" and "tuning (capacitive/inductive)"), 3:21-32, 4:61-67 ("Tuning can be capacitive . . . It can be a capacitor bank"), Figs 11-12; Cook-Provisional at 23, 25-28, 40-41, 45,

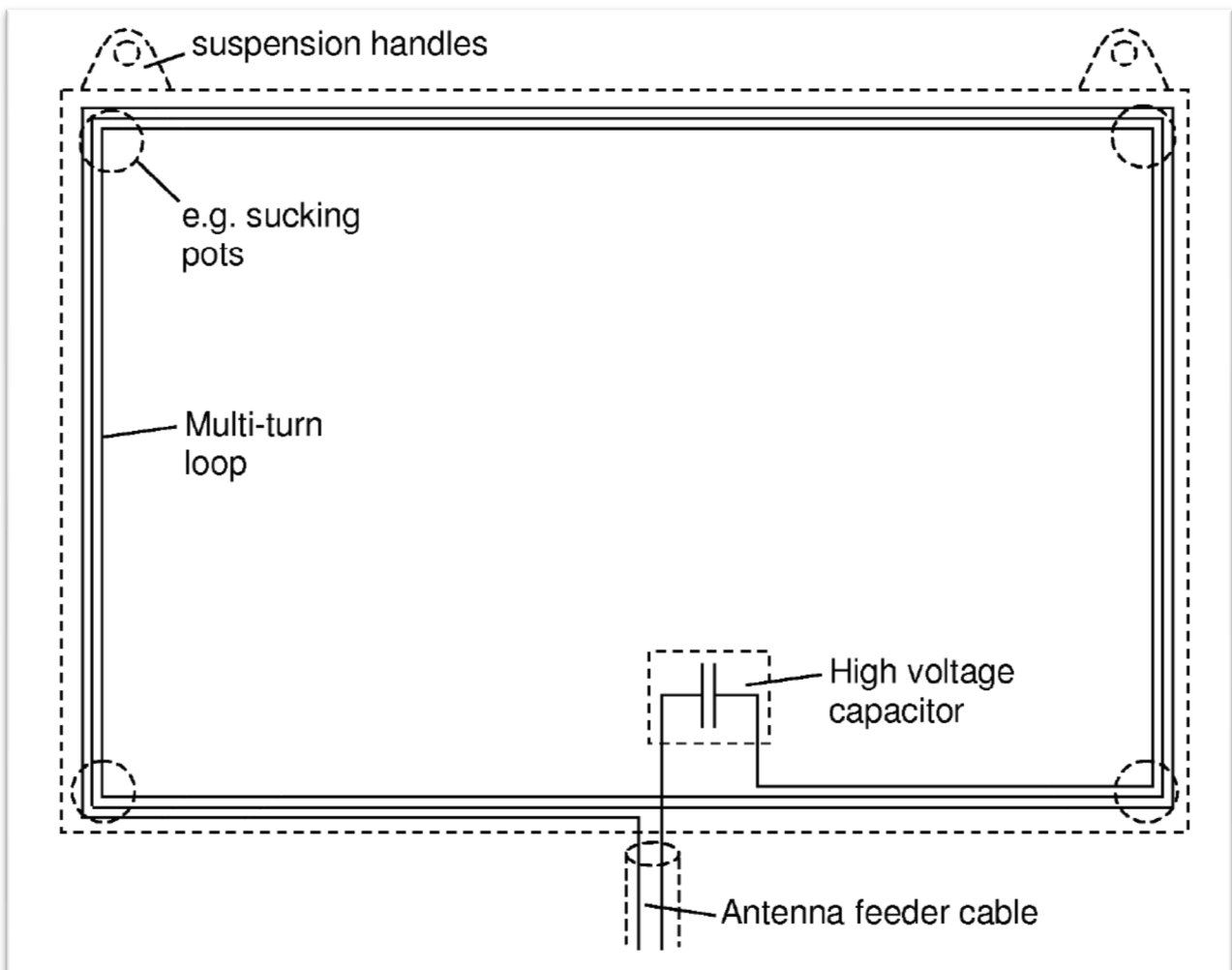
Figs. 3-1, 4-8, 4-11 (same as Cook-554 Fig. 13). I note that Cook-554 states that Figure 13's transmit subsystem can be "used with any of the wireless power embodiments in this application," but also Cook-554 specifies that Figure 13 is used in the Wireless Power Bridge embodiment. Cook-554 at 11:20-24, 11:41-51, 19:51-64 ("block diagrams of the Wireless Power Bridge as shown in FIGS. 13 and 15"); Cook Provisional at 28.

161. As shown in Figure 14, below, the Wireless Power Bridge's transmitting antenna unit is a "flat panel" that has a "typical layout" that includes a flat planar coil connected to a high voltage capacitor and other circuitry through the Antenna Feeder Cable:



Cook-554 at Fig. 14, 13:30-41; *see also* Cook-554 at Figs. 11-12 (side view of transmit antenna unit, same as Cook Provisional Fig. 4-8), 13:30-41, 10:25-31,

10:61-62; Cook Provisional at 43, Fig. 4-13. A POSA would have understood that Cook-554's Figure 14 includes a minor drawing error in that the "multi-turn loop" has all of the loops disconnected from one another. A POSA would have understood that the multi-turn loop in Figure 14 is intended to be drawn as a spiral with interconnected loops, which is how it is shown in the Cook Provisional's equivalent Figure 4-3.



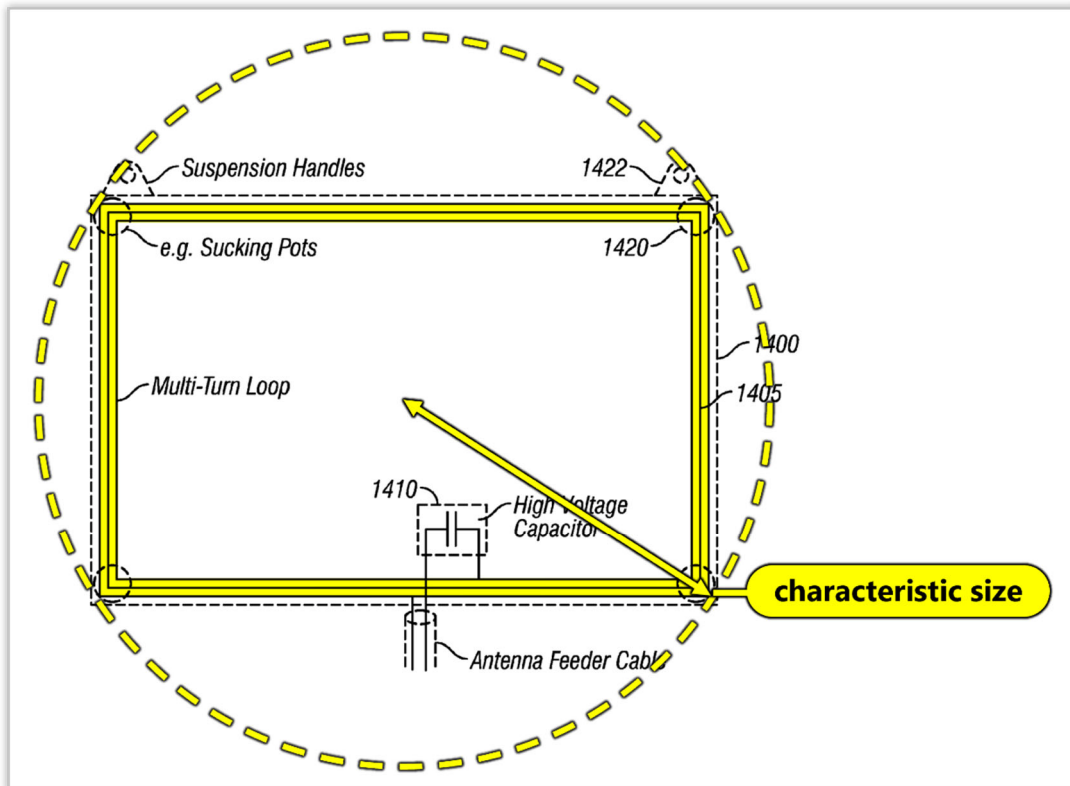
Cook Provisional at Fig. 14-3; *see also* Cook-554 at 1:4-6 (incorporating Cook Provisional by reference).

162. Cook-554 also discloses that its flat panel transmit antenna unit has a “high quality factor,” which corresponds to the claimed “ Q_1 .” Cook-554 at 13:35-41, 10:32-44 (“resonant transmit antenna” used in “Wireless Power Bridge” has a “high Q-factor” (typically >200).”), 10:61-65; Cook Provisional at 40, 43. Cook-554’s “source resonator” also includes a tuning circuit which is connected through the “antenna feeder cable” in Figure 14 to “help keep a high Q” for the antenna while also “not impair[ing] the antenna’s Q-factor.” Cook-554 at 11:31-33, 12:19-38, 17:34-40, Figs. 13-14 (Cook Provisional Figs. 4-11, 4-13); Cook Provisional 41-42, 51-52. Cook-554 also generally teaches setting the Q of the transmit antenna unit as high as possible. *See also* Cook-554 2:6-7 (“antennas preferably have Qs that are greater than 1000”), 4:32-34 (“Q-factor as high as possible”), 4:35-38 (“Q-factors up to 300 are achievable at LF and up to 600 in the HF frequency range), 13:24-25 (“maximize unloaded Q-factor”), 17:27-33; Cook Provisional at (¶)5, 14, 28, 30-31, 39.

163. Cook-554’s Wireless Power Bridge embodiment transfers energy wirelessly “based on magnetic coupled resonance.” Cook-554 at 10:32-34 (“The Wireless Power Bridge is based on magnetic-field inductive coupling between a resonant transmit antenna and a resonant receive antenna”), 15:23-26; 15:23-26; Cook Provisional at 14, 22, 24, 37. Therefore, its source resonator is a “magnetic

resonator” with a “characteristic size X_1 ” equal to the radius of a sphere that can enclose its coil element.

164. The “characteristic size” of Cook-554’s source resonator in the Wireless Power Bridge is shown in annotated Figure 14 below:

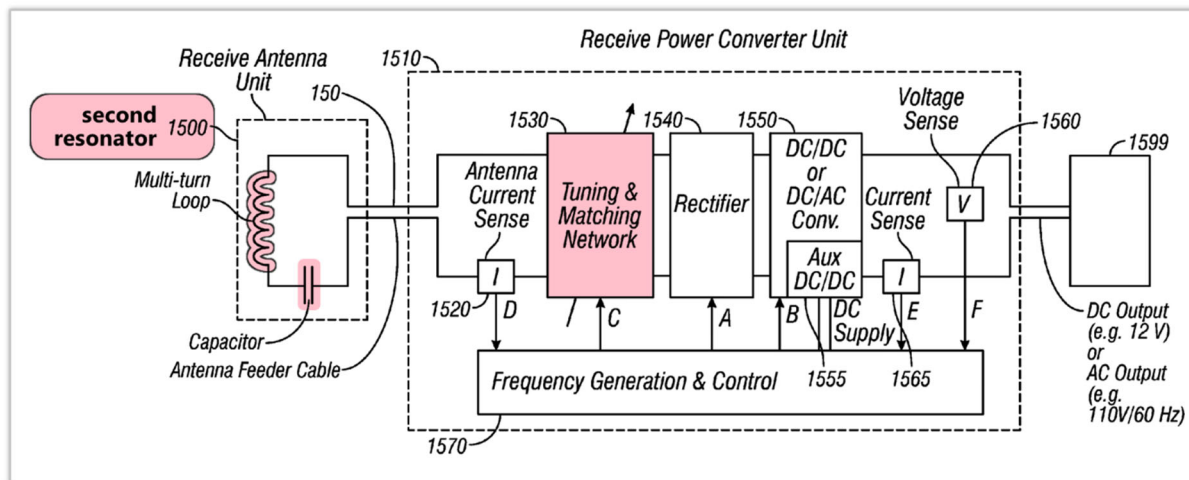


Cook-554 at Fig. 14 (annotated), 13:13-41; '719 patent at 23:33-37 (defining “characteristic size” of a magnetic resonator); *see also* Cook-554 at 10:61-62; Cook-Provisional at 28, 30-31, Fig. 4-13.

C. Element [17b]: Second Resonator

165. Claim 17 next recites “a second resonator having a Q-factor Q_2 and a characteristic size x_2 , and located a distance D from the source resonator,” which is the same as element 16[b] above. Cook-554 taught this element.

166. As discussed with respect to element [16b] above, Cook-554’s “receive antenna unit” and associated “tuning and matching network” corresponds to the claimed “second resonator.” In the Wireless Power Bridge, Cook-554’s “receive antenna unit” and its associated “tuning and matching network,” are shown in Figure 15, also reproduced below. The receive antenna unit includes a multi-turn loop (coil) and, a capacitor, and the tuning and matching network can include that can include a “capacitor bank” used for “tuning of the antenna’s resonance frequency”:

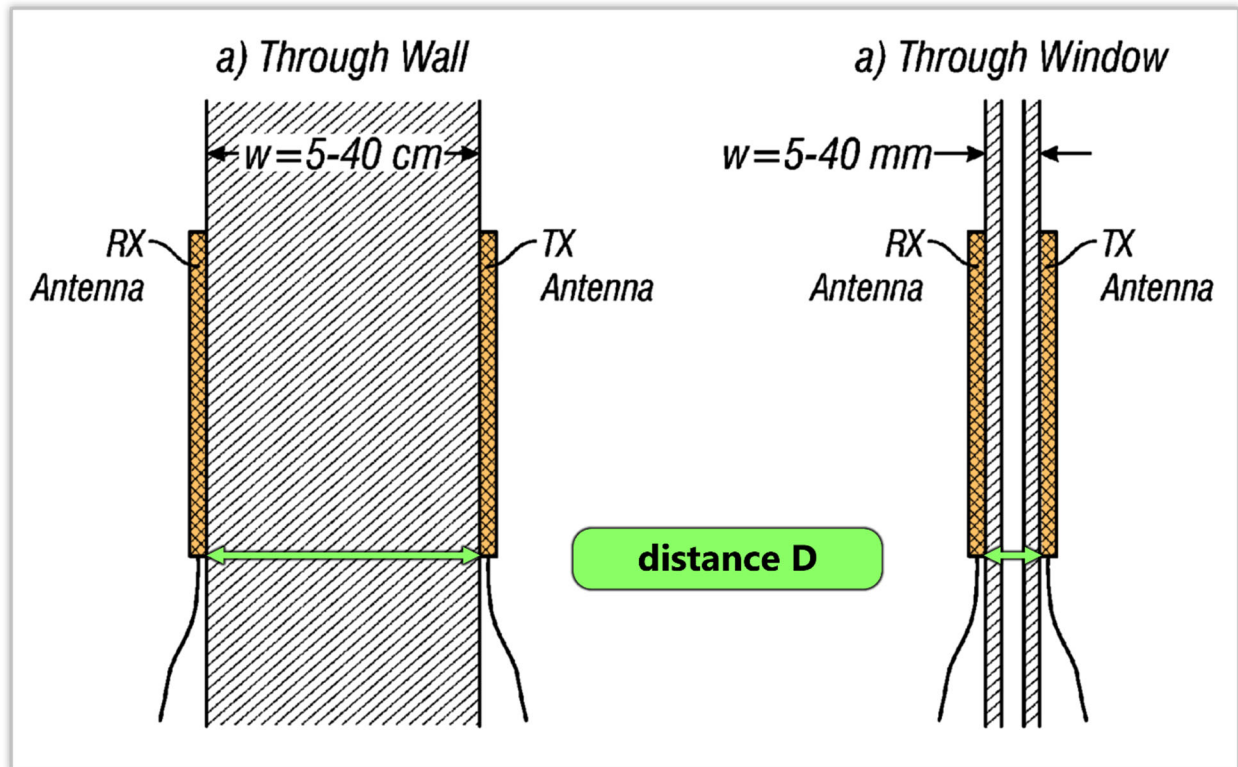


Cook-554 at Fig. 15 (annotated, same as Cook Provisional at Figure 4-12), 13:46-54; 6:14-19, 6:40-62 (describing tuning of receiver), Figs. 2 (Cook Provisional at

Fig 4-2), 11-12 (Cook Provisional at Fig. 4-8), 16 (Cook Provisional at Fig. 5-1); CProv 28-30, 43, 50.

167. Cook-554 explained that the receive antenna unit “may be identical to the transmit antenna unit 1310,” including as a “flat panel” in the Wireless Power Bridge embodiment. Cook-554 at 13:46-54, 10:63-65; Cook Provisional at 39-40. The transmit antenna unit 1310 is described above as part of the “source resonator” in element [17a] above, which has a “characteristic size” and “quality factor.” Because Cook-554’s receive antenna unit (second resonator) can be “identical” to the transmit antenna unit, it has a “quality factor Q_2 ” and “characteristic size x_2 ” for the same reasons. *See* Ground 2 Element [17a]; *see also* Cook-554 at 15:23-26 (“Efficient wireless energy transfer” uses “highest possible quality factor” in the “receiver”); Cook Provisional at 37.

168. Cook-554’s receive antenna unit (“second resonator”) is “located a distance D ” from the transmit antenna unit (“source resonator”). For example, Cook-554 shows that the receive (RX) antenna can be placed on the other side of a wall or window from the transmit (TX) antenna as depicted in Figure 11 below.



Cook-554 at Figs. 11-12 (annotated), 10:25-11:19; Cook Provisional at 39-40, Fig. 4-8.

169. As described further below, Cook-554 also discloses that the receiving antenna unit receives power “wirelessly” from the transmitting antenna unit, which means the antenna units are separated by some amount of distance. Cook-554 at 19:51-64; Cook Provisional at 47; *see also* Ground 2 Element [17c] Wireless Energy Transfer.

D. Element [17c]: Wireless Energy Transfer

170. Claim 17’s next recites “wherein the source resonator and the second resonator are coupled to exchange energy wirelessly among the source resonator and the second resonator.” Cook-554 taught this element.

171. Cook-554 generally explained that its embodiments use “[w]ireless energy transfer” between the transmit antenna unit (the claimed “source resonator”) and the receive antenna unit (the claimed “second resonator”) based on magnetic coupled resonance. Cook-554 at 19:51-64; Cook Provisional at 59. In the Wireless Power Bridge it is the same: the “Wireless Power Bridge is based on magnetic-field inductive coupling between a resonant transmit antenna and a resonant receive antenna” and can wirelessly transfer energy “up to 100 W, or similar.” Cook-554 at 10:32-60; Cook Provisional at 39-40; *see also* Cook-554 at 3:6-10, 3:21-31, 4:26-28, 6:14-21, 11:3-8, 11:47-51, 15:23-26, 17:24-26, Tables 1-3, Figs. 1-2, 11-16; Cook Provisional at 10, 13, 14, 22, 28, 37, 56, Figs. 3-1, 3-2, 4-1, 4-8, 4-11, 4-12, 4-13, 5-1; *See* Ground 1 Element [16c].

E. Element [17d]: High Quality Factor

172. Claim 17’s next recites: “wherein $\sqrt{Q_1 Q_2}$ is greater than 100,” which I note is identical to claim element 16[c]. Cook-554 disclosed this limitation.

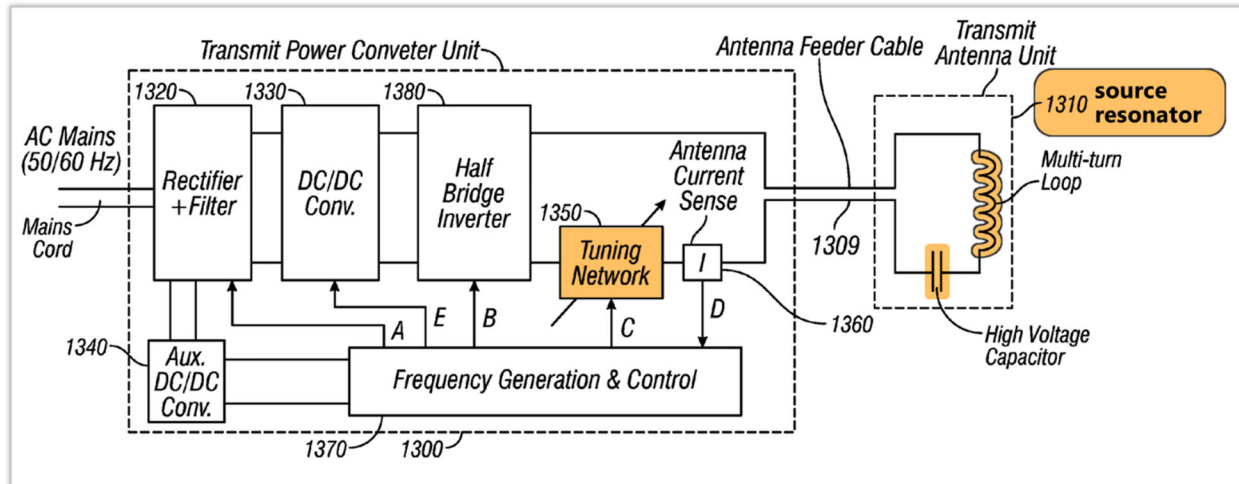
173. Cook-554 discloses that the transmit antenna unit and receive antenna units in Cook’s “Wireless Power Bridge” embodiment have a “high Q-factor (typically >200).” Cook-554 at 10:32-45; Cook Provisional at 40. Further, as I described above with respect to claim element 16[c], Cook-554 generally taught that quality factors should be as high as possible for better efficiency and to improve, i.e., increase, the distance that power can wirelessly transfer. *See* Ground 1 Element

16[d]; *see also, e.g.*, Cook-554 at 4:35-38 (“Q-factors up to 300 are achievable at LF and up to 600 in the HF frequency range) 6:33-35 (“Q-factors up to 150 may be typical at LF and up to 200 in the HF frequency range”), 2:6-7 (“antennas preferably have Qs that are greater than 1000”); Cook Provisional at 5, 17, 28. And when Q_1 and Q_2 are greater than 200, the “ $\sqrt{Q_1 Q_2}$ is greater than 100” as claimed.

F. Element [17e]: Planar Coils And Capacitors

174. Claim 17 next recites “wherein at least one of the resonators includes a coil of a plurality of turns of a conducting material connected to a network of capacitors, wherein the plurality of turns are in a common plane.” Cook-554 taught this element.

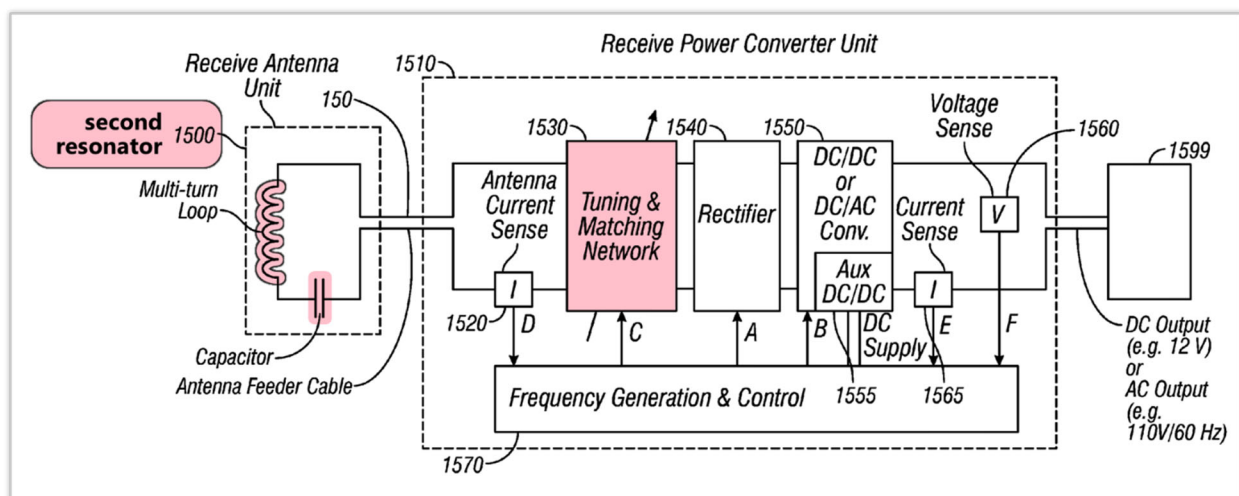
175. Cook-554’s source resonator in the Wireless Power Bridge embodiment has a transmit antenna unit with a “multi-turn loop (coil)” made from conductive “copper wire.” Cook-554 at 13:12-16; *see also* Cook-554 at 4:39-42; Cook Provisional at 26, 42. This conductive copper wire “multi-turn loop” coil is the claimed “coil of a plurality of turns of a conducting material. This copper wire coil is also connected to a “high-voltage capacitor” and to the “tuning network” shown below in annotated Figure 13.



Cook-554 at Fig. 13 (annotated), 13:49-51 (explaining that the “receive antenna unit” “may be identical to the transmit antenna unit”); *see also* Cook-554 at Fig. 1 (showing a block diagram of an energy transmitter for wireless control with a “Resonant Antenna” attached to “Tuning”); Cook Provisional at 42-43, Figs. 4-11, 4-13. Cook explains that its transmitter “tuning network” can be implemented using a “[c]apacitor bank.” Cook-554 at 4:61-67 (explaining that “[t]uning can be capacitive or inductive or both” where “[c]apacitive tuning may be accomplished using mechanically tuneable capacitors”), Fig. 1 (block diagram showing tuning), 17:41-45 (“The capacitive tuning can use a set of capacitors, e.g., a capacitor bank, in a series or parallel arrangement with RF switches that may be opened or closed to adjust the effective capacitance”); *see, e.g.*, Cook-554 at Fig. 16 (disclosing exemplary implementation of a “series resonant transmitter circuit with a tuning capacitor bank 1600”), 17:46-62 (describing Fig. 16, which shows “an embodiment of a series resonant transmitter circuit with a tuning capacitor bank”); Cook

Provisional at 52 (explaining that a “common method of tuning of a resonant transmit antenna circuit uses a set of capacitors (capacitor bank)”), 27, 52, Fig. 3-1 (same as Cook-554 Fig. 1). Thus, Cook’s “coil” (the multi turn loop) is connected to a network of capacitors, the “High Voltage Capacitor” and “Tuning Network” in Figure 13 above.

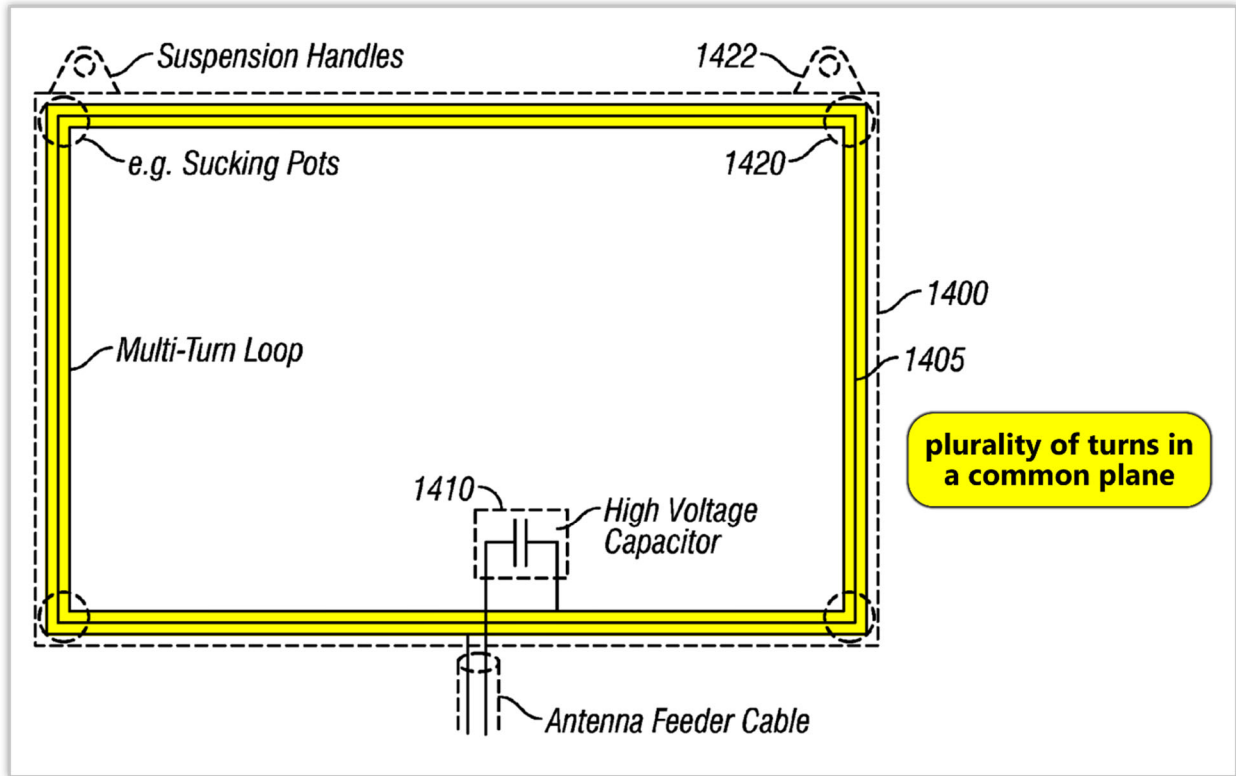
176. As discussed previously, Cook-554 taught that its “receive antenna unit” may be “identical to the transmit antenna unit,” and so the receive antenna unit would also include a conductive copper coil having a plurality of turns. Cook-554 at 13:46-54. Again, the coil (i.e., the “Multi-turn Loop” in the figure below) is connected to a “network of capacitors,” including “Capacitor” in the receive antenna unit and a “Tuning & Matching network” connected to the coil through the “Antenna Feeder Cable” in annotated Figure 15 below.



Cook-554 at Fig. 15 (annotated) (same as Cook Provisional Fig. 4-12)); Cook-554 13:46-54; 6:14-19, 6:40-62 (describing tuning of receiver), Figs. 2 (Cook

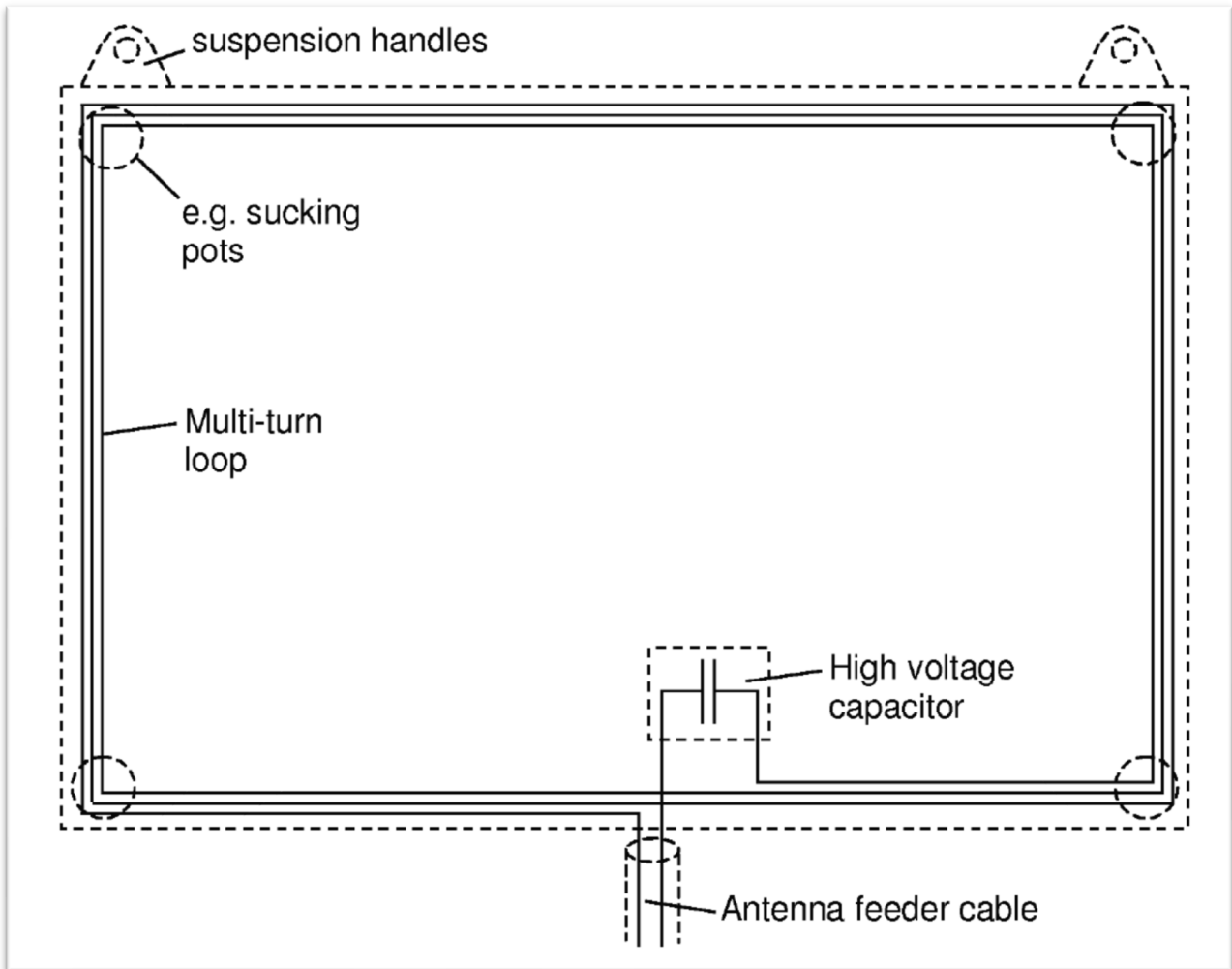
Provisional Fig 4-2), 11-12 (Cook Provisional Fig. 4-8), 16 (Cook Provisional Fig. 5-1); Cook Provisional at 28-30, 43, 50. As with the transmitting/source unit, Cook-554 discloses that the tuning and matching network in the receiver can include a “bank of capacitors. Cook-554 at 6:56-62 (“capacitive tuning” in the receive subsystem can be a “bank of capacitors”), 17:41-45 (“capacitive tuning can use a set of capacitors, e.g., a capacitor bank”), 19:1-3 (describing a “further method” for “fine tuning a receive antenna, e.g., in conjunction with a capacitor bank for coarse tuning”); Cook Provisional at 30, 52, 55, Fig. 3-2 (same as Cook-554 Fig. 2); 4-12 (same as Cook-554 Fig. 15).

177. Further, Cook-554’s Wireless Power Bridge embodiment implements the multi-turn loop coils in the source and second resonator antenna units as “flat panel[s].” Cook-554 at 10:61-65; Cook Provisional at 40. These “flat panels” include multiple turns in a single plane (i.e., so that the coil is “flat”), also commonly understood as a planar or spiral coil to a POSA. *See, e.g.,* Smith at 8:63-65 (“flat spiral transmit resonator”), 15:24-39 (“Tx Coil and/or Rx Coil may be arranged as substantially flat or planar in design” that can be fabricated by “forming a suitable number of turns” on a “substrate or armature that maintains the appropriate flat geometry”). In Figure 14 of Cook-554, the “flat panel” is shown as having a three-turn loop with the turns in the same plane (i.e., the claimed “plurality of turns are in a common plane”), as shown below:



Cook-554 at Fig. 14 (annotated), 10:61-65 (“Transmit antenna unit (flat panel)”), 10:63-65 (“Receive antenna unit (flat panel) that integrates a multi-turn loop (coil)”), 13:31-41 (“flat panel transmit antenna unit is shown in Fig. 14”), 13:42-45, 13:50-51 (“receive antenna unit 1500 may be identical to the transmit antenna unit”); *see also* Cook-554 at Figs. 11, 12 (side views of the antenna units in the Wireless Power Bridge), 10:61-62, 17:19-23; Cook Provisional at 40, 42, 51, Fig. 4-13 (same as Cook-554 Fig. 14). Cook-554 further explains that there can be a “larger number of turns” than the three represented in the figure above. Cook-554 at 15:38-54; Cook Provisional at 49 (“use thin copper wire and a large number of turns”).

178. As I previously mentioned, a POSA would have understood the turns in Figure 14 of Cook-554 would be connected to one other in a spiral as shown in Fig. 4-13 of the Cook Provisional:



Cook Provisional at Fig. 14-3; *see also* Cook-554 at 1:4-6 (incorporating Cook Provisional by reference). A POSA would have understood that in Figure 14, the non-connecting rectangles is a simple drawing error because they would form three “single” loops and not a “multi-turn loop” as Cook-554 describes and as labeled in Fig. 14. Cook-554 at 13:12-17, Fig. 14.

G. Element [17f]: Characteristic Thickness and Size

179. Claim 17 next recites “wherein a characteristic thickness of the at least one of the resonators is much less than a characteristic size of the at least one of the resonators.” Cook-554 disclosed or rendered obvious this limitation to a POSA.

180. Cook-554’s transmit and receive antenna units are both magnetic resonators. Thus, their characteristic size, as defined by the ’719 patent, would be the radius of the smallest sphere that contains the inductive element. As I explained above for claim limitations 17[a] and [b], transmit and receive antenna units both have this characteristic size. I again note that the ’719 patent does not prescribe a particular value to this size but instead only requires that the resonators have a characteristic size.

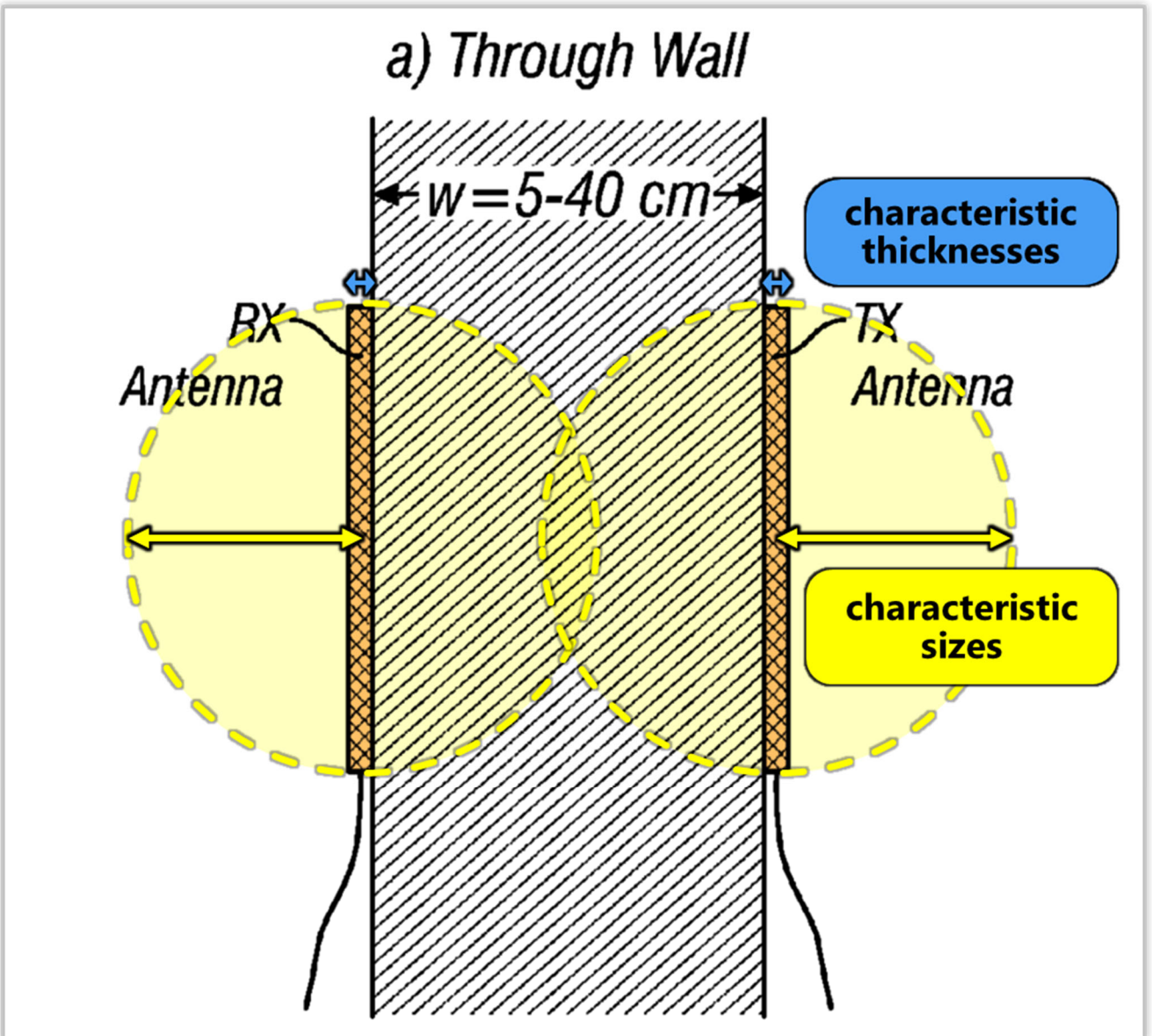
181. In addition, as magnetic resonators, the ’719 patent defined “characteristic thickness” for Cook-554’s resonators would be equal to the highest point of the inductive element as measured from the surface that it is formed on. ’719 patent at 23:38-42.

182. A POSA would have understood or found obvious that Cook-554’s Wireless Power Bridge embodiment has the transmit and receive antennas with characteristic thicknesses that are much smaller than their respective characteristic sizes.

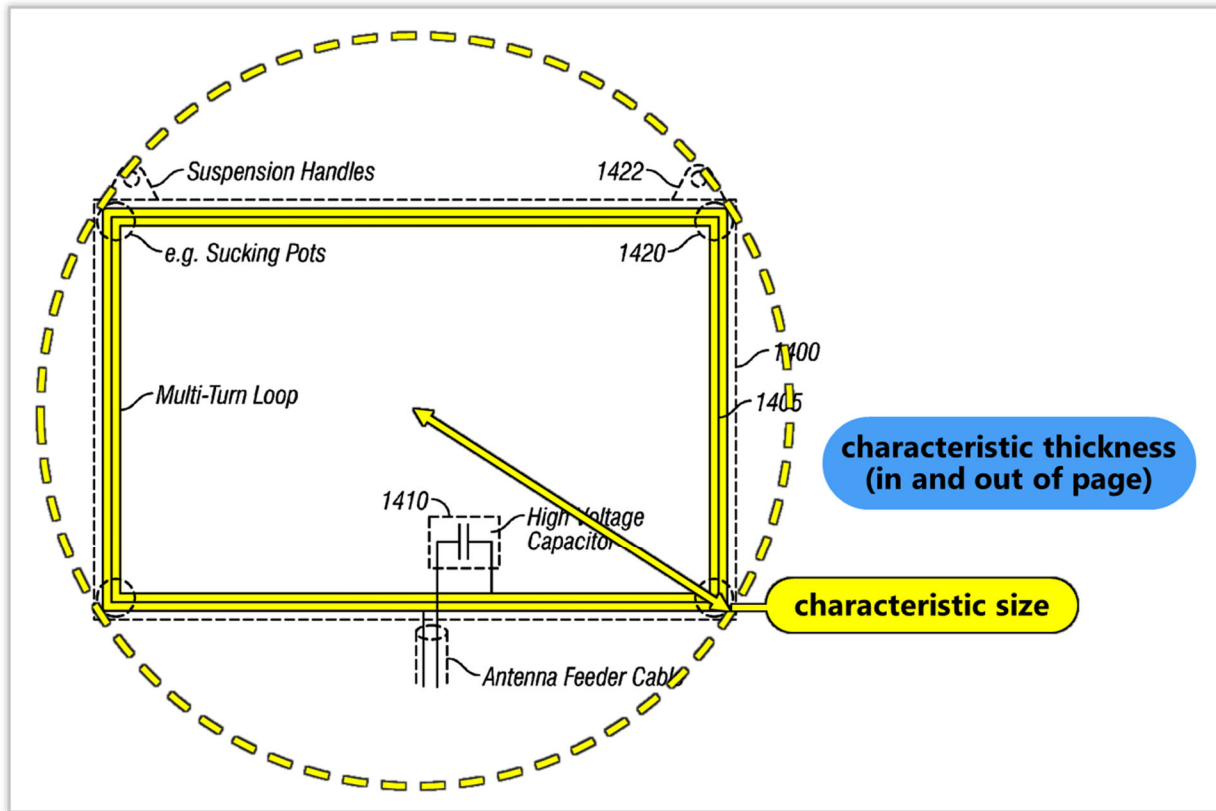
183. Cook-554 explains that the transmit and receive antenna units are “flat,” which a POSA would have understood to mean that their thickness is much less than their size. Indeed, the commonly understood meaning of “flat” in this context in the pre-2008 timeframe (and today) was “having a relatively broad surface in relation to thickness or depth.” The American Heritage Dictionary of the English Language (4th ed. 2000) (defining “flat”); *see also* Concise Oxford American Dictionary (2006) (defining “flat” as “having a broad level surface but little height or depth”). This is also how a POSA would have understood “flat” resonators in the wireless power transfer context, as indicated by Smith. Smith 15:24-39 (“Tx Coil and/or Rx Coil may be arranged as substantially flat or planar in design. In addition to improving integration with smaller and more planar-sized structure such as a laptop, a flat coil structure can also reduce unwanted spurious radio frequency (RF) emissions, because the substantially flat coil will have a smaller dipole moment in the direction perpendicular to the flat coil.”), 8:59-65, Fig. 1c (showing “flat spiral transmit resonator (Tx Coil)” with much larger size than thickness), 15:62-16:13 (“Substantially flat coils for wireless power transfer” having around 6 turns). In Cook-554, the antennas are “flat” with a characteristic thickness equal to the dimension of the conductor line forming the coil, and a characteristic size approximately equal to the radius of the outermost loop of the coil. Because there

are multiple loops the radius of the outermost loop would be much larger than the conductor line dimension.

184. This is what Cook-554 explains when stating that the wires forming the coils can be “thin,” whereas there can be a “large number of turns for the coil.” Cook-554 at 15:38-54; Cook Provisional at 49. Cook-554 further explains that the loop should have a “maximum loop size for a given outer contour form factor.” Cook-554 at 13:30-41; Cook Provisional at 43. Further, the distance the Wireless Power Bridge could efficiently transfer power would “depend[] on the size of the antenna.” Cook-554 at 10:37-44; Cook Provisional at 40. These teachings are reflected in Cook-554’s figures, which show the Wireless Power Bridge embodiment’s flat panel antenna units having a much smaller characteristic thicknesses than their characteristic size, as depicted in the annotated figure below:



Cook-554 at Fig. 11, Cook Provisional at Fig. 3-8 (same). Cook-554 taught that the Wireless Power Bridge antennas in Figure 11 are also shown from a top-down view (with the thickness not visible) in Figure 14, which shows that the coil would be arranged around the entire outer contour of the antennas in Figure 11.



Cook-554 at Fig. 14 (annotated); Cook Provisional at Fig. 4-13 (same). Here, the characteristic size relative to the characteristic thickness in Cook-554's figures clearly show that the resonator's characteristic thickness is "much less" than its characteristic size. I note that a POSA would not need to rely on any precise proportions of any elements in Cook-554's figures to determine that Element [17f] is taught. Thus, taken together, a POSA would have understood that the "characteristic thickness" of Cook-554's resonators would therefore be "much less" than their characteristic size as required by the claim.

185. In any event, a POSA would have been motivated by Cook-554 itself to design Cook-554's flat panel resonators with a characteristic size greater than

the thickness so that a “high-voltage capacitor” can be “mounted in the interior of the loop” and for a “maximum loop size for a given outer contour form factor.” Cook-554 at 13:30-41, Fig. 14; Cook Provisional at 31, Fig. 4-13. Indeed, Cook-554 taught that the distance which power can be transferred depends on resonator size but also taught that the resonators should be “flat” so that they could be mounted on a wall or window. Cook-554 at 10:8-44; Cook Provisional at 39-40. Thus, a POSA would have been motivated to increase the size of the resonator without substantially increasing its thickness when, for example, designing a Wireless Power Bridge for thicker walls or windows.

186. A POSA also would have understood and found it obvious that the characteristic thickness of Cook-554’s source and second resonators in the Wireless Power Bridge embodiment is much less than their characteristic size because Cook-554 incorporates by reference Cook-086, which provides exemplary dimensions for a coil that could be used in Cook-554’s system. For example, Cook-086 provides examples of simulations of “loop antennas” with a radius (characteristic size) that is more than twelve times greater than the diameter of the wire (characteristic thickness), and that those loop antennas could have a quality factor of 1000. Cook-086 at 10:55-11:32. Therefore, a POSA would have a reasonable expectation of success applying similarly sized coil dimensions to Wireless Power Bridge antennas,

which Cook-554 taught should have quality factors greater than 200. *See* Cook-554 at 10:42-44; Cook Provisional at 36.

* * *

187. For these reasons, claim 17 of the '719 patent is unpatentable in view of Cook-554.

X. GROUND 3: CLAIMS 16 IS OBVIOUS OVER COOK-523 AND POHJONEN

188. Claims 16 of the '719 patent would have been obvious over the combination of Cook-523 and Pohjonen because Cook-523 discloses each element of claim 16 except for the “low loss tangent material” that encloses at least one of the resonators, which would have been obvious in view of Pohjonen.

A. Motivation to combine Cook-523 and Pohjonen

189. A POSA could have and would have been motivated to implement Pohjonen’s material selection in Cook-523’s wireless power transfer system.

190. First, the references are in the same field of endeavor as the '719 patent and reasonably pertinent to the particular problem with which the inventor was concerned.

191. Here, Cook-523 and Pohjonen are directed to similar fields of endeavor to each other and to the '719 patent: the integration of an “antenna” that receives “wireless energy” into a mobile device. Cook-523 describes integrating “antennas”

for receiving wireless energy at radio frequencies (e.g., 13MHz) into portable electronic devices. Cook-523 at 1:30-37, 3:61-63. Pohjonen similarly describes “the technology of antennas for portable radio devices and devices including radio functionality.” Pohjonen at 1-2 (describing frequencies in the “range from 1MHz to 10GHz”), 9 (“From the viewpoint of antenna operation, the low-loss thermoplastic material constitutes a radiation window that is essentially transparent (i.e., causes only a very little amount of dielectric loss) to radio waves”). A POSA would have therefore recognized that both Cook-523 and Pohjonen concern similar technologies. Cook-523 and Pohjonen are also in the same field of endeavor as the ’719 patent, which similarly describes the integration of an antenna in a mobile device like a cell phone. ’719 patent at 28:40-60, 30:65-31:9, 59:40-53 (device resonators can be “enclosed in an enclosure” made from “low loss tangent materials,” including that the “device resonator may be integrated into ... cell phones”).

192. In addition, Cook-523 and Pohjonen describe minimizing losses to antennas caused by materials in the area near the antenna. *See* Cook-523 at 2:48-53 (explaining disclosed antennas are primarily “non-radiative” but “[o]f course, part of the output from the antenna will in fact radiate”), 4:5-7, 4:15-19, Figs. 4A-4B, Fig. 7B; Pohjonen at 1, 9. This is similar to the problem that the ’719 was purporting to address with its “low loss tangent material” that was intended to have a “negligible impact” on losses of a magnetic resonator. ’719 patent 34:53-35:6 (“low loss tangent

materials and objects may have a negligible impact on the losses of a magnetic resonator”).

193. Further, as I address in more detail below, a POSA could and would have been motivated to complete Cook-523’s portable device receiving wireless power by enclosing Cook-523’s second resonator antenna structure in a low loss tangent cover as taught by Pohjonen because it would: (1) protect Cook-523’s second resonator from damage during manufacturing or use, (2) improve Cook-523’s second resonator’s efficiency while protecting it, and (3) increase durability and enable surface treatments like decorative painting. In addition, a POSA also would and could have used a low loss tangent material to enclose Cook-523’s second resonator and would have done so with a reasonable expectation of success because it would have been easy and cost-effective to do so using common, well-known injection molding plastics. *See* Cook-523 at 1:34-36 (explaining that “cost may be a factor” when implementing wireless power in mobile devices); Pohjonen at 2 (“A vast majority of outer covers for portable radio devices are manufactured by injection moulding”), 6-7 (outer cover made of material with “suitably low loss tangent value” and “well suited for injection moulding”), 11.

194. First, it would have been advantageous for a POSA implementing Cook-523’s second resonator in a portable electronic device to enclose the resonator in a low loss tangent material to protect it from damage during manufacturing and

hand-held use of the portable device. Doing so was routine and known to POSAs. Cook-523 at 1:34-36 (explaining that receiving antennas are “preferably of a small size to allow it to fit into a mobile, handheld device”), 13:17-28 (describing wireless power transfer integrated into portable devices with a housing); Dabov at 10:43-50 (describing use of an “antenna chassis” to “protect the antenna from mechanical damage (e.g., during manufacturing of the electronic device) and from rusting”).

195. And as Pohjonen explained, outer covers with low loss tangent were “typical” to protect antennas integrated in portable radio devices. Pohjonen at 1 (“internal antenna[s]” in “portable radio devices” are typically “enclosed inside an essentially continuous outer cover of the device”); *see also, e.g.*, Tamura at 2:19-20 (describing “second protective material is provided in order to physically protect the antenna circuit”), 4:24-27 (identifying low loss tangent materials including poly vinyl chloride (PVC) to “physically protect[] the antenna circuit”).

196. Indeed, a POSA in September 2008 would have been very familiar with low loss tangent enclosures for antennas used in portable electronic devices because the “housing material” that was “normally used in portable electronic devices” had low loss tangents, including polycarbonate (PC) and polystyrene (PS). *See* Wang-041 at 5:67-6:2 (“plastic housing material as is normally used in portable electronic devices (e.g., ABS, polycarbonate, polystyrene or the like).”); Pohjonen at 2 (identifying polycarbonate and polystyrene as some of “the most common materials

used for” outer covers of portable electronic devices and having following loss tangents: PC 0.0004-0.0006, PS 0.0004-0.0006,); Dabov at 10:27-50 (explaining that “[s]uitable materials” for an antenna enclosure will have a “low loss tangent” such as a “low density plastic such as polycarbonate”). Cook-523’s second resonator within a low loss tangent enclosure would have been obvious to a POSA because it is nothing more than the application of a known technique (low loss tangent covers) to known prior art ready for the improvement.

197. Second, a POSA would have known that enclosing Cook-523’s second resonator in a low loss tangent outer cover would increase Cook-523’s antenna efficiency while also physically protecting it. Indeed, Cook-523 taught that its resonators were designed to transmit and receive power at radio frequencies, and one should avoid “lossy” materials near the antenna because they “can have a deleterious effect on high Q resonators.” Cook-523 at 11:55-62; *see also* Cook-523 at 3:61-4:8, 6:62-67 (describing conclusions based on equations related to energy transfer), 7:15-20 (same), 11:1-18 (equations showing that radiative losses decrease Q), 12:51-58 (explaining that “exemplary resonators for environments with lossy dielectrics may include a couple loop” while “conversely, a low L/C ratio can operate without the coupling loop”); Terman at 3. Therefore, a POSA implementing Cook-523 would have turned to Pohjonen’s enclosure because it was non-lossy at radio frequencies, which would preserve the Q and efficiency of Cook-523’s second

resonator. Pohjonen at 1-2, 6-7, 9-10. Pohjonen “advise[d] that if a portable telephone device has a radiating antenna element attached to or close to an outer cover part, it is advisable to make said outer cover part of a material with a loss tangent value less than about 0.005.” Pohjonen at 6. Even though Cook-523’s antennas in the disclosed embodiments are primarily non-radiative antennas, Cook-523 taught that its non-radiating antenna would still “in fact radiate” and that losses decrease the Q.² Cook-523 at 2:47-54, 11:1-18 (describing equations for Q factor), 13:17-39 (describing wireless power for integration into portable devices as shown in Figs. 12A-12C), Figs. 12A-12C (depicting antenna element surrounding perimeter of device); *see also* ’719 patent at 22:9-10. Pohjonen explains that at values less than about 0.005, “the loss tangent value becomes acceptable in terms of only very little additional loss caused to the antenna.” Pohjonen at 6. A POSA would thus understand that using a material with this low loss tangent level would be most effective in maintaining a high Q factor.

² A POSA would have similarly understood that Pohjonen’s antennas would also include a non-radiative component to the magnetic field in the near field where the cover is located.

198. Third, a POSA would have been motivated to enclose Cook's second resonator in low loss tangent materials for durability and aesthetic purposes because without an outer cover or enclosure, Cook-523's portable electronic device with an integrated antenna would leave exposed conductive coils with ridges on the external surface of the portable electronic device, which could catch on a user's clothing and could therefore inadvertently break or be damaged. *See* Cook-523 at Figs. 12A-12C (depicting internal components of Cook-523's portable electronic device). Aesthetically, coils on the exterior surface would also make it more difficult to add logos, decorations, or other designs to the device. But enclosing Cook-523's second resonator in Pohjonen's low loss tangent material would provide "sufficient mechanical stiffness and durability as well as dimensional accuracy" and as well as serve "as a good basis for surface treatments such as decorative painting." Pohjonen at 2.

199. Further, a POSA would have had a reasonable expectation of success applying to Cook-523's second resonator Pohjonen's cover because Pohjonen's cover is not limited to any "form or operating principle of the radiating antenna elements" and was designed to enclose antennas "made of good [] conductor materials," like that found in inductive component of Cook-523's second resonator. Pohjonen at 9; Cook-523 at 11:50 (describing a good conductor material by disclosing "Coil material: Silver plated copper"), 12:50-58 (loops formed from

“silver plated copper”), 14:4-6 (“Copper and silver are the best conductors”). Similarly, Cook-523 taught that its second resonator could be integrated into a portion of a mobile phone that “rotates, slides, or folds away from the case,” which Pohjonen is “equally well applicable to.” Cook-523 at 13:29-31; Pohjonen at 12. Further, it was well known to a POSA that common portable electronic devices that Cook-523’s secondary resonator was intended to “fit into” (Cook-523 at 1:33-36) already (and commonly) used polycarbonate and polystyrene enclosures for portable electronic devices. Accordingly, a POSA would have understood that an outer cover like Pohjonen’s could be implemented using already well-known techniques while not adding significant costs. Cook-523 at 1:34-36 (describing antennas for a “mobile, handheld device); Pohjonen at 1-2, 7.

200. At most, “modifying” Cook-523 with Pohjonen’s material selection is merely a combination of known prior art elements (i.e., antenna structures used in portable electronic devices and common plastic housings) according to known methods to yield predictable results (i.e., enclosures that protect an antenna while minimizing radio frequency losses in the cover materials).

201. For these reasons, a POSA could and would have combined Cook-523 and Pohjonen’s teachings and arrived at the claimed inventions of the ’719 patent.

B. Independent Claim 16

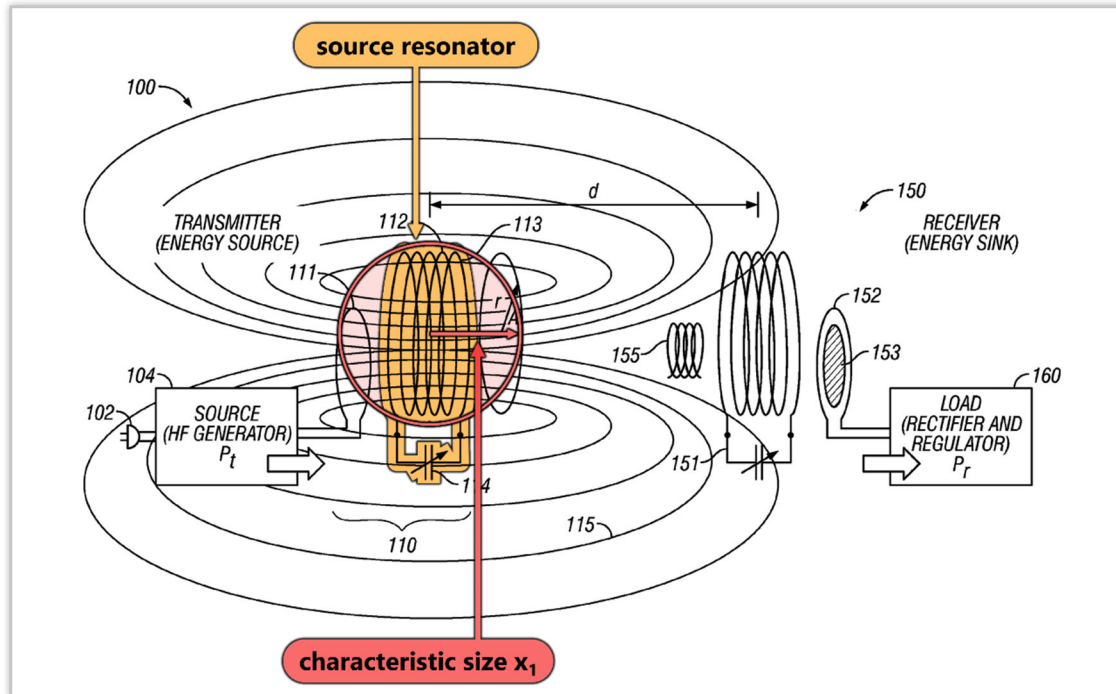
1. Element [16pre]: Preamble

202. Claim 16's preamble recites "a system, comprising." To the extent that the preamble is limiting, it is disclosed by Cook-523 and Pohjonen as I explain in the following sections. *See also, e.g.*, Cook-523 at 1:30-32 ("The system can use..."), 1:59-60 ("wireless power systems").

2. Element [16a]: Source Resonator

203. Claim 16 next recites "a source resonator having a Q-factor Q_1 and a characteristic size x_1 ." Cook-523 teaches this element.

204. Cook-523 discloses a "transmitting antenna" with a "high Q resonant antenna part." Specifically, and by means of example, Cook-523 discloses a "high Q resonant antenna 112" with a "number N of coil loops 113" connected in series with "[a] capacitor 114" as shown in annotated Figure 1 below.



Cook-523 Fig. 1 (annotated), 2:37-40 (“resonant antenna includes a number N of coil loops 113 each loop having a radius r_A ”); *see also* Cook-523 at 3:9-14 (“a wire loop forming at least one loop or turn of a coil, in series with a capacitor that electrically loads the antenna into a resonant state”), Fig. 3, Figs. 4A-B (equivalent circuit diagrams showing inductive and capacitive components of source resonator), Figs. 10A-10B. This “transmitting antenna” corresponds to the claimed “source resonator.” Cook-523’s source resonator “capacitor” can be “a totally separate structure from the coil” or can instead be the “self capacitance of the wire forming the coil [].” Cook-523 at 2:42-45.

205. Cook-523’s source resonator uses “magnetic field coupling” to transfer energy to the secondary resonator and that “much of the output of the

antenna” is “a magnetic field which is more stationary.” Cook-523 at 2:49-52, 2:66-3:14. Therefore, Cook-523’s source resonator is, as that term is used in the ’719 patent, a “magnetic resonator.” *See* ’719 patent at 18:38-49. Cook-523’s coil loops 113 of its source resonator have “a radius r_A ,” and therefore the source resonator has a “characteristic size x_1 ” as claimed. Cook-523 at 2:37-40, 3:58-64, Figs. 1, 3; *see also* ’719 patent at 23:33-37. Again, I note that claim 16 does not require any specific characteristic size, just that it exist.

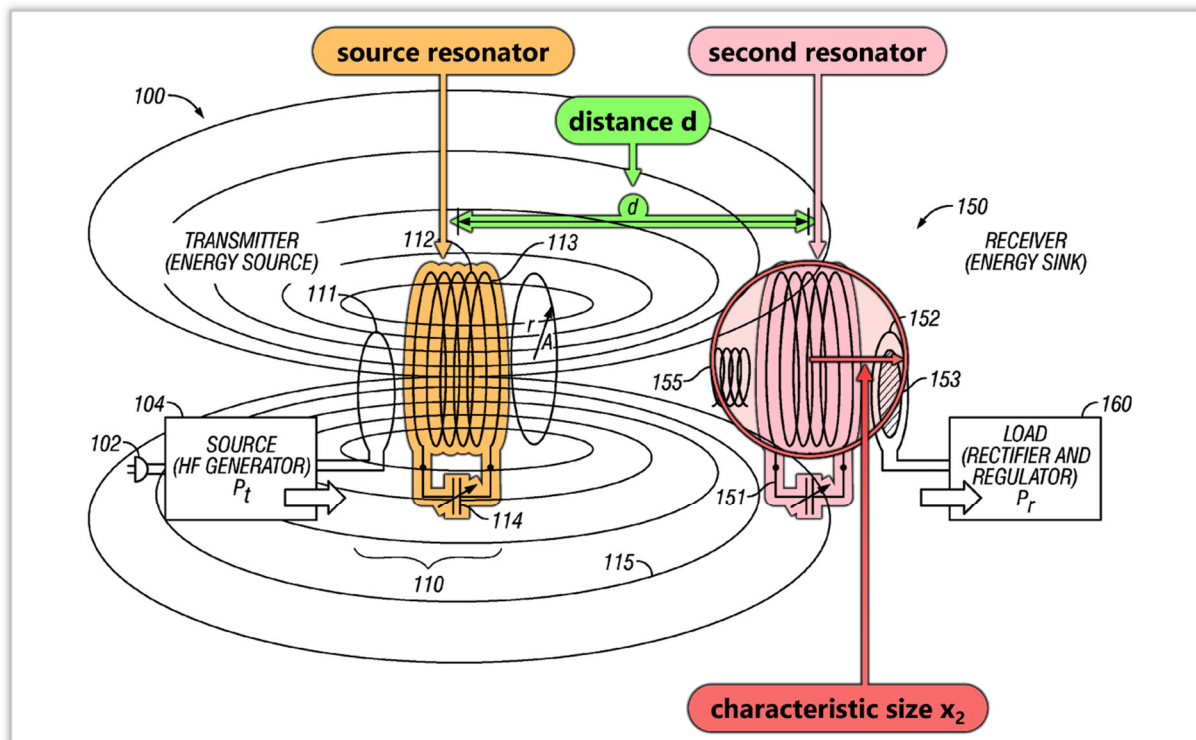
206. Cook-523’s source resonator also has a “high quality factor[,]” which is referred to in Cook as “ Q_t ” or “Q-factor,” corresponding to the claimed “Q-factor Q_1 .” Cook-523 at 1:40-44, 2:38-39 (source side resonator is a “high Q resonant antenna”), 4:25-50 (equations for the “unloaded Q-factor [Q_t] of transmitter resonator antenna”), 11:51-52, 12:65-13:15, Fig. 7B.

207. For these reasons, Cook-523 discloses a source resonator having a Q-factor Q_1 and a characteristic size x_1 .”

3. Element [16b]: Second Resonator

208. Claim 16 next recites: “a second resonator having a Q-factor Q_2 and a characteristic size x_2 , and located a distance D from the source resonator.” Cook-554 taught this element through its “receive antenna unit” disclosures. Cook-523 taught this element.

209. Cook-523's "receiver" includes a "high Q resonant coil antenna [] having a coil part and a capacitor." Cook-523 at 2:57-60, Fig. 1. This corresponds to the claimed "second resonator." As I show in Figure 1, reproduced and annotated below, Cook-523's second resonator is located a "distance D away from" the source resonator.



Cook-523 at Fig. 1 (annotated), 2:55-60; *see also* Cook-523 at 1:63 (“FIG. 3 shows wireless transfer using resonant coil antenna”), 3:9-14 (describing magnetic field coupling using wire loop in series with a capacitor), 3:51-4:4 (describing “receiver [] receiving power from the transmitter that has been wirelessly transmitted” and “located a transfer distance d away from the transmit antenna”), Figs. 3, 4A-B (equivalent circuit diagrams), 12A-12C.

210. And like the source resonator discussed above in element 16[a], Cook-523's second resonator is a "magnetic resonator" because it is "magnetically coupled" to the source resonator, and thus has a "characteristic size x_2 " as defined in the '719 patent that is equal to the radius of a sphere containing the inductive coil of the receiving resonator. Cook-523 at 2:55-3:14, Figs. 1, 3; *see also* Claim Construction section above. Again, I note that claim 16 does not require any particular characteristic size for the second resonator, only that it exists.

211. Corresponding to the claimed "Q-factor Q_2 ," Cook-523 also discloses that its second resonator is designed with a "high Q," or " Q_r ." Cook-523 at 1:40-44, 2:56-60 (receive side resonator is a "high Q resonant coil antenna"), 4:53-68 (equations for the "receive antenna unloaded Q-factor"), 5:25-45 (" Q_r "); *see also* Cook-523 at 11:51-52 (describing theoretical and measured Q-factors of 2790 and 1300, respectively), 12:65-13:15 (describing high Q factors of 1500-2600), 15:46-48 (describing "very high Q factors as high as 10,000).

4. Element [16c]: Wireless Energy Transfer

212. Claim 16 next recites: "wherein the source resonator and the second resonator are coupled to exchange energy wirelessly among the source resonator and the second resonator." Cook-523 taught this element.

213. Specifically, Cook-523 taught that the receiving resonant coil (i.e., the claimed second resonator) is coupled to and receives power from the "magnetic

field” that is wirelessly transmitted from the source resonant coil (i.e., the claimed source resonator). Cook-523 at 3:51-4:4, Figs. 1, 3; *see also* Cook-523 at 3:24-26 (describing magnetic field coupling), 11:55-58 (describing “magnetic power transmission according to this disclosure”), 13:17-18 (wireless power integrated into portable devices). This provides a “transfer of energy from a power source to a power destination via electromagnetic field coupling.” Cook-523 1:48-52.

5. Element [16d]: High Quality Factor

214. Claim 16 next recites: “wherein $\sqrt{Q_1 Q_2}$ is greater than 100.” Cook-523 disclosed this to a POSA.

215. As explained for claim elements 16[a] and [b], Cook’s source and receive “high Q resonant antennas” are resonators with quality factors Q_1 and Q_2 , respectively. These resonators “preferably have Qs that are greater than 1000” for “efficient power transfer.” Cook-523 at 1:37-39. And Cook-523 further describes, for example, that the “Q factors of the described antennas” can “vary between 1500-2600.” Cook-523 at 13:65-14:15; *see also e.g.*, Cook-523 at 11:51-52 (describing experimental transmitting and receiving resonant antennas with theoretical Q-factors of 2780 and measured Q-factors of 1300), Fig. 7B.

216. Because both Q_1 and Q_2 are each greater than 100, “ $\sqrt{Q_1 Q_2}$ is greater than 100” as claimed. Indeed, for any of the values of Q from 1500-2600 described

by Cook-523, the square root value would easily exceed the required value of “greater than 100.”

7. Element [16e]: Low Loss Tangent Material Enclosure

217. Claim 16 next recites “and wherein at least one of the resonators is enclosed in a low loss tangent material.” A POSA would have found this obvious in view of Cook-523 and Pohjonen.

218. Cook-523 disclosed that the secondary resonator that receives wireless power is intended to be integrated into a “mobile, handheld device.” Cook-523 at 1:30-40, 13:17-40 (describing “wireless power” that “may be integrated into portable devices” as shown in Figs. 12A-12C”), Figs. 12A-12C, 13A. Pohjonen taught that outer covers were typical for portable devices that have an integrated antenna and further taught that “if a portable telephone device has a radiating antenna element attached to or close to an outer cover part, it is advisable to make said outer cover part of a material with a loss tangent value less than about 0.005.” Pohjonen at 1-2, 6-7. Applying the combined teachings of Cook-523 and Pohjonen, a POSA would have found it obvious to enclose Cook-523’s second resonator in a low loss tangent outer cover for the reasons I discussed previously in the Motivation to Combine Section. *See* Ground 3 Motivation to Combine Section.

219. For example, a POSA could have and would have applied Pohjonen’s teachings to improve Cook-523’s integration of its secondary resonator into a

portable electronic device. *See* Section Ground 3 Motivation to Combine Section. The low loss tangent outer cover provides, as Pohjonen teaches, an antenna structure that has “low losses and good reliability in operation” and which thus also “increases the convenience of use to a human user.” Pohjonen at 3. Further, a POSA would have reasonably expected success making such a modification to Cook-523 since it would involve using known materials for known uses (i.e., as cheap, formable covers for electronics that does not interact with the electronic components). And a POSA would have known that doing so would improve the reliability of Cook-523’s second resonator by protecting the coil from damage without significant losses in the cover, which in turn increases the user’s ability to handle the device, as well as improves its aesthetics.

220. For these reasons, the combination of Cook-523 and Pohjonen teach this limitation to a POSA.

XI. GROUND 4: CLAIMS 17 IS OBVIOUS OVER LEE AND COOK-523

221. Lee and Cook-523 combined taught each element of claim 17 of the ’719 patent. Lee taught each element of claim 17, except for “wherein $\sqrt{Q_1 Q_2}$ is greater than 100” as required by Element 17[e] because it does not expressly quantify the quality factors of its disclosed resonators. However, a POSA reading Lee, would have known and understood and would have been further motivated to implement Lee’s resonators using resonators with a high quality factor in order to

achieve Lee's taught "high impedance" at resonance and "drastic" decreases in impedance away from resonance. A POSA's general knowledge as well as Cook-523 teaching that resonators used for wireless power transfer could and should have high quality factors greater than 100, and preferably over 1000, which would have made this limitation obvious to try in Lee's resonators.

A. Motivation to Combine Lee and Cook-523

222. A POSA could have and would have been motivated to implement a high quality factor resonator in Lee's wireless power transfer teachings.

223. First, Lee and Cook-523 are directed to the same field of endeavor because both generally relate to systems and methods for efficient wireless power transfer through magnetic coupling of resonators. Lee describes a "system and method for efficient and safe transfer of electrical power without needing conductive contacts," where a first resonator structure "generate[s] [an] inductive magnetic field" and a second resonator structure "can resonate with the inductive magnetic field" to transfer RF power. Lee at ¶¶ 1, 54, Fig. 1. Similarly, Cook-523 describes "efficient power transfer" wirelessly between "resonant antennas" via "electromagnetic field coupling." Cook-523 at 1:37-41, 2:33-65, Figs. 1, 3, 4A-4B, 10A-10B.

224. Further, as I explain below, a POSA would have known and understood or at least found it obvious that Lee's system could and should be designed with a source and device resonators having high Q values.

225. Although Lee does not quantify the Q of its resonators, a POSA reading Lee would have understood that the system is designed with source and device resonators having a Q as high as possible (i.e., “nearly infinite” so as to provide “nearly infinite” impedance to the source as described below). See Lee ¶ 56 (“the LC network exhibits nearly infinite impedance to the RF source, hence the primary load current through such network is normally blocked provided that all the local LC networks are tuned to the primary driving frequency.”).

226. First, a POSA reading Lee would have understood that the source resonators should be designed with as high of Q as possible because Lee teaches that each source resonator is a “parallel LC” circuit which provides a “large primary load impedance to the RF power supply,” and more particularly a “nearly infinite impedance to the RF source” when operated at the resonator’s resonant frequency. Lee at ¶ 55-56.

227. A POSA would have known and understood that in order to have “nearly infinite impedance” at resonance, Lee’s parallel LC circuit would need to also have a “nearly infinite” Q factor. That is because in Lee’s system, the “parallel LC” resonators have an impedance at resonance that increases approximately linearly with Q, as provided in the following well-known formula detailed by Dr. Terman:

$$\text{Parallel impedance at resonance} = \frac{(\omega_0 L)^2}{R_s} = (\omega_0 L)Q \quad (3-14)$$

Terman at 52.

228. Further, Lee taught that the primary unit's "LC balance" should be "strongly altered" by a secondary circuit so that the "nearly infinite" impedance of the source resonators will "decrease[] drastically to allow primary RF load current to flow into the local region." Lee at ¶ 55. This also means Q is very high because the Q in a resonator affects how "drastic" an impedance change will be off of resonance. Indeed, Q was also referred to as the "sharpness of resonance" because the slope of impedance change off of resonance is proportional to Q. See Terman at 48-49. Higher Qs have a "sharper" (more drastic) decrease in impedance when the circuit is shifted off resonance. Thus, a "drastic" decrease in impedance off of resonance in a parallel LC resonator, as Lee taught, means a "drastic" Q.

229. Second, a POSA would have understood that Lee's device resonator should also have a very high Q to promote efficient power transfer. As discussed below, this will also help to achieve the goal that "incompatible electronic devices or a foreign object" would not "shift the local resonance enough to cause even a minute amount of power transfer." Lee at ¶ 55.

230. Lee is describing the well understood concept that when a second resonant circuit is placed in the area around a first resonant circuit, the second circuit

will “couple” with the first circuit and cause a new combined circuit with a “coupled impedance” that is equal to the “self-impedance of the primary plus whatever impedance of the secondary circuit couples into the primary.” Terman at 63-67. As discussed previously, Lee’s source resonator has a “nearly infinite” impedance at resonance, and so that “nearly infinite” impedance to be “strongly shifted,” the impedance of the secondary circuit would preferably be “nearly infinite.” Lee’s second resonator is a “parallel LC” circuit and thus to have the desired impedance shift, it would have a similar “nearly infinite” Q as the source resonator. *See* Lee at ¶ 57; Terman at 52.

231. This high Q device resonator would cause the desired “drastic” change in local load impedance of the source resonator and “shift[] the primary local parallel LC resonance away from the operating frequency” when it is placed close to a source resonator. Lee at ¶ 61. A coupled high Q device resonator would cause localized current to flow in the source, but not other incompatible devices. Lee at ¶ 55 (“The need of an adaptive component in the secondary unit 30 also means that it would be nearly impossible for any incompatible electronic device or a foreign object such as a metal bar, low reluctance magnetic material, or saline water to shift the local resonance enough to cause even a minute amount of power transfer. This greatly contributes to the safety of the present invention.”); O’Brien at 111 (higher Qs allow for “frequency selectivity” in a wireless power system)..

232. Thus, POSAs would have understood and found it obvious to design Lee's resonators with high Q, and a POSA reading Lee would know that "nearly infinite" means Q values as high as practically possible. Lee at ¶ 12 (acknowledging Q cannot be "infinite" in practice); Story of Q at 592 ("[i]n a majority of situations the desired value of Q is the highest one economically attainable.").

233. POSAs implementing Lee's teachings would have been motivated to look to known prior art for high Q values that were practical, attainable, and used in resonant wireless power transfer systems with the understanding that those Q values would have a reasonable expectation of success. This would have led the POSA to Cook-523, which like Lee, taught source and device resonators with a planar coil and a capacitive element that also implemented device resonators within, for example, mobile devices. See Lee at ¶¶ 55-57 (describing Figures 2 and 3 showing the primary unit with an array of coils and an LC architecture), 76 (describing the secondary unit), Fig. 3; Cook-523 at Fig. 1, 2:37-65 (describing the antenna to be used in devices such as "an electrical appliance, a computer, a rechargeable battery, a music player or an automobile."); 13:16-17 (describing Fig. 12A-C with non-electrically conductive housing).

234. Notably, a POSA would have known and understood that Cook-523's resonators are "series LC" circuits with impedance minimized at resonance, whereas Lee's source resonators are "parallel LC" circuits with impedance maximized at

resonance. *See* Terman 44-50 (describing series resonant circuits), 50-57 (describing parallel resonant circuits). These impedance characteristic differences would have been known, and a POSA would have understood and found it obvious that Cook-523's inductor and capacitor designs for high Q resonators could be applied to Lee's resonators in a parallel configuration because it was well known that a parallel LC circuit's "resonant curve" with high Q values has the "same shape" as a resonant circuit having "a series configuration with the same inductance, capacitance, and resistances." Terman at 52-53 ("working rules" for series resonance "also apply" to "parallel resonance when the circuit Q is moderate or high" with the "only difference is that the signs of the phase angles are now reversed"); *see also* Lee at ¶ 56 (referring to parallel LC network as having an "anti-resonance frequency" that can be used interchangeably with "resonance frequency" applicable to series LC circuits). Indeed, as explained in Terman, "parallel" resonance is "analogous" to "series" resonance. Terman 50-51. Further, Cook explained in other prior art patent applications that it was known to use "parallel LC circuit" with a "relatively high Q, for example a Q that is higher than 1000" for resonant wireless power transfer. Cook-918 at [0011], Cls. 6, 13, Fig. 1.

235. Cook-523 also explained that quality factors of a source resonator and a device resonator used for wireless power transfer can be equal and are preferably "greater than 1000" for "efficient power transfer." Cook-523 at 1:37-39, 1:44-45;

see also Cook-523 6:31 (“doubling transmitter Q-factor doubles efficiency”); 11:55-56 (“magnetic power transmission according to this disclosure may rely on high-Q for improved efficiency”), Figs. 12C (showing planar coil), 13A (same); 12:65-13:15 (explaining that “Q factors of the described antennas” can “vary between 1500-2600”); Fig. 7B (showing exemplary Q factors from 2000-4000 for a resonant antenna).

236. A POSA would therefore have had a reasonable expectation of success implementing Lee’s resonator quality factors in the hundreds or thousands because Cook-523 taught that those values were achievable. A POSA also would have been able to design a circuit that achieves these Q values with a high degree of success based on well-known formulas that demonstrate high Q values can be achieved by adjusting the RLC components of resonators. *See* Terman at 51-52; O’Brien 114-115. This is consistent with long-held industry knowledge that “a typical value of Q is of the order of 100,” and that higher Q values will lead to higher voltage transfers. Terman at 46; Joannopoulos at ¶ 27 (resonator with 1 cm radius coil for use in a cell phone with $Q=1225$), Cls. 2-5 (first and second resonators with Q_1 and Q_2 greater than 100, 200, 500, and 1000); Cook-554 at 2:6-7; Cook Provisional at ¶ 5.

B. Independent Claim 17

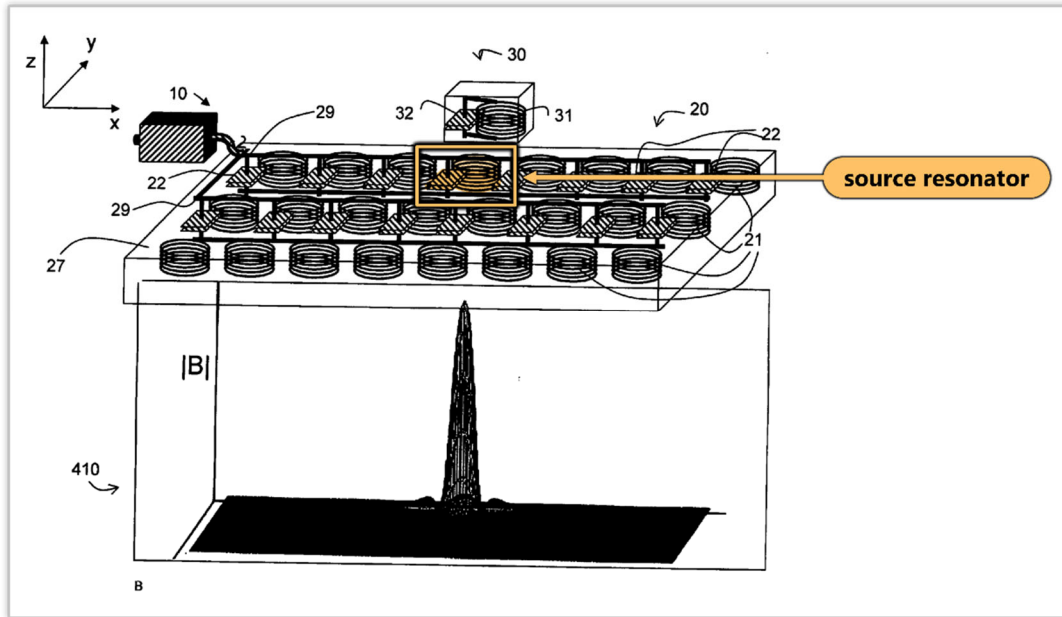
1. Element [17pre]: Preamble

237. Claim 17's preamble recites "A system, comprising." To the extent the preamble is limiting, Lee and Cook-523 taught a "system" for the reasons explained below. *See also* Lee at Title ("System and Method for Contact Free Transfer of Power"), ¶ 1 (same).

2. Element [17a]: Source Resonator

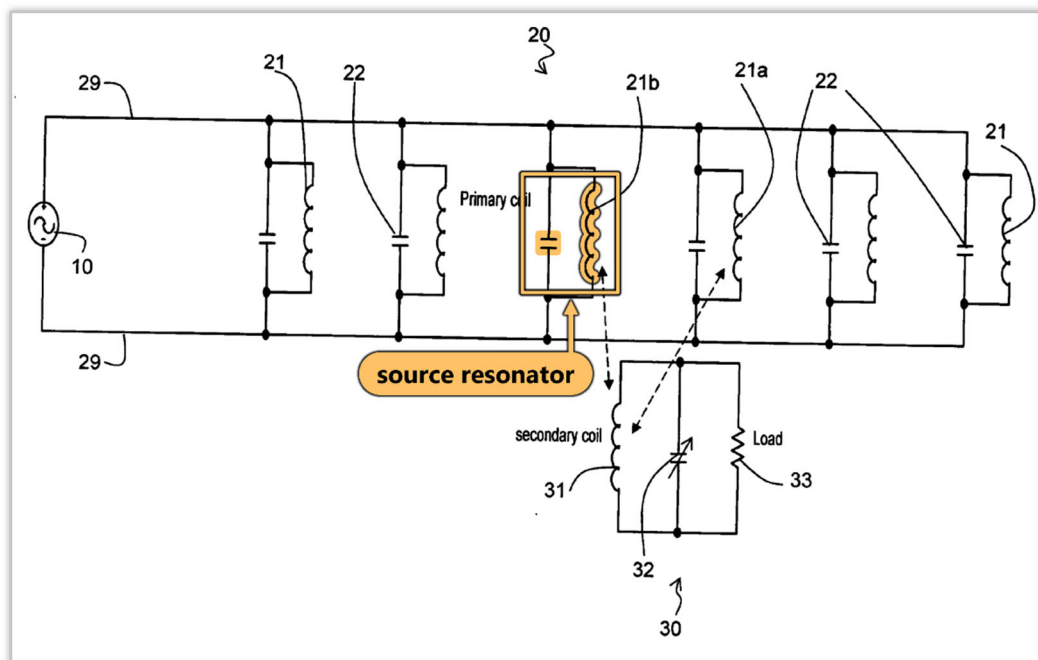
238. Claim 17 next recites "a source resonator having a Q-factor Q_1 and a characteristic size x_1 ," which is the same as element 16[a]. Lee and Cook-523 taught this.

239. In the Lee and Cook-523 combination, Lee's "primary unit" architecture includes "local parallel LC (inductance 21-capacitance 22)" circuits that have a resonant frequency. Lee at ¶¶ 55-57. This corresponds to the claimed "source resonator." For example, Figure 3, shown below with annotations, provides a primary unit 20 with an array of source resonators, each of which includes inductive field coil 21 and capacitor 22:



Lee at Fig. 3 (annotated), ¶ 56; *see also* Lee at Figs. 2, 4, ¶¶ 54-55 (describing Figs. 1 and 2), 57-58 (describing Figs. 3 and 4).

240. Further, Lee discloses the following equivalent circuit diagram showing its array of source resonators:



Lee at Fig. 4 (annotated), ¶ 58 (“FIG. 4 is a schematic view showing the interaction between the primary induction coils 21 of the primary unit 20 and the receiving coil 31 of the secondary unit 30 in a simplified single primary coil array system for illustration purpose.”).

241. Lee’s source resonators have a characteristic size x_1 and quality factor (Q-factor) Q_1 as explained below.

242. Lee describes that its source resonators transmit power through their magnetic field to a second resonator. Lee at ¶¶ 54-55 (describing “inductive magnetic field of the primary”), 57 (describing “local magnetic field intensity”), 60 (describing “magnetic coupling of the primary coils 21 to the secondary coil 31”). Therefore, each source resonator in Lee’s array is a “magnetic resonator,” and according to the ’719 patent, the “characteristic size” is equal to the radius of a sphere that encompasses its inductive element. Lee at ¶ 57; ’719 patent at 23:28-37; Claim Construction section above.

243. Further, a POSA would have known and understood that Lee’s array of source resonators, each of which include an inductive and capacitive element with a resonance frequency, has a quality factor. Lee at ¶¶ 55 (“local resonance nature of the primary RF circuit”), 56 (describing its LC network), 57 (“When a compatible secondary unit 30 sits on top of the primary surface 27, the parallel LC resonance frequency is shifted away from the driving frequency of the RF source 10, which, in

turns, causes the effective local LC impedance to decrease sufficiently to enable the load current to flow into the local LC network. The receiving coil in the secondary unit 30 likewise has a compensating capacitor 32 in parallel with the receiving induction coil 31.”).

244. A POSA would have known that Q applies “to any resonant structure or device.” Story of Q at 588. This includes Lee’s source resonator, which is a “local LC network” in the primary unit forming “a local resonance substructure.” Lee at ¶ 57; Terman 50-52 (Q is a “fundamental relation[] of a parallel resonant circuit” described in “every introductory book on a-c circuit theory”); O’Brien at 114 (“parallel resonant circuits” are “elementary” with characteristics that are “well established” including their quality factor).

245. The ’719 patent is consistent with a POSA’s understanding that Lee’s source resonator will have the claimed “first Q-factor Q_1 ” because it is a resonator and therefore some amount of energy decay and loss. *See* ’719 patent at 11:64-66. Indeed, during prosecution of Patent Owner’s other applications, multiple Examiners recognized that the quality factor is an inherent property of resonators. *See* 12/649,635 FH at 1206 (“[O]nce something is determined to be a ‘resonator’ it will inherently show the intrinsic quality factor with the attendant capability to store electromagnetic energy and the intrinsic loss rate and resonant frequency.”); 12/639,963 FH at 1226 (“As the circuits are considered to be resonators, they

inherently exhibit the claimed resonant frequency, intrinsic loss rate, and a capability to store electromagnetic energy with a high intrinsic Q.”).

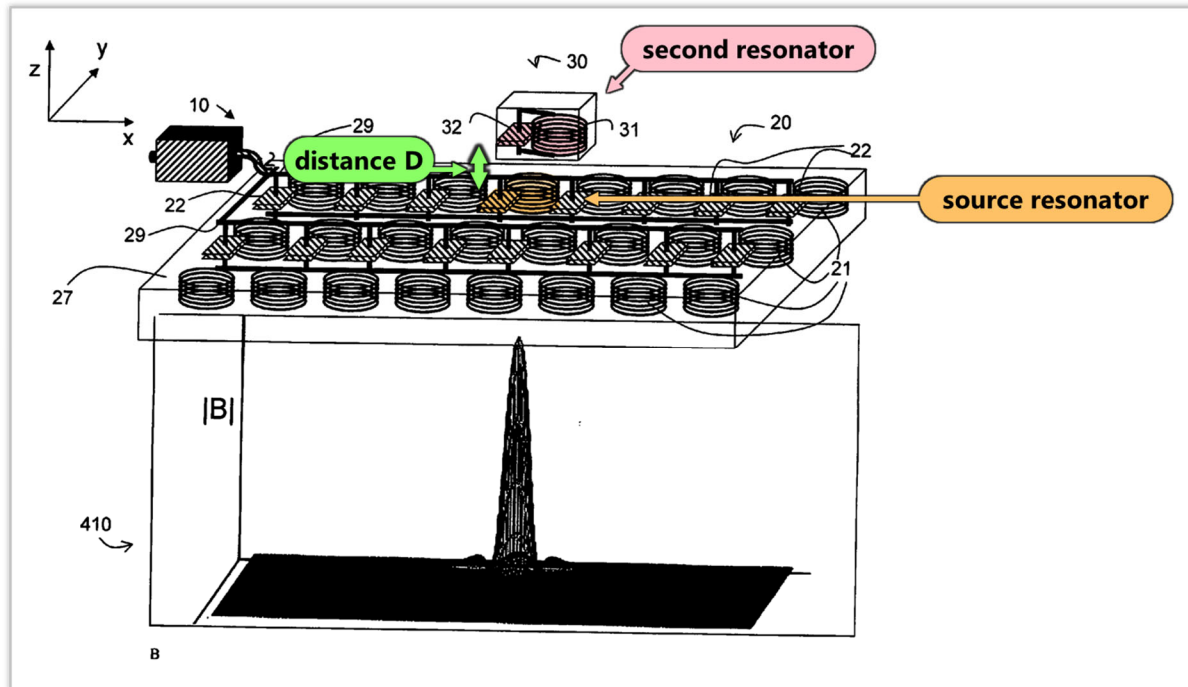
246. Therefore, Lee’s localized LC resonant circuit in its primary unit has a first quality factor Q_1 . Furthermore, in the Lee and Cook-523 combination, a POSA would have been motivated to select Q values for Lee’s source resonator in view of Cook-523, which also taught source resonators with an inductor, capacitor, and operating at a resonant frequency and having a quality factor. Cook-523 at 1:40-44 (describing “high-Q antennas”), 2:38-39 (“The antenna 110 includes an inductive loop, which is inductively coupled to a high Q resonant antenna part 112”), 4:25-50 (describing “equations” for “transfer efficiency”), 11:51-52 (describing theoretical and measured high Q factors of 2780 and 1300, respectively); *see also* Section Ground 4 Motivation to Combine.

3. Element [17b]: Second Resonator

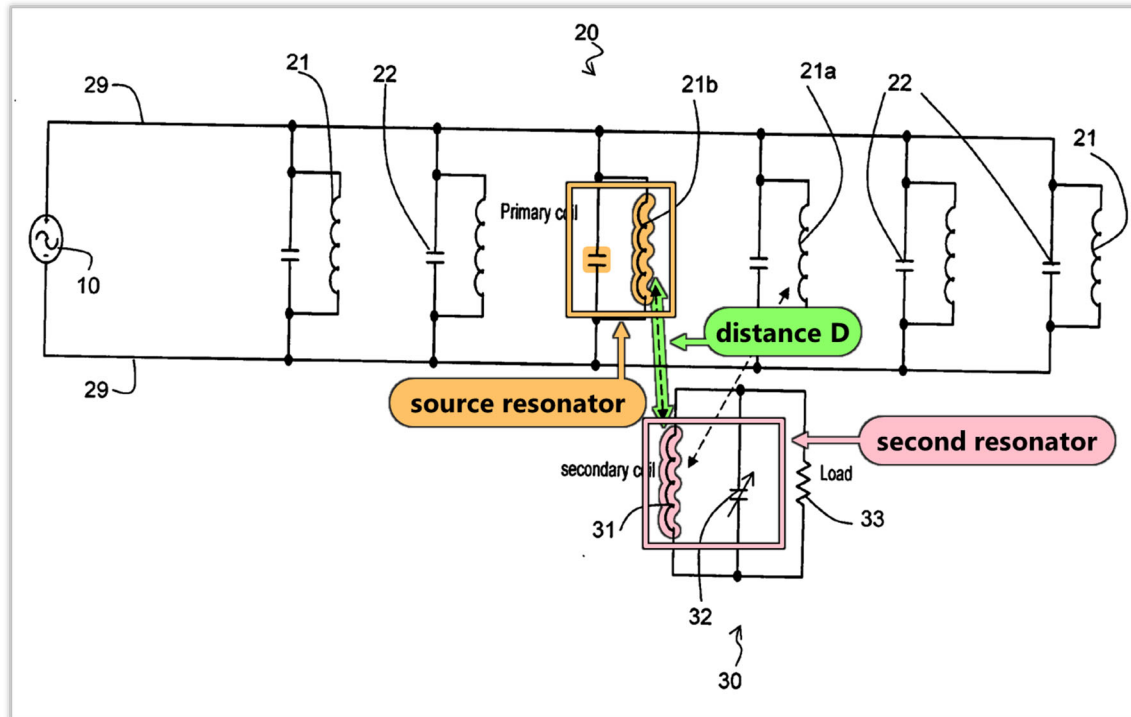
247. Claim 17 next recites “a second resonator having a Q-factor Q_2 and a characteristic size x_2 , and located a distance D from the source resonator.” which is the same as element 16[b]. Lee and Cook-523 taught this.

248. Lee’s “secondary unit” that receives wireless power includes a receiving coil and a tunable capacitive element. Lee at ¶ 57 (describing second resonator), 75 (describing Fig. 12 showing an “exemplary embodiment of the secondary coil 31 and circuit elements in the device adapter). This corresponds to

the claimed “second resonator.” As shown in annotated Figures 3 and 4 below, the second resonator is located a distance D from the source resonator for “contact free power transfer.”



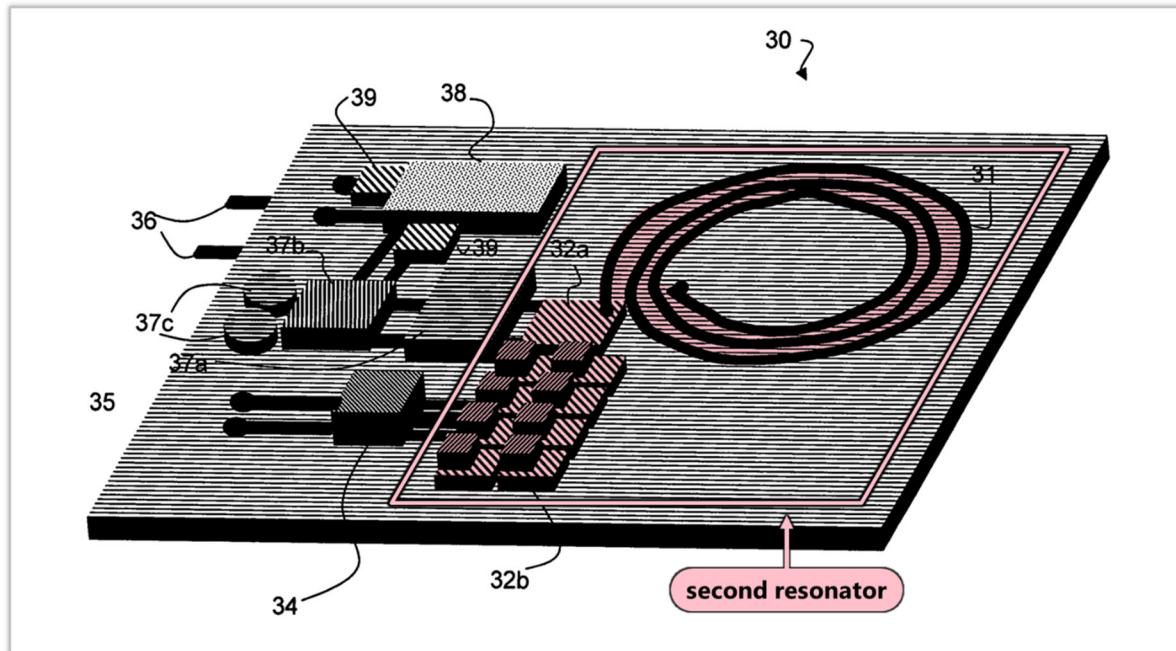
Lee at Fig. 3 (annotated), Title (“System and method for contact free transfer of power”), ¶¶ 54 (“wireless power transfer between a primary unit 20 and a secondary unit 30”).



Lee at Fig. 4 (annotated), ¶¶ 58, 60 (“secondary unit 30 comprises a receiving coil 31 in parallel with a matching capacitor 32”); *see also* Lee at ¶¶ 23-35 (summarizing embodiments used for “[transferring/receiving] power wirelessly”), Figs. 1-3, 12-13, ¶¶ 37 (describing Fig. 2 as showing “isometric view of a single array of inductive field coils of the primary unit together with a single coil of the secondary unit”), 54-55 (describing Figs 1-2 showing wireless power transfer between a primary and secondary unit), 57 (describing what occurs when “a compatible secondary unit 30 sits on top of the primary surface 27), 78 (describing circuit elements presented in Fig. 13 used for “magnetic coupling with the primary unit”).

249. As shown below in Figure 12, Lee further discloses a tunable capacitive element 32 of the second resonator that can be implemented using capacitors,

including a “main capacitor 32a” and a “bank of switched capacitors 32b,” connected in parallel with the receiving coil 31:



Lee at Fig. 12 (annotated), ¶¶ 47, 75; *see also* Lee at Fig. 13 (detailed circuit diagram corresponding to Fig. 12), ¶¶ 48, 76-78 (further describing Figs. 12-13.)

250. Lee’s second resonator also has a characteristic size x_2 and quality factor Q_2 .

251. First, like the source resonator, Lee’s second resonator is a magnetic resonator that coupled to the magnetic field of the source resonator. Therefore, by the ’719 patent definition, it has a characteristic size equal to the radius of the smallest sphere that would enclose the receiving coil. Lee at Fig. 3, ¶ 70 (explaining that coils “often take the shape of a spiral”), ¶ 75 (second resonator with “spiral

shaped PCB trace coil”); *see also* Ground 4 Element [17a] (Source Resonator above); '719 patent at 23:28-37; Claim Construction Section above.

252. Second, because Lee's second resonator has an inductive element, a capacitive element, and a resonant frequency, a POSA would have understood that Lee's second resonator has a quality factor Q_2 . Lee at ¶¶ 55 (“resonance circuitry within the secondary unit 30”), 57, 60 (“capacitance of the secondary unit is chosen” so there is “parallel LC resonance at the operating frequency of the primary unit 20”); *See also* Ground 4 Element [17a] (Source Resonator).

253. In addition, in the combination of Lee and Cook-523, a POSA would have been motivated to select Q values for Lee's second resonator in view of Cook-523, which also taught source resonators comprising an inductor, capacitor, and tuned to a resonant frequency have a quality factor. Cook-523 at 1:40-44, 2:56-60, 11:51-52.

8. Element [17c]: Wireless Energy Transfer

254. Claim 17 next recites “wherein the source resonator and the second resonator are coupled to exchange energy wirelessly among the source resonator and the second resonator.” Lee and Cook-523 discloses this element to a POSA.

255. Lee discloses having a primary unit to “transfer[] power wirelessly” and the “secondary unit” to “receiv[e] power wirelessly.” *See generally* Lee at ¶¶ 20, 23-25 (summarizing embodiments wherein “electric power is to be transferred in a

contactless fashion” and there is “provided a primary unit for **transferring power wirelessly**”), ¶¶ 26-35 (summarizing embodiments with a “secondary unit for **receiving power wirelessly**”), Figs. 3, 4, 12. Specifically, Lee discloses “magnetic coupling of the primary coil[] 21” of Lee’s source resonator “to the secondary coil 31” of Lee’s second resonator. Lee at ¶ 60; *see also* Lee at ¶¶ 37 (describing Fig. 2), 55 (same), 57 (describing power transfer when a secondary unit sits on top of the primary unit).

9. Element [17d]: High Quality Factor

256. Claim 17 next recites “wherein $\sqrt{Q_1 Q_2}$ is greater than 100,” which is identical to claim element 16[c]. Lee and Cook-523 taught this.

257. As I explained above, a POSA would have been motivated to implement Lee’s source and second resonators with high (i.e., “nearly infinite”) quality factors, including greater than 100 and preferably greater than 1000 as taught by Cook-523. *See* Ground 4 Motivation to Combine Section above; Cook-523 at 1:37-39, 11:51-52, 11:55-56, 13:17-19. Cook-523 further taught that antennas, like those described in Lee, that comprise a planar coil made of conductive material connected to a capacitor can have “Q factors” that “vary between 1500-2600.” Cook-523 at 12:65-13:15, 13:17-19 (high Q resonators “may be integrated into portable devices”), Figs. 12B, 12C, 13A; *see also e.g.*, Cook-523 at 11:51-52 (describing experimental transmitting and receiving resonant antennas with

theoretical Q-factors of 2780 and measured Q-factors of 1300); Fig. 7B (showing exemplary Q factors from 2000-4000 for a resonant antenna having particular characteristics).

258. A POSA could have and would have implemented Lee's source and second resonators with high quality factors to achieve Lee's high (or "nearly infinite") impedance resonators at resonance and desired "drastic" change in localized impedance when a second resonator is in proximity to a source resonator as well as to have efficient and non-lossy power transfer. Lee at ¶¶ 55 (describing Fig. 2), 60-61 (describing how "resonance enhanced coupling drastically altered the local load impedance of the combined network"); Cook-523 at 1:37-39 ("An efficient power transfer may be carried out between two antennas by storing energy in the near field of the transmitting antenna, rather than sending the energy into free space"); *see also* Ground 4 Motivation to Combine Section above.

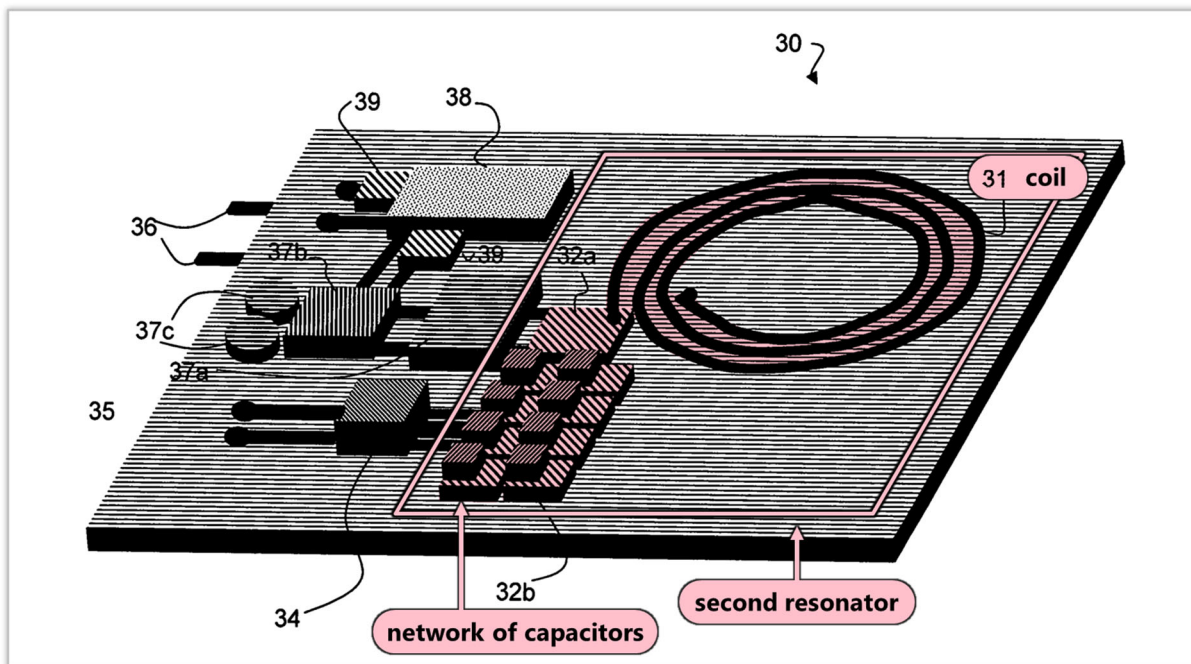
259. Accordingly, when Lee's source and second resonators each have quality factors greater than 100 (and preferably greater than 1000 as in the combination), the " $\sqrt{Q_1 Q_2}$ is greater than 100" as claimed.

10. Element [17e]: Planar Coils And Capacitors

260. Claim 17 next recites "wherein at least one of the resonators includes a coil of a plurality of turns of a conducting material connected to a network of

capacitors, wherein the plurality of turns are in a common plane.” Lee and Cook-523 taught these elements.

261. As shown in annotated Figure 12 below, Lee’s second resonator includes a “spiral shaped PCB trace coil” with turns in the common plane of the PCB surface and connected to a network of capacitors (32a and 32b):



Lee at Fig. 12, ¶¶ 75 (“a main capacitor 32a in parallel connection with the receiving coil 31, and a bank of switched capacitors 32b”), 78 (describing the circuitry shown in Fig. 13), 26-27 (describing, among other things, secondary coil with “multiple turns” that are “substantially flat”), 86; *see also* Lee at ¶ 26 (second resonator coil has “multiple turns”), ¶ 27 (second resonator with a “switched capacitor bank”), Figs. 1-4 (showing the system of the subject invention, including the primary and

secondary units), 13 (showing secondary coil and circuit elements in the device adapter).

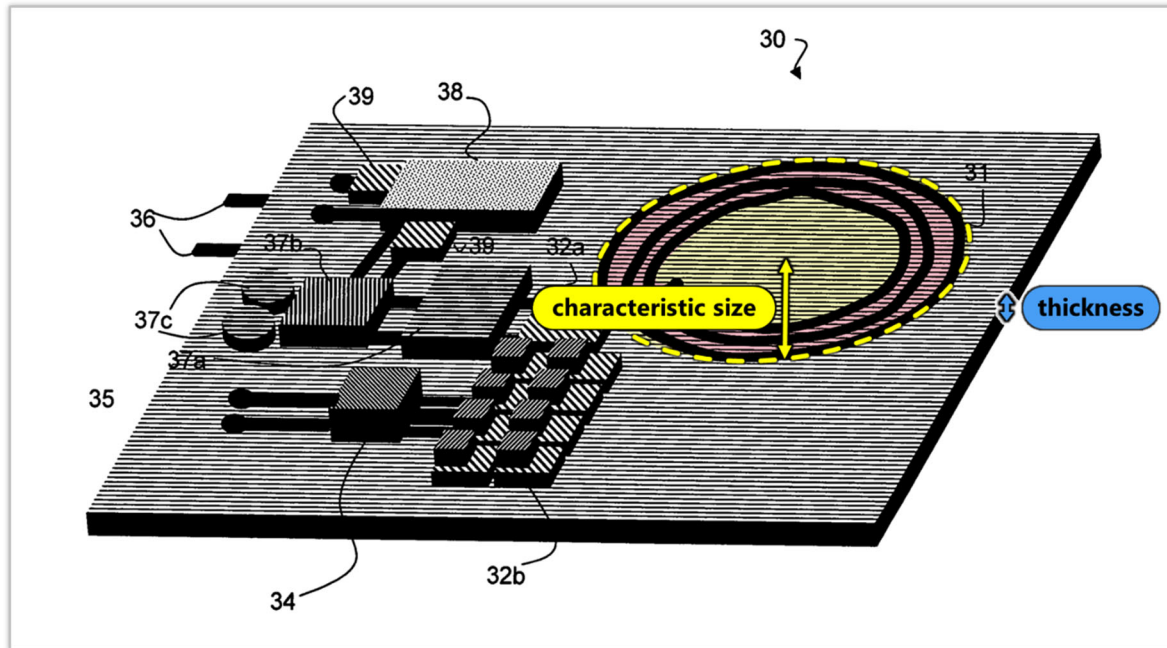
262. Further, coil 31 is a “conducting material” that “can resonate with the inductive magnetic field excited by the primary coils.” Lee at ¶¶ 26 (describing coils for coupling), 54, 55 (describing “coil 31”), 57 (same), Cls. 2 (“secondary unit comprises a conducting structure to generate a radio frequency”), 4 (similar); *see also* Lee at ¶ 2 (contact free power transfer “has been around for a long time” and uses a “secondary conducting coil”).

11. Element [17f]: Characteristic Size

263. Claim 17 next recites “wherein a characteristic thickness of the at least one of the resonators is much less than a characteristic size of the at least one of the resonators.” Lee and Cook-523 taught this element.

264. Lee’s second resonator, shown below in Figure 12, is a “magnetic resonator” with a “characteristic thickness” equal to the highest point of the receiving coil measured from the PCB surface based on the ’719’s use of this term. Lee at ¶ 75; *see also* ’719 patent at 23:38-42. Because Lee taught that the coils are “substantially flat” with “multiple turns,” a POSA would have known and understood that the coil thickness is much less than the radius of a sphere that contains the multi-turned spiral shaped coil. Lee at ¶¶ 26 (describing secondary unit with a flat coil with “multiple turns”), 75 (describing Fig. 12 showing a secondary

coil 31 and other circuit elements); *see also* Ground 2 Element [17f] (providing definitions of “flat”). In addition, I note that Lee’s Figure 12 clearly shows that the thickness of the coils is much less than its overall size:



Lee at Fig. 12 (annotated), Abstract, ¶¶ 26, 75. Like with Cook-554 in Ground 4, a POSA would not need to measure any precise dimensions of any element in Figure 12 of Lee to know that the claimed relationship of thickness to size is disclosed.

XII. CONCLUSION

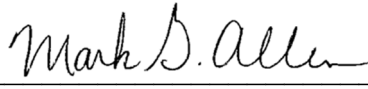
265. In view of the reasons set forth above, it is my opinion that claims 16 and 17 of the '719 patent are unpatentable based on the prior art.

266. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful

Declaration in Support of *Inter Partes* Review of USP 8,461,719

false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code. I declare under penalty of perjury that the foregoing is true and correct.

Date: July 17, 2023



Mark Allen