

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INDUCTEV, INC.
Petitioner,

v.

WITRICITY CORPORATION,
Patent Owner.

Case IPR2023-01182
Patent 8,461,719

**DECLARATION OF MARK N. HORENSTEIN
REGARDING VALIDITY OF CHALLENGED CLAIMS FOUND IN U.S.
PATENT NO. 8,461,719**

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

DECLARATION OF DR. MARK HORENSTEIN

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

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

I. INTRODUCTION

3. I have been retained on behalf of WiTricity Corporation to provide my opinions regarding U.S. Patent No. 8,461,719 (Ex. 1001, “the ’719 patent”) and the patentability of the claims challenged by InductEV (“Petitioner”). In this declaration, I provide my opinions regarding the applicability of prior-art references put forth by Petitioner and the failure of these references to invalidate the challenged claims. I also offer my rebuttal opinions regarding the July 16, 2023 Declaration of Dr. Mark Allen (“Allen”), expert on behalf of InductEV, in this matter. I herein provide my opinions in consideration of the state of the art at the time of the claimed inventions and the knowledge that a person of skill in the art (“POSA”) would have had at the time of the claimed invention.

4. My opinions and views set forth in this declaration are based on my education, training, and experience in the field of electrical engineering, inductive energy transfer, battery-powered electric vehicles (“EV”) and related technical areas,

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as well Petitioner's Exhibits 1001-1030 and other materials that are cited and discussed herein.

5. It is my understanding that the Petitioner is challenging independent claims 16 and 17 of the '719 patent. In my opinion, as discussed herein, Petitioner and Dr. Allen have failed to show that each of the elements of the challenged claims appears in the cited prior art or in the mind of a POSA. In particular, Petitioner has, at minimum, failed to show where the cited prior art discloses the claim elements of "enclosed in" and "low loss tangent material" in claim 16, and "a network of capacitors" in claim 17. I further explain below.

II. BACKGROUND

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

I have a Ph.D. in Electrical Engineering from the Massachusetts Institute of

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

7. I am a Life Fellow of the Institute of Electrical and Electronic Engineers (IEEE) and have been a Registered Professional Engineer (Electrical) in the Commonwealth of Massachusetts. I hold certification from the National Association of Radio and Telecommunications Engineers.

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

9. The courses that I taught over the 40 years I spent as a regular faculty member at Boston University encompassed electromagnetics, antennas, and radio communication, as well as basic electrical circuits, analog and digital electronics, control circuits, power electronics, electric motors, electric machines,

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microcontrollers, robotics, and engineering design. I was named "Teacher of the Year" in Engineering at Boston University four times.

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

11. I have considerable experience in the areas of transformers, antennas, wireless charging devices, battery charging methods, and power circuits in general. I also have extensive experience in the design, analysis, and testing of consumer electrical products, including power supplies, battery chargers, microcontroller-based systems, and control systems of all types. In support of my research in deformable mirror systems, I designed two different analog-multiplexed, high-voltage storage arrays.

12. Similarly, as part of my work in developing self-cleaning solar panels, I have designed switching power supplies that produce low-frequency, 3-phase, 1.5-kV outputs which in turn are powered by low-voltage DC/DC power converters. As part of my work overall in applied electromagnetics, I have designed DC power controllers for thermal management systems, power-amplifier circuits, and analog amplifiers. I also have designed and used transformers of all types, including

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ferromagnetic, ferrite, and air-core varieties. I have practical knowledge of wiring methods and have wired numerous residential and industrial electric supplies, both indoor and outdoor. I have considerable hands-on experience in electrical wiring (e.g., 12-V DC, 120 VAC and 240 VAC) for commercial and residential purposes and a working knowledge of the National Electric Code (NEC) published by the National Fire Protection Association (NFPA-70).

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

14. My curriculum vitae ("vita"), which includes a summary of my background, experience, publications, and expert-witness experience is marked as Exhibit 2012.

15. My training and profession encompass broad areas of engineering. The opinions I express in this declaration involve the application of my engineering

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knowledge, expertise, and experience to the evaluation of U.S. Patent No. 8,461,719 with respect to various claim terms found therein.

16. The opinions proffered in this declaration are based on the documents I have reviewed, my experience and background in the field, my knowledge of electrical engineering, and my professional judgment. In the course of conducting my analysis and forming my opinions, I have reviewed the references and materials cited herein, including those listed below.

17. I am being compensated for services provided in this matter. I was recruited for this engagement by Cahn Litigation Services which is billing my time at a rate of \$400 per hour. I am also being reimbursed for reasonable expenses, such as travel expenses, should any arise. My compensation is not contingent on my opinions, on the outcome of any aspects of this matter, or on any of the technical positions that I explain in this declaration. I have no financial interest in Petitioner InductEV, the Patent Owner (who I understand to be WiTricity Corporation), or the '719 Patent.

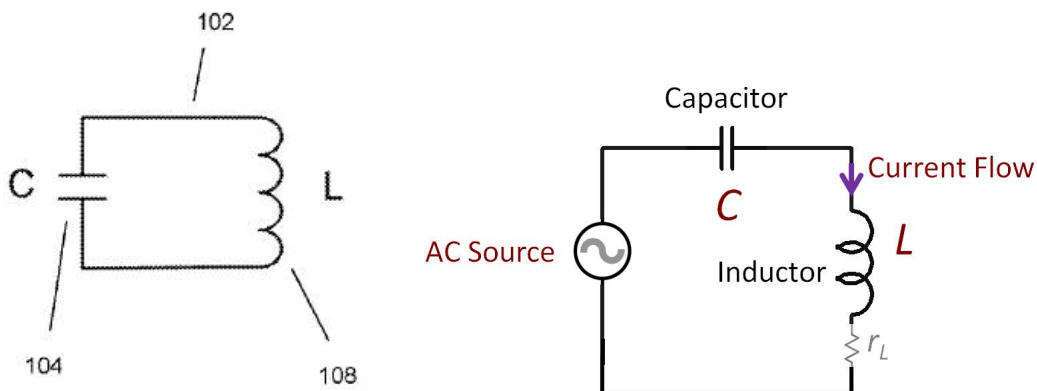
18. The opinions set forth in this declaration are my own. My opinions are based on my review of the materials cited throughout this Declaration; my educational background; my experience working in the areas of inductive coupling

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and wireless charging, and my experience as a technical consultant providing expert testimony in numerous cases involving similar and/or related technology.

III. OVERVIEW OF THE '719 PATENT

19. U.S. Patent 8,461,719 (Ex. 1001, “the '719 patent”), entitled “Wireless Energy Transfer Systems”, was filed on September 25, 2009 and issued on June 11, 2013. The patent describes “improved capabilities for ... source resonator[s]” used in wireless power transfer. ('719 patent, Abstract). The focus of the patent is on resonators that have quality factors Q greater than 100. Generally, a resonator is an inductor/capacitor (LC) circuit that can be represented by the circuit diagram below (left). This diagram from '719 patent Fig. 6(a) is a simplified representation of the more complete representation on the right which incorporates the parasitic series resistance of the inductor.



Left: '719 patent, Fig. 6(a); Right: Circuit that includes series resistance;

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20. When energized at its resonant frequency by an AC power source, each of these circuits can build up large oscillations in current flow at its resonant frequency, given approximately by:

$$\omega_{res} = 2\pi f_{res} = \frac{1}{\sqrt{LC}}$$

(See, e.g., '719 patent at 20:46-48). Here L is the value of the inductor, C the value of the capacitor, and r_L represents the internal parasitic resistance of the inductor or any other series resistance in the circuit. Also, as is well known, $\pi \approx 3.1416$ ("pi").¹

21. The Q factor ("quality") is a measure of the losses in the resonator that prevents the oscillations from increasing without bound. The higher the value of Q , the lower the losses in the system. Generally, Q is limited by r_L plus any other resistances that may be connected to the resonator. The formula for Q for the circuit on the right, which presents the energy contained in each cycle divided by the energy lost over each cycle, is the following:

$$Q = \frac{1}{r_L} \sqrt{\frac{L}{C}}$$

¹ The frequency ω_{res} is expressed in radians-per-second, while the commonly used frequency f_{res} is expressed in Hz, or "cycles per second."

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22. Note that Q increases as the resistance r_L heads toward zero, thus a “high Q ” circuit is one with very small series resistance r_L . Theoretically, a perfect resonator with zero resistance would have infinite Q .

23. It is clear from the specification of the '719 patent that its focus is on the near-field component of the field from magnetic resonators. For example:

“The resonator may be constructed such that the energy stored by the electric field is primarily confined within the structure and that the energy stored by the magnetic field is primarily in the region surrounding the resonator. Then, the energy exchange is mediated primarily by the **resonant magnetic near-field**. These types of resonators may be referred to as **magnetic resonators**.” ('719, 18:43-49; emphasis added)

“The high-Q **electromagnetic resonators used in the near-field** wireless energy transfer system disclosed here may be sub-wavelength objects. That is, the physical dimensions of the resonator may be much smaller than the wavelength corresponding to the resonant frequency. Sub-wavelength magnetic resonators may have **most of the energy in the region surrounding the resonator stored in their magnetic near-fields**, and these fields may also be described as stationary or **non-propagating** because **they do not radiate** away from the resonator.” ('719 patent, 22:41-50; emphasis added)

24. Much of the '719 patent is thus directed toward magnetic resonators. In a magnetic resonator power transfer system, power is transferred from a transmitting

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resonator to a receiving resonator by the magnetic field produced by the current flowing in the transmitting resonator, i.e., its inductor coil. The capacitors, while necessary to establish circuit resonances, do not play a role in power transfer via magnetic resonators, because the electric field of the capacitor in the transmitting resonator is largely confined inside the capacitor and does not interact with the receiving resonator. The '719 patent explains this aspect of magnetic resonators as follows:

“If the resonators are designed such that the energy stored by the electric field is primarily confined within the structure and that the **energy stored by the magnetic field is primarily in the region surrounding the resonator**. Then, the energy exchange is mediated primarily by the resonant magnetic near-field. These types of resonators may be referred to as **magnetic resonators.**” (**'719 patent 2:22-29; emphasis added**)

25. The '719 patent also explains the difference between the near-field (local) and far-field (radiating) components of the magnetic field emanating from the transmitting resonator:

“Energy or power may be transferred wirelessly using a variety of known **radiative, or far-field, and non-radiative, or near-field, techniques.**” (*Id.*, 1:33-35; emphasis added)

As the '719 patent further explains:

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“There is disclosed herein a **non-radiative or near-field wireless energy transfer scheme** that is capable of transmitting useful amounts of power over mid-range distances and alignment offsets.”
(*Id.*, 2:14-17; emphasis added)

26. It is important to note that the terms “near field” and “far field” have long been well known in the electromagnetic arts and have been used for at least many decades to describe electromagnetic fields. The Wiley IEEE Dictionary defines the near-field and far-field regions as follows:

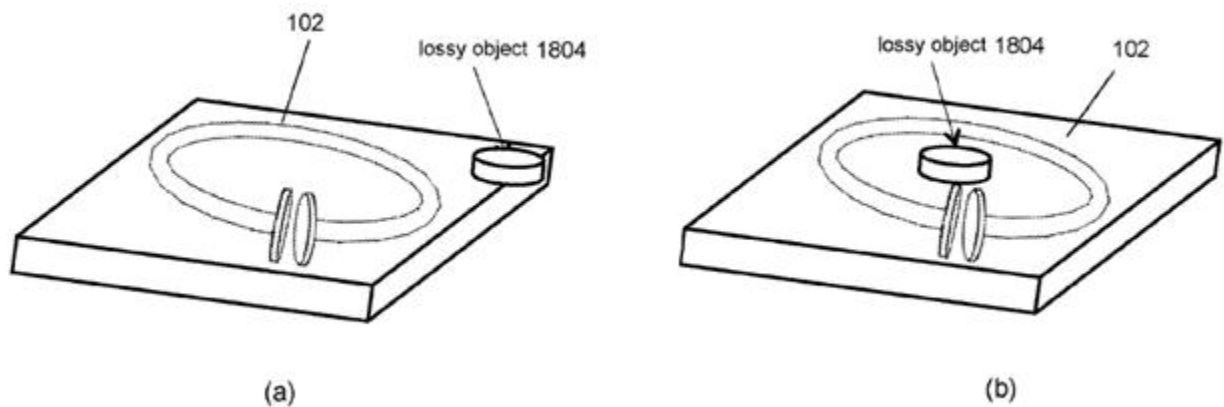
near-field region: For a transmitting antenna, the electromagnetic field **extending no further than a distance of $2D^2/\lambda$** , where D is the maximum overall dimension of said antenna, and λ is the wavelength considered. **Beyond this distance, the far-field region begins.**
(Wiley (Ex. 2015) 498; emphasis added)

far-field region: The region in which the transmitted energy from an antenna behaves as if it were emanating from a point source in the vicinity of said antenna. Such a region **usually begins at a distance of $2D^2/\lambda$ from the antenna**, where D is the maximum overall dimension of said antenna, and λ is the wavelength considered. **The region of space closer to the antenna than the far field is the near-field region.** (*Id.* 275; emphasis added)

27. As disclosed in the '719 patent, “[t]he magnetic resonators may be free standing or they may be enclosed in an enclosure, container, sleeve or housing.”

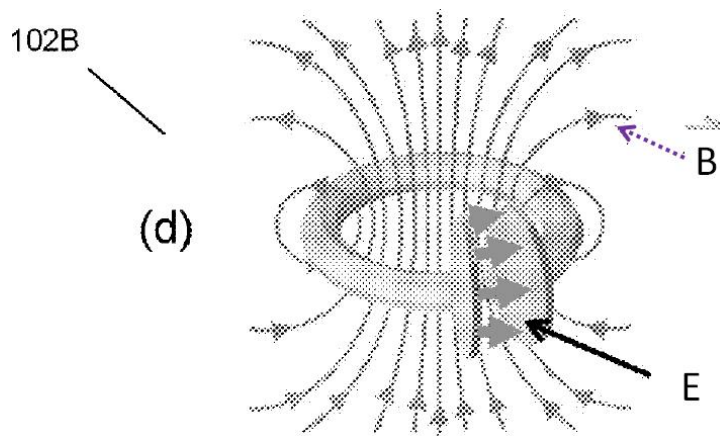
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(’719 patent: 26:16-17, 59:40-42). In some applications, the enclosure may be composed of a low-loss material such as “Teflon, REXOLITE, styrene, and the like.” (*Id.* 26:20-22, 59:43-45). Figure 24 from the ’719 patent (reproduced below) illustrates a magnetic resonator and its enclosure, along with a lossy object placed on the corner or center of the outer surface of the enclosure. (*Id.* 8:36-42).



28. A simplified drawing of some of the electric (E) and magnetic field lines (B) associated with an exemplary energized magnetic resonator can be found in ’719 Fig. 6(d), reproduced below. This drawing shows that most of the energy available for power transfer is stored in the magnetic field in the region around the resonator coil. The typical magnetic resonator is designed to confine the electric fields and expose only the magnetic field lines, as in ’719 Fig. 6(d).

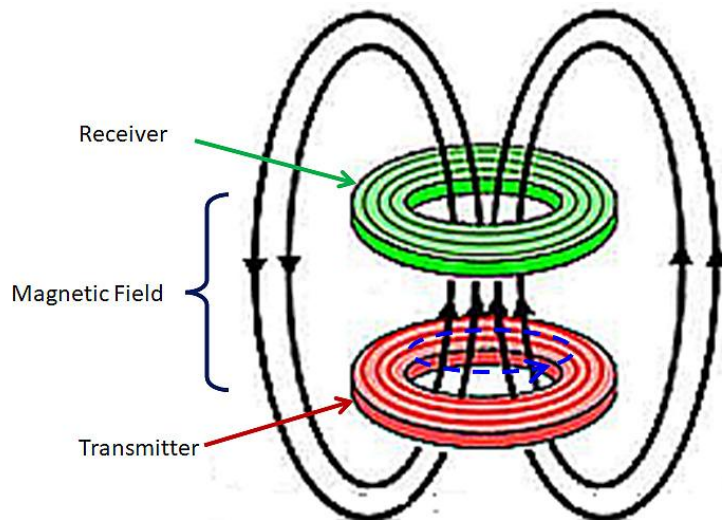
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'719 patent, Fig. 6(d), annotated.

29. The '719 patent discloses the use of two resonators, one a transmitting resonator and the other a receiving resonator. The transmitting resonator is driven at its resonant frequency by a power source, producing current in the resonator's inductance, or "coil". The receiver captures some of the magnetic field lines from the transmitter. This capture, called *induction*, causes an induced current to flow in the receiver. This current can be sent directly to an energy-consuming load or can be used to perform other tasks such as battery charging.

30. When a receiving resonator is placed in proximity to a transmitting resonator, a wireless exchange of power can occur. This induction process is depicted graphically in the figure below. Note that the figure shows the near-field magnetic flux lines only; these field lines are produced and appear only in the vicinity of the resonator. No far-field, radiated energy at large distances from the resonator is occurring:



31. The '719 patent highlights the difference between the near field and the far field of a resonator, for example:

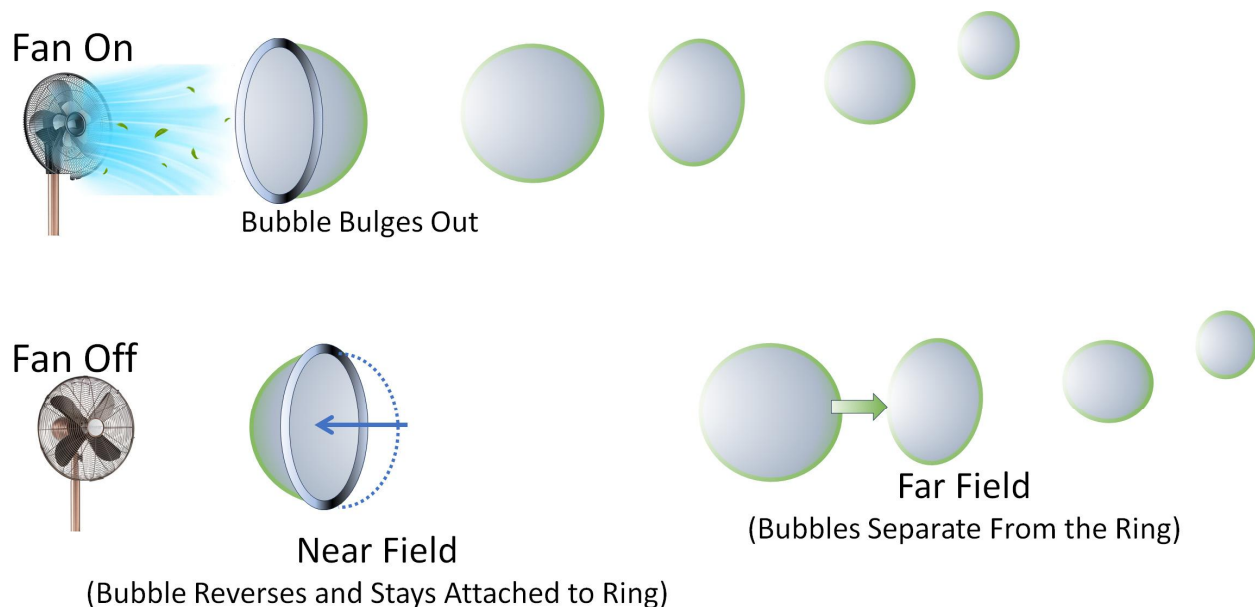
“Energy or power may be transferred wirelessly using a variety of known radiative, or **far-field**, and non-radiative, or **near-field**, techniques.” ('719 patent 1:33-35; emphasis added).

“A known non-radiative, or **near-field**, wireless energy transfer scheme, often referred to as either induction or traditional induction, **does not (intentionally) radiate power**, but uses an oscillating current passing through a primary coil, to generate an oscillating magnetic near-field that induces currents in a near-by receiving or secondary coil.” (*Id.*, 1:57-62; emphasis added).

32. The difference between the non-radiating near-field and the radiating far-field can perhaps be better understood by considering the analogy shown below. A ring containing a soap film is placed in front of a fan that periodically goes on and

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off, i.e., produces an “AC” flow of air. When the air is on, a bubble may flex out from the ring but stay attached, only to fall back into the ring when the air goes off. Such a bubble represents the near field. Any bubbles that detach from the ring and travel away from it, never to be seen again by the ring, represent the far field:



33. As explained in the '719 patent, using a pair of coupled magnetic resonators will enable wireless power transfer wherein “a resonant antenna ...efficiently couples energy from a primary structure (a transmitter) to a distal positioned secondary structure (a receiver) via a magnetic field.” ('719 patent, 1:17-22). As the patent further explains, in such systems “both primary and secondary are tuned to a common resonance frequency.” (*Id.*). Here “tuned” means that values of L and C have been appropriately selected to obtain the desired resonant frequency.

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34. The '719 patent also invokes the concept of the *loss tangent* of insulating materials. Materials that have an internal loss tangent are in the category of “dielectrics” (insulators) that are generally part of the family of plastics. Electric-field loss occurs in dielectrics such as plastic due to “molecular friction” under an oscillating electric field. When an electric field E enters a dielectric, its magnitude inside the material over its time-varying oscillatory cycle can essentially be described by an equation (here simplified) of the form:

$$E(t) = E_m \cos(2\pi f t)$$

where E_m has a value representing the magnitude of the field inside the material, and f is the frequency of oscillation of the field. For a dielectric that is lossy (has an internal resistive or molecular-friction property), the complete mathematics yields an E_m that is a “complex” number having a real and an imaginary part², i.e.:

$$E_m = E_{\text{real}} + j E_{\text{imag}}$$

The symbol $j = \sqrt{-1}$ is unit imaginary number.

35. The ratio $E_{\text{imag}}/E_{\text{real}}$ represents the loss occurring in the material,. This ratio is called the loss tangent δ , because the ratio represents the tangent of an angle

² Here “complex” does not mean “complicated”. A complex number is one that has both a real and an imaginary part.

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describing the oscillation in complex number space. The smaller the losses, the smaller the magnitude of E_{imag} , and the smaller the loss tangent. An ideal, lossless material has a loss tangent of zero.

IV. CLAIM CONSTRUCTION

36. It has been explained to me that in interpreting a patent claim, the words of the claim are assumed to have their plain and ordinary meanings. If the patent specification directly defines a claim term, however, then that definition supersedes the plain and ordinary meaning. I believe the term “network of capacitors” in the '719 patent merits construction. I provide below my opinion regarding the construal of this claim term.

Independent claim 17 of the '719 patent reads as follows:

Claim 17 (emphasis added)

A system, comprising:

a source resonator having a Q-factor Q_1 and a characteristic size x_1 , and
a second resonator having a Q-factor Q_2 and a characteristic size x_2 , and
located a distance D from the source resonator;

wherein the source resonator and the second resonator are coupled to
exchange energy wirelessly among the source resonator and the second
resonator, and

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wherein $\sqrt{Q_1 Q_2}$ is greater than 100;

and 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, 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.

37. The claim term “network of capacitors” has a very specific meaning in the '719 patent. In circuit theory, a “network” is defined as a circuit “...made up of resistances, inductances, mutual inductances and capacities [capacitors] connected together some manner.” (Terman-1943 (Ex. 2013) 197.) The capacitors provide reactance components to the circuit. As I explain in detail below, and for all the reasons given, I believe that “network of capacitors” should be construed to mean “a circuit topology of passive components including one or more capacitors that provides two or more degrees of freedom.”

38. The '719 specification provides several examples of a “network of capacitors.” One such example is the following:

“At least one of the source resonator and the second resonator may be a coil of at least one turn of a conducting material connected to a first

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network of capacitors. The first network of capacitors may include **at least one tunable capacitor.**" ('719 Patent, 5:23-27; emphasis added)

39. The specification generalizes the meaning of "network of capacitors" to include equivalent circuit structures, in the following:

"It will be appreciated that a **network of capacitors**, as used herein, may in general refer to any circuit topology including **one or more capacitors**, including without limitation any of the circuits specifically disclosed herein using capacitors, or any other **equivalent or different circuit structure(s)**, unless another meaning is explicitly provided or otherwise clear from the context." (*Id.*, 52:32-38; emphasis added)

40. Thus, although the phrase "one or more capacitors" may be seen contradictory to the intended meaning of "network of capacitors", a person of skill in the art, upon reading the above excerpt from the '719 patent, would understand that "network of capacitors" (with capacitors in the plural) would apply to circuits having one or more capacitors, *or their equivalent*. Thus, in order to understand the full scope of the claimed "network of capacitors" in claim 17, one must first understand the purpose and function that such a network plays in the various embodiments in Figs 30 (a)-(f). The specification explains that a network of capacitors is to be used to match the impedance of the power generator:

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“At least one of the first network of capacitors and the second network of capacitors may include at least one tunable capacitor. The first network of capacitors and the second network of capacitors may be adjustable to **change an impedance of the impedance matching network at a driving frequency of the power generator.**” (*Id.*, 5:44-59, emphasis added)

The patent provides several examples of circuits containing one or more capacitors that can be used to match the impedance of a load to the impedance of a power source:

“FIG. 30 shows six examples (a)-(f) of directly-coupled impedance-matching circuits, where the two tunable elements are capacitors, and six examples (h)-(m) of directly-coupled impedance-matching circuits.” (*Id.*, 52:16-19)

41. Two features of the networks in Figs. 30 (a) – (f) are evident. First, each circuit contains one or more capacitors.³ Each capacitor in the network has an imaginary impedance $1/j\omega C$, i.e., a negative reactance of $-1/\omega C$. Each inductive

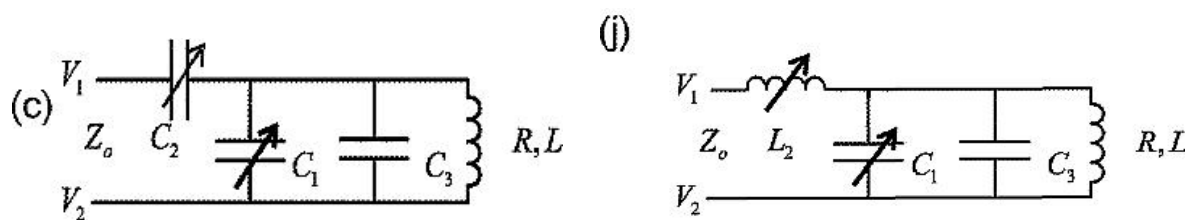
³ The arrow through a capacitor symbol indicates a variable capacitor whose capacitance can be changed in-circuit. Capacitors of this type can be seen in various of the Fig. 30 circuits:



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element in the circuits similarly has an imaginary impedance $j\omega L$, i.e., a positive reactance of ωL . Impedance matching to the resonator on the right of each circuit diagram requires that all of the reactive components seen at the input port, e.g., V_1 and V_2 , be canceled out by the “network of capacitors”.

42. More generally, for each of the circuits shown in Figs. 30 (a)-(m), doing so requires that the network provide two or more degrees of freedom in the form of adjustable reactive elements (i.e., adjustable capacitors and/or inductors). (*See, e.g., Id.* 44:3-6, 42-46, 45:58-61, 69:56-60.) These degrees of freedom are needed to control the real and imaginary parts of the complex impedance seen at the input port terminals, e.g., V_1 and V_2 , or V_1 and $-V_1$. These terminal pairs are found on the left-hand side of each circuit diagram. Two sample circuits, Figs. 30(c) and 30(j), are shown below for reference purposes:

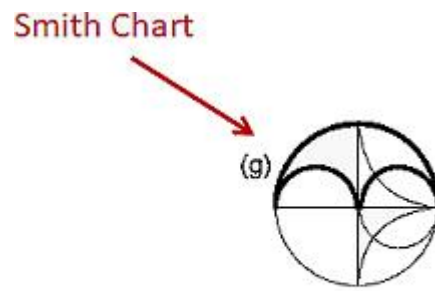


'719 Patent, Figs. 30(c) and 30(j)

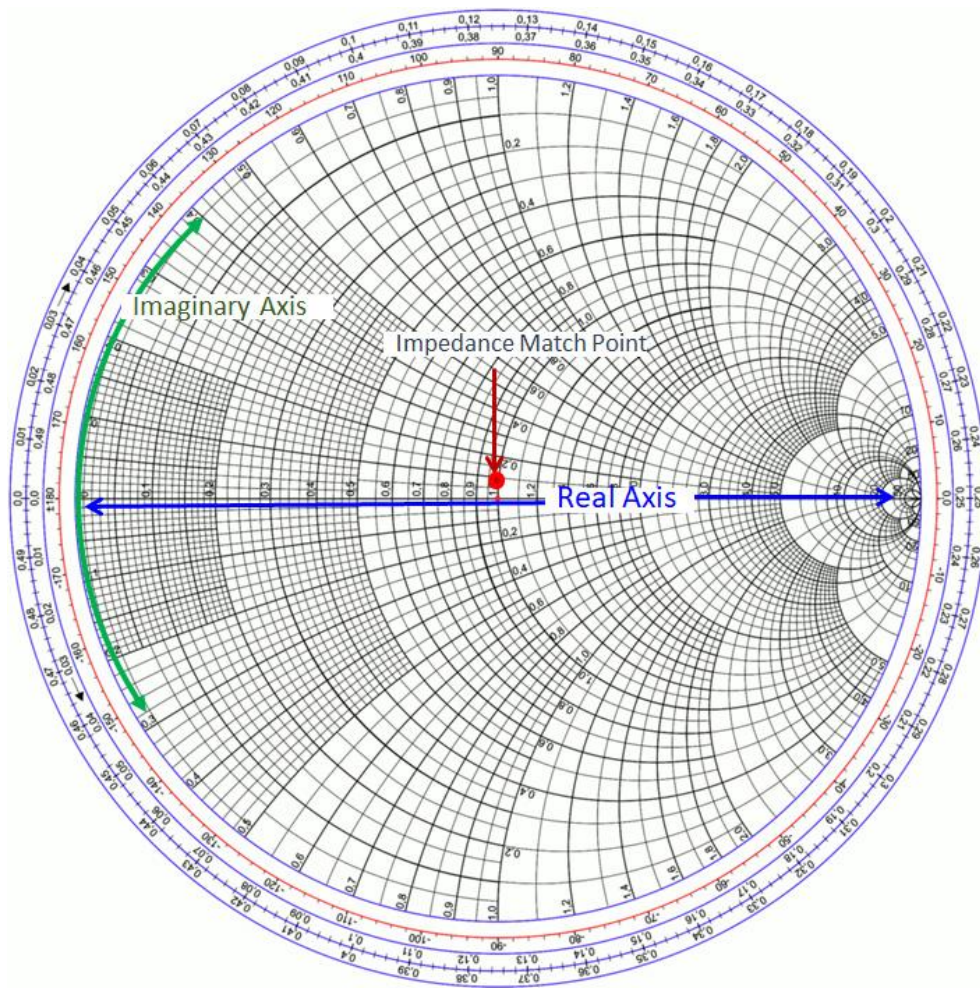
43. The circuits in Fig. 30 (a)-(f) are accompanied by the symbol for a Smith Chart [*see, e.g., Fig. 30(g)*]. Figure 30(g) shows a symbolic version of the Smith chart. The next figure below shows a version of the actual Smith chart used by

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engineers. The horizontal axis represents the normalized real component of the impedance. The point of perfect match is achieved when the tuning trajectory arrives at the center of the circle:



'719 patent, Fig. 30(g)



Smith Chart

44. As a person of skill in the art of electromagnetics would have known, a Smith chart can be used to properly sequence the tuning of multiple variable capacitors in a network so as to arrive at an impedance match. (This iterative tuning process is described in detail in the '719 patent 52:39-65.) The pathway in bold on the Smith chart of Fig. 30(g) is traversed as the various capacitors in the network are, in turn, incrementally adjusted, following the curved axes of the Smith chart,

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until a perfect match at the center of the Smith chart is achieved. As a person of skill would have known, a circuit having two tunable reactances, e.g., capacitors, can establish an impedance match, and it also can be used to guarantee maximum power transfer from the source to the load.

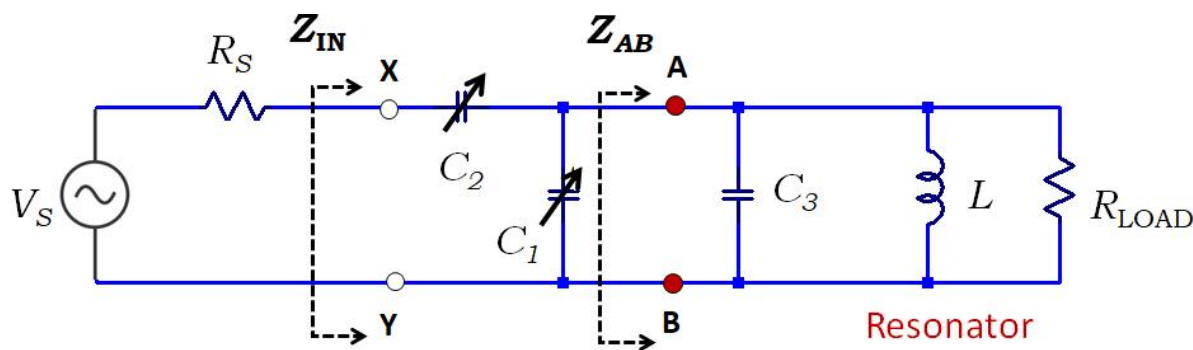
45. As discussed above, an impedance in general includes both resistive (R) and reactive (X) components. The reactive component can be positive (inductive) or negative (capacitive). Transforming a complex impedance $Z = R + jX$ into a completely real value at the desired matching resistance requires at least two degrees of freedom to allow for independent control of the reactive components. The degrees of freedom in an impedance matching network are thus provided by two or more independent reactive elements.

46. The Smith chart is a tool used to understand and visualize the degrees of freedom provided by an impedance matching network, e.g., a “network of capacitors”. The Smith chart allows one to visualize the adjustments in the resistive and reactive components of impedance that result from changes in the values of the reactive elements in the impedance matching network. In a Smith chart, the real and imaginary axes are circular, rather than rectilinear. In the Smith chart below, for example, the full circles that are tangent to the ∞ point on the right, labeled 0.1 to

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5.0, are the real-value axes. The semicircles emanating from the ∞ point on the right, labeled $+j5$ to $-j5$, are the imaginary axes.

47. The concept of tuning via multiple degrees of freedom is best illustrated by way of an example. Consider the capacitor network of '719 patent Fig. 30(c), reproduced below. The source resistance R_S is assumed equal to $50\ \Omega$, one of the standard source-resistance values used in practice. R_S is normalized to 1.0 at the center of the Smith chart (imaginary part of zero). It is desired to transform the impedance seen at terminals X and Y to the value of 1.0. This goal is accomplished by first adjusting C_1 , and then C_2 , until $Z_{IN} = 1.0$.



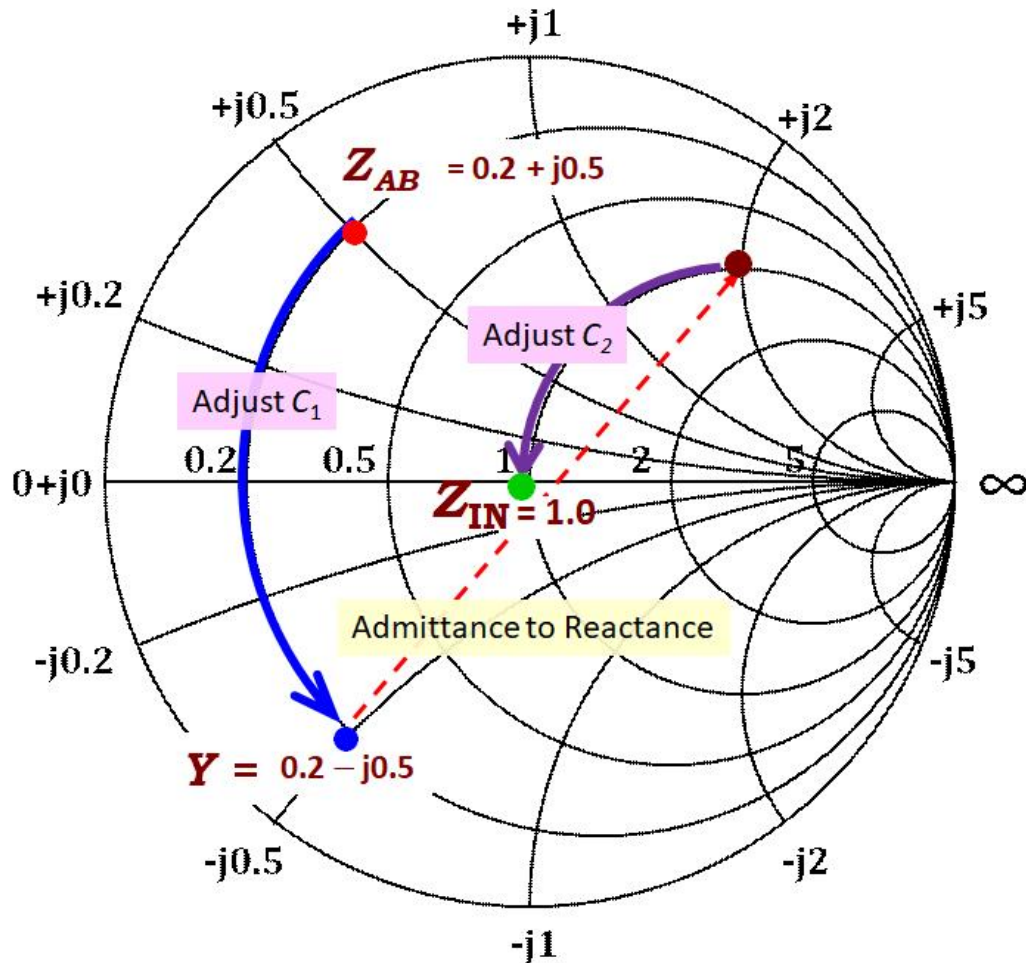
'719 Patent, Fig. 30(c), adapted and labeled

48. Suppose that the combination of the resonator L and C_3 plus the load resistor R_{LOAD} produce a normalized impedance of $Z_{AB} = 0.2 + j0.5$ as seen at terminals A and B . This impedance is represented by the red dot on the Smith chart below. The procedure is to adjust C_1 and C_2 in a two-step process, where each of the

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capacitors provides a degree of freedom, until the net impedance seen at the terminals X and Y is $Z_{IN} = 1.0$, so as to provide a perfect match for R_S .

49. With reference to the Smith chart, beginning at the red dot at $Z_{AB} = 0.2 + j0.5$, capacitor C_1 is adjusted until it adds a negative reactance of $-j1.0$. This addition causes the impedance seen at the left of C_1 to follow the blue curve until it arrives at the admittance value $Y = 0.2 - j0.5$ (blue dot). Transforming this shunt admittance into a series impedance (red dotted arrow) yields an impedance of $1.0 + j2.0$ (brown dot). Finally, C_2 is adjusted, following the trajectory of the purple arrow, until the net impedance arrives at the green-dot value of $Z_{IN} = 1.0$. This matching is accomplished via the network of capacitors shown in Fig. 30(c).



Smith chart example of Z_{AB} to Z_{IN} transformation.

50. In contrast to the term “network of capacitors”, the alternate term “capacitor bank” can also be found in the ’719 patent, as well as throughout Petitioner’s chosen prior art. Examples of its appearance in the ’719 patent include:

“The tunable elements may be **electrically switched capacitor banks**”(’719 Patent 57:56-57; emphasis added)

“**Switched capacitor banks** and other switched element banks may be used to assure the convergence to the operating frequencies and

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impedance values required by the system design.” (*Id.*, 69:7-8; emphasis added)

51. As I now show, “capacitor bank” in the art has a very different meaning from “network of capacitors” as used in the ’719 patent.

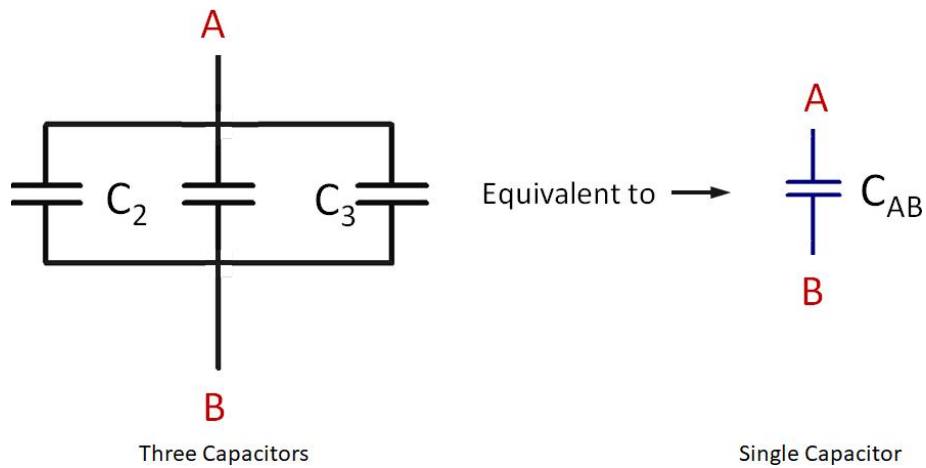
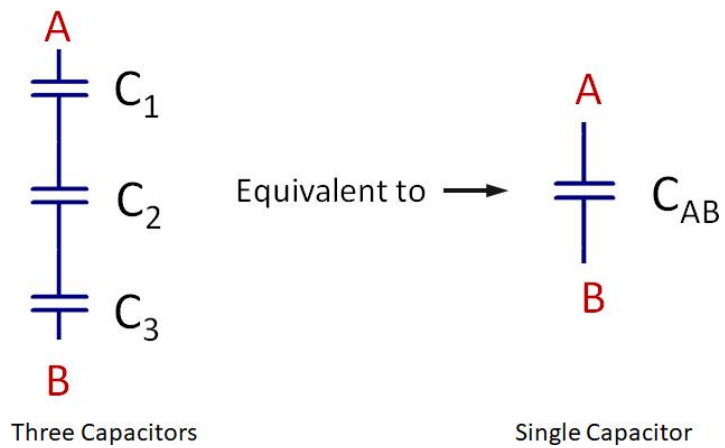
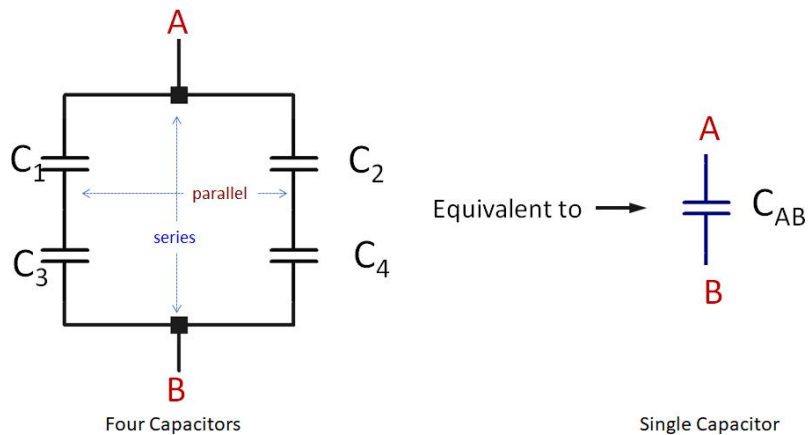
52. The Wiley IEEE Dictionary defines “capacitor bank” as:

capacitor bank A group of capacitors connected in series and/or parallel. (Wiley 92; emphasis original)

It would have been clear to a person of skill that the connection of the capacitors in series and/or parallel is a key feature of a capacitor bank. The two circuits shown below illustrate these classic connections that can be found in every textbook on electric circuits. A POSA would further have known that when capacitors are connected in one these series, parallel, or series/parallel connections, the net result is just a single capacitance C_{AB} of equivalent value as seen between the bank's connection terminals A and B:

Capacitors Connected in Parallel:

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Capacitors Connected in Series:Capacitors Connected in Series/Parallel:

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53. For the three capacitors connected in parallel⁴, the equivalent capacitor C_{AB} between terminals A and B is given by:

$$C_{AB} = C_1 + C_2 + C_3 \text{ (parallel)}$$

54. For the three capacitors in series, the equivalent capacitor C_{AB} between terminals A and B is given by:

$$C_{AB} = (1/C_1 + 1/C_2 + 1/C_3)^{-1} \text{ (series)}$$

55. For the four capacitors in series/parallel, the equivalent capacitor C_{AB} between terminals A and B is given by:

$$C_{AB} = (1/C_1 + 1/C_3)^{-1} + (1/C_2 + 1/C_4)^{-1} \text{ (series/parallel)}$$

56. As these examples of capacitor bank (“a group of capacitors connected in series and/or parallel”) show, a capacitor bank is not the same thing as a “network of capacitors”, because the bank can represent just a single capacitance adding just one degree of freedom to the tuning process. In a capacitor bank, all capacitors share either the same voltage (for a parallel bank) or the same current (for a series bank), whereas in each of the capacitor networks of Fig. 30 (a) – (m), there is no common

⁴ The examples of three or four capacitors here is arbitrary and chosen for illustration purposes.

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sharing of voltage or current between capacitors or inductors in the network connected to the resonator.

57. In each of the above examples, a single capacitor of value C_{AB} could be used in lieu of the designated bank of capacitors, and the result, as seen between terminals A and B, would be indistinguishable from the original circuit. A bank of series, parallel, or series/parallel-connected capacitors would thus *not* constitute a “network of capacitors”, because a single capacitor (e.g., C_{AB}) could be substituted for the bank, and the circuit would not be able to discern the difference and have multiple degrees of freedom.

58. An example of a capacitor bank can be found in the figure below, taken from Fig. 16 of Cook-554 (Ex. 1005). This circuit shows a bank of parallel-connected capacitors, wherein any given capacitor is brought into the parallel connection when its switch is closed, thus forming the equivalent of a single, variable capacitor. As in the circuits above, when Cook's capacitors are connected in parallel, their individual values simply add together to create a single capacitance (e.g., C_{AB}). The capacitor bank in Cook Fig. 16 could thus be replaced with a single capacitor. When connected to an inductor, this capacitor bank cannot perform the

function of a multi-reactance network.

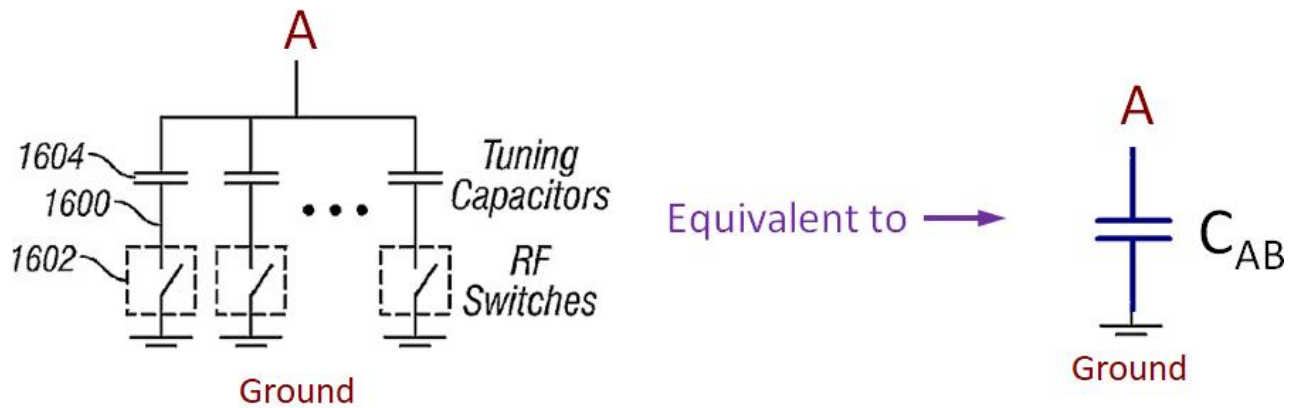


FIG. 16

Cook-554 Fig. 16, annotated. (The common grounds at the bottom have been connected together in the figure on the right.)

59. In contrast to the capacitor bank of Cook-554, the circuits of '719 Figs. 30 (a) – (f) show networks of capacitors in which the capacitors cannot be replaced by a single, equivalent capacitance. Rather, each capacitor in the network has a distinct set of connections, and each has a specific role in establishing an impedance match.

60. Given all of the above, I believe that an accurate construal for “network of capacitors” would be:

“a circuit topology of passive components including one or more capacitors that provides two or more degrees of freedom.”

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V. PETITIONER FAILS TO SHOW CLAIMS 16 AND 17 ARE OBVIOUS

61. In my opinion, Petitioner's obviousness analysis for claims 16 and 17 of the '719 patent fails for several reasons. First, Petitioner asserts that claim 16 is unpatentable as being obvious over Cook-554, either alone or combined with Pohjonen (Ex. 1009) (Ground I). Petitioner also asserts that claim 17 is unpatentable as being obvious over Cook-554 (Ground II). Petitioner further asserts that claim 16 is unpatentable as being obvious over the combination of Cook-523 (Ex. 1007) and Pohjonen (Ground III), and further asserts that claim 17 is unpatentable as being obvious over Lee (Ex. 1008) combined with Cook-523 (Ground IV). As I explain below, in my opinion, Petitioner has failed to demonstrate that these claims are unpatentable as being obvious over the prior art.

62. The filing date of the Cook-554 patent does not pre-date the earliest claimed September 27, 2008 priority date of the '719 patent. It has been explained to me that Cook-554 constitutes prior art to the '719 patent only if Cook-554 is entitled to the earlier March 5, 2008 date of what the Petition refers to as the "Cook Provisional" (Ex. 1006). It has further been explained to me that this earlier priority date applies to Cook-554 only if support for the claims of Cook-554 can be found in Cook Provisional. As I show below, it is my opinion that such support is not present in the Cook Provisional application.

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63. Even if Cook-554 is found to constitute prior art, however, it is my further opinion that Ground I still fails to invalidate '719 claim 16, because Cook-554 does not disclose "wherein at least one of the resonators is enclosed in a low loss tangent material," as required by claim 16. Cook-554 in fact discloses integration of a resonant magnetic antenna into a portable device, but POSA would at best understand this to mean that the resonant magnetic antenna is included as a part of the portable device, but not fully enclosed inside.

64. Claim 16 of the '719 patent requires that at least one of the claimed resonators be enclosed in a low-loss-tangent material. Given all the relevant embodiments in the patent, a POSA would have understood "enclosed in" to mean "inside a structure that is closed off on all sides." (*See, e.g., '719 patent Figs. 14 and 24, where "FIG. 24 shows a drawing of a magnetic resonator and its enclosure"* ('719 patent, 8:37-38). A POSA would that have understood the term "enclosed in" by its plain and ordinary meaning as "inside a structure that is closed off on all sides".

65. The Petition fails to articulate sufficient motivation for a POSA to have enclosed the resonant magnetic antenna of Cook-554 inside a low loss-tangent material, based on Pohjonen. Likewise, Ground III fails because the Petition does not provide sufficient motivation for a POSA to have enclosed the non-radiative

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antenna of Cook-553 in a low loss tangent material, again based on Pohjonen. A POSA would have readily understood that a design incorporating a resonant magnetic antenna into a portable device requires complicated tradeoffs that take into account a number of design constraints. These design constraints do not dictate that a magnetic resonant / non-radiative antenna must be enclosed in a low loss-tangent material.

66. I also find that Grounds I and III fail because a POSA considering Cook-554 or Cook-523 would not have looked to the teachings of Pohjonen. Cook-554 and Cook-523 are both directed to magnetic resonators that are non-radiative, meaning they rely on the near field of the resonator for power transfer. Such antennas are designed to produce a magnetic field that is localized to the near-field region and does not propagate away from the resonator. In contrast, Pohjonen is directed toward a cover for a high-frequency antenna designed to radiate electromagnetic energy into the far-field region. Such radiation leaves the antenna and constitutes energy sent into free space. A POSA would have understood that the such far-field antennas are subject to different design constraints compared to near-field resonators; accordingly, the POSA would not have looked to the radiating antennas of Pohjonen when designing a portable device incorporating the magnetic field/non-radiative antennas of either Cook-554 or Cook-523.

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67. In my further opinion, Grounds II and IV that relate to claim 17 also fail to show invalidity, because neither Cook-554, nor the combination of Lee with Cook-523, teaches or suggests all of the features of the claim. In particular, the cited references do not teach or suggest “at least one of the resonators includes a coil of a plurality of turns of a conducting material connected to a network of capacitors.” The Petition cites to each of Cook-554 and Lee as teaching a switched capacitor bank. In any case neither Cook-554 nor Lee teaches or suggests a resonator that includes a switched capacitor bank, much less a network of capacitors.

68. For at least these reasons, it is my opinion that Petitioner has failed to demonstrate that the challenged claims are unpatentable as obvious over the prior art.

A. Overview of the Prior ArtCook-554

69. Cook-554, entitled “Packaging and Details of a Wireless Power Device”, was filed on March 4, 2009 and issued on October 7, 2014. The patent discloses “A wireless power system [that] includes a power source, power receiver” and associated components. The patent focuses on “getting power to portable devices” (Cook-554, 1:45) and presents several embodiments of wireless power systems.

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70. Like the '719 patent, Cook-554 describes systems for effecting wireless power transfer. While missing several of the key features disclosed in the '719 patent, the Cook-554 embodiments effect power transfer using the local magnetic field ("near field component") of the resonator, rather than the radiated far-field component. For example, Cook-554 discloses the following:

"One embodiment uses an efficient power transfer between two antennas by storing energy in the near field of the transmitting antenna, rather than sending the energy into free space in the form of a travelling electromagnetic wave." (Cook-554 1:64-67)

An embodiment uses magnetically coupled resonance to transfer the power from source to receiver. In contrast to ordinary inductive coupling, loosely coupled resonant loop/coil antennas, preferentially of high quality factor, are used for energy transfer. (*Id.*, 9:29-33)

"A preferred technique for wireless energy transfer is based on coupled magnetic resonance using magnetic field antennas, e.g., a loop or coil operating either in the LF or HF frequency range. (*Id.*, 9:54-56)

Cook-554 does not discuss radiated fields or the far-field region away from the resonator. Figure 1 from Cook-554, reproduced below, provides one exemplary embodiment of a power transfer system:

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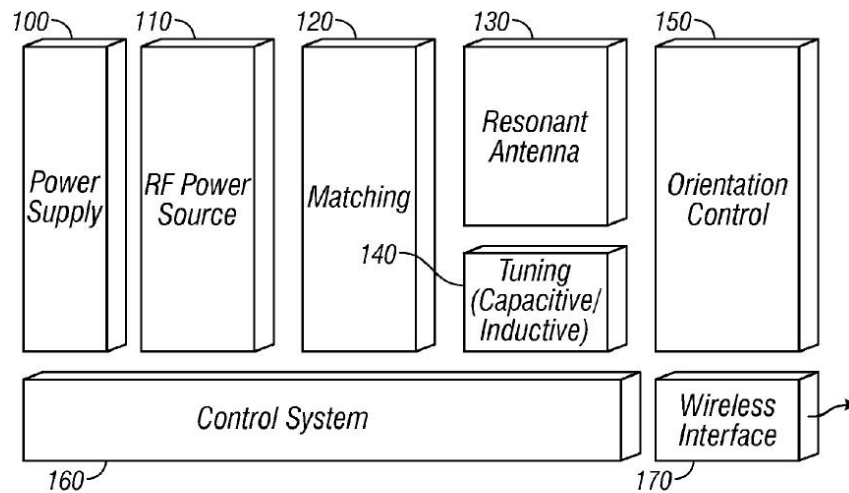


FIG. 1

71. I note that the embodiments in Cook-554 are limited to portable devices such as cell phones and laptop computers, as summarized by Fig. 4. (See, for example, Cook-554 2:53-67)

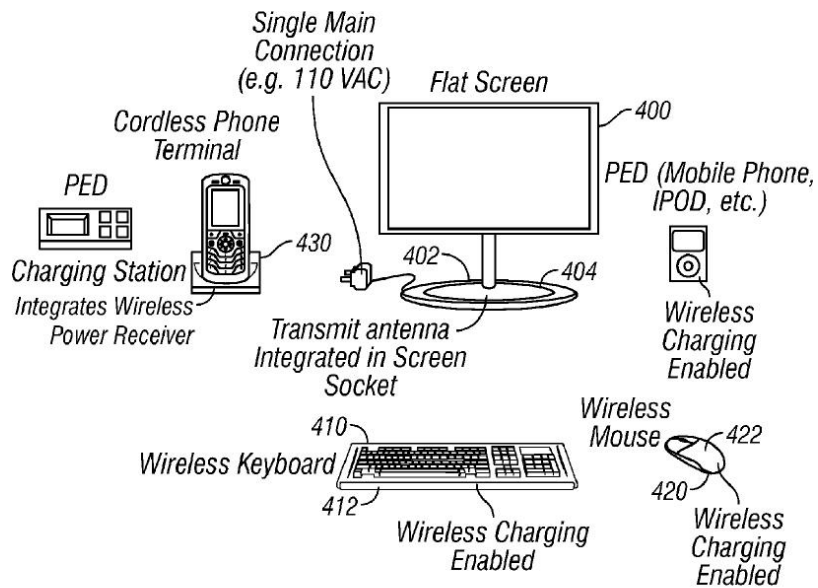
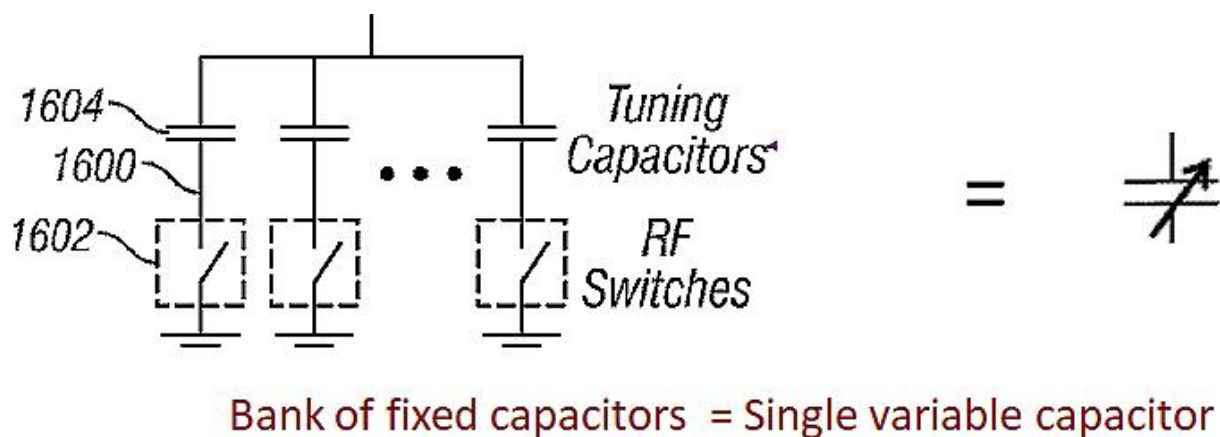


FIG. 4

Cook-554, Fig. 4

72. Cook-554 discloses that “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.” Cook-554 thus teaches replacing a single fixed capacitor by a capacitor bank which is essentially the same as one variable capacitor. The arrangement is shown as part of Cook-554 Fig. 16:



73. In an *LC* circuit, a capacitor bank can be used in lieu of a fixed capacitor to set the circuit's resonant frequency, but the bank cannot be used for impedance matching. As demonstrated by my Smith chart example and discussion above, impedance matching requires a minimum of two degrees of freedom in the tuning process, which requires at least two reactive elements (e.g., a network of capacitors). If only one capacitor or inductor is present, the resonant frequency can be set to the desired value, but achieving desired resonance *and* an impedance match cannot be accomplished with a single reactive element (e.g., a capacitor) only. The

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network-of-capacitor circuits shown in the '719 patent provide the needed degrees of freedom to facilitate adjustment for impedance matching.

Cook-523

74. Cook-523 was filed on September 16, 2008 and issued on February 19, 2003. A precursor to Cook-554, the Cook-523 patent similarly focuses on wireless power transfer. Cook-523 purports to have invented an antenna which "...has a part that amplifies a flux to make the antenna have a larger effective size than its actual size." (Cook-523, Abstract). The primary objective of the disclosed invention is "to transfer electrical energy from a source to a destination without the use of wires to guide the electromagnetic fields." (*Id.*, 1:19-21).

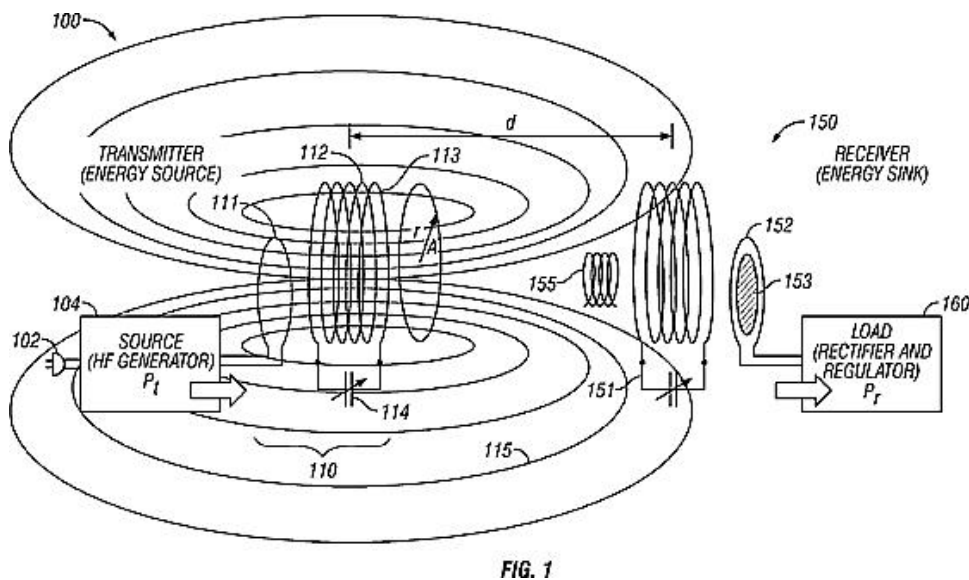
75. Cook-523 explains the difference between the near-field and far-field components produced by a resonant antenna, where the energy sent into free space constitutes the far field:

"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** in the form of a travelling electromagnetic wave." (*Id.*, 36-41; emphasis added).

As illustrated in Fig. 1 of Cook-523, reproduced below, the power transmitter assembly includes a high-Q resonant coil antenna 112 with a number of coil loops 113 in series with a variable capacitor 114. (*Id.* 2:33-41). As described in the patent,

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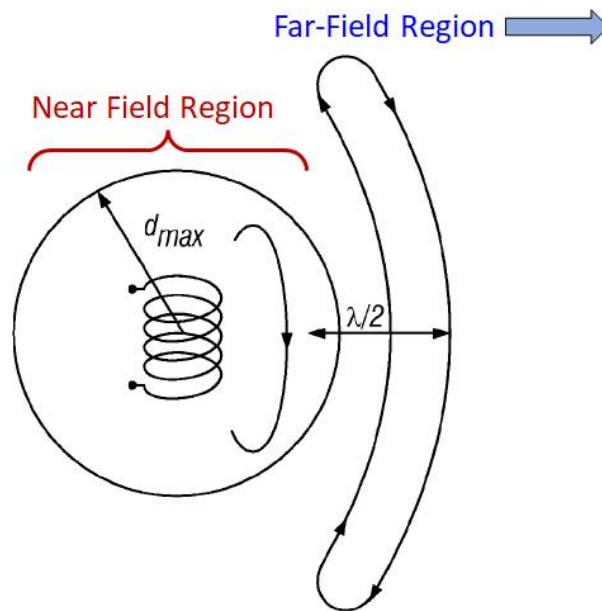
“The antenna 100 is non-radiative, in the sense that much of the output of the antenna is not electromagnetic radiating energy, but is rather a magnetic field which is more stationary. Of course, part of the output from the antenna will in fact radiate.” (*Id.* 2:49-53).



Cook-523, Figure 1

The receiver is likewise a high-Q resonant coil antenna that includes a coil in series with a capacitance. (*Id.* 2:56-58).

76. As further disclosed in Cook-523, the power transmitter assembly and the receiver may transfer energy through magnetic-field coupling, which is more advantageous than electric-field coupling due to its relatively weak influence from external objects. (*Id.* 2:66 – 3:8, 3:24-39). Figure 2A from Cook-523, shown below, illustrates the boundary between the near-field region and the far-field region:

**FIG. 2A**

Cook-523 Fig. 2A, annotated

77. Non-radiative energy transfer in the near field region, from a transmitting to a receiving resonator, is described by Cook-523 as “[a]n efficient power transfer [that] 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 in the form of a travelling electromagnetic wave.” (*Id.* 2:36-40, 3:40-41).

78. As is the case with Cook-554, Cook-523 also describes the integration of an antenna into a portable device. (See, e.g., Cook-523 Figs. 11A-11C, 12A-12C, as well as 2:13-16, 13:16-17, 13:32-34. Figure 11A from Cook 523, (reproduced below) illustrates an embodiment in which the antenna is a rectangular loop antenna

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that surrounds the perimeter of a portable device having a non-metallic case (a non-electrically conductive housing). (*Id.* 13:18-20).

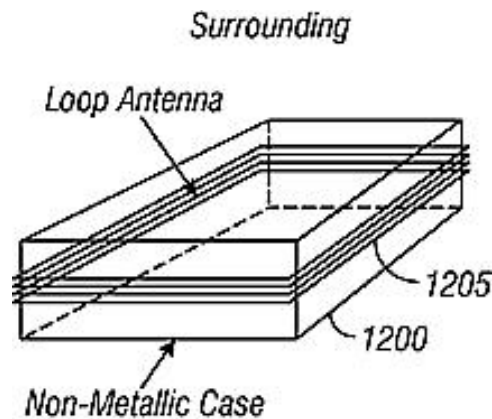
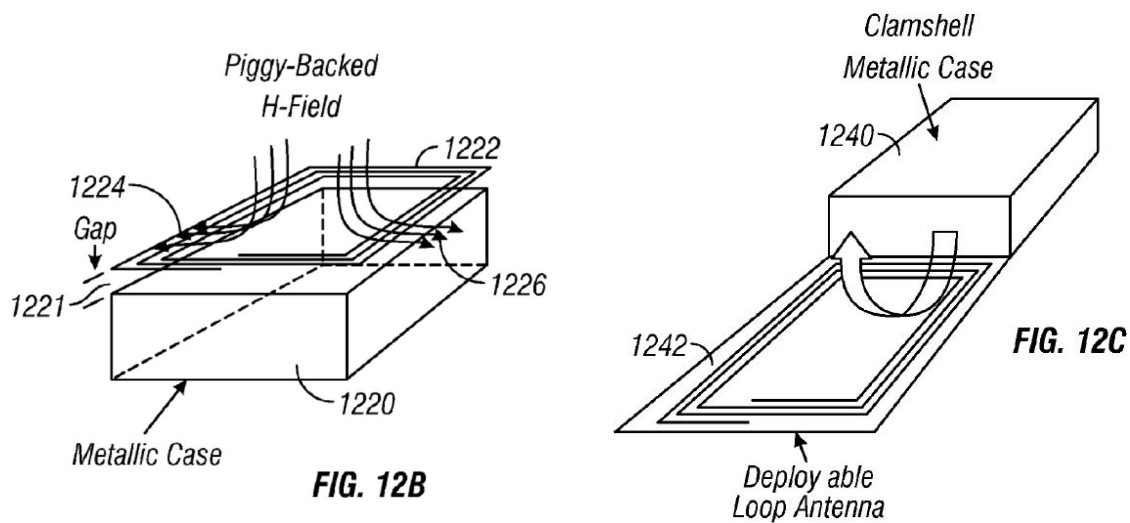


FIG. 12A

Cook-523, Figure 12A

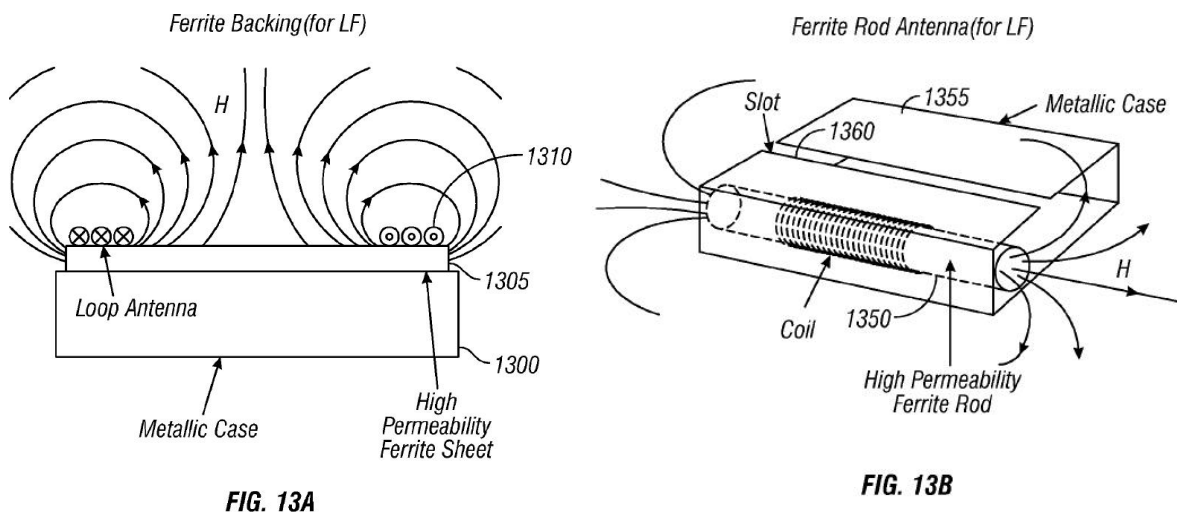
79. In Cook-523 Figs. 12B, 12C, 13A and 13B, also reproduced below, the antenna is integrated into a portable device having a metallic case. (*Id.* 13:23-25, 29-31, 34-35, 40-42). In the embodiment of Fig. 12B, the antenna is a rectangular loop antenna that is wound around an insulator that is separated from a metallic case by a gap. (*Id.* 13:23-28). In this embodiment, “the magnetic field created by the antenna passes through that gap ..., in order to escape.” (*Id.*)

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Id., Figs. 12B and 12C

80. In the embodiment shown above in Fig. 12C, the antenna is again a rectangular loop antenna, but in this case is deployable. (*Id.* 13:29-31). The loop antenna rotates, slides, or folds away from the metallic case. (*Id.*) In the embodiment shown below in Fig. 13A, the metallic case is covered by a high permeability ferrite sheet on which a loop antenna is formed. (*Id.* 13:34-39.)

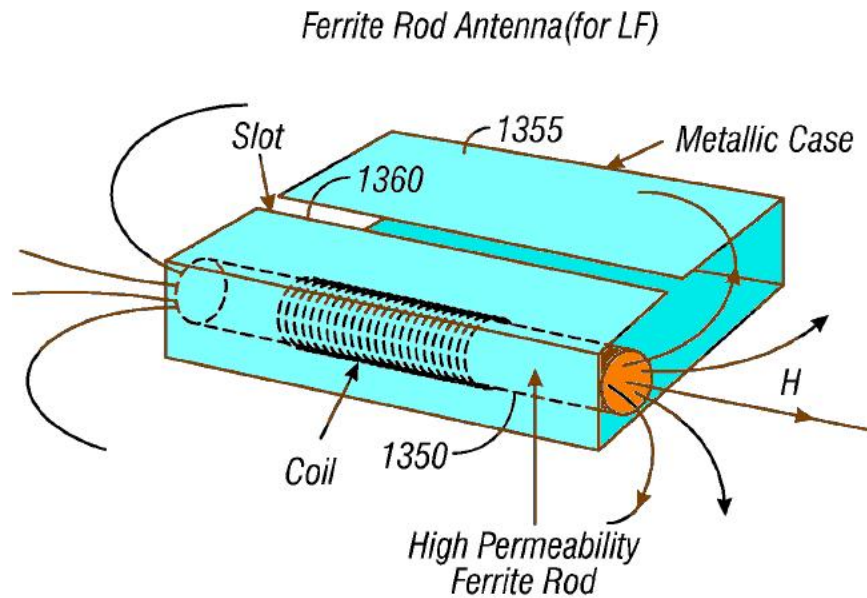


Id., Figs. 13A and 13B

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81. In the embodiment shown above in Fig. 13B, the antenna is a high-permeability ferrite rod with a wound-coil that is within the metallic case of the portable device. (*Id.* 13:40-42). In this embodiment, the metallic case includes openings at its ends and an open slot/slotted area through which the magnetic field is received. (*Id.* Fig. 13B, 13:43-44).

82. Figures 12A – 13B from Cook-523, described above, disclose several antenna configurations juxtaposed on device cases. In looking at these various case configurations, a POSA would conclude that none of them appears to completely enclose the antenna of the device. The case configuration that comes closest to a full enclosure is that of Fig. 13B, reproduced below. The patent describes this case configuration as, "...a case ...that minimizes eddy current effects" (Cook-523 13:33-34) and having "an open slot or slotted area 1360 [to] provide the area through which magnetic field H is received." (*Id.*, 13:41-43). In other words, the blue shaded portion of Fig. 13B below is made from metal. What remains unshaded in the figure is open air. In my opinion, this structure would not have been considered "an enclosure" by a person of skill.

**FIG. 13B**

Cook-523 Fig. 13B, annotated

Pohjonen

83. Pohjonen was filed on September 13, 2007. The focus of Pohjonen is on “a portable radio device” that has a “radiating antenna” inside an “outer cover”. (Pohjonen, Abstract). Pohjonen contemplates various materials to be used for outer covers for radiating antenna elements, i.e., antennas that transmit radio frequency energy into the far field. Pohjonen further concerns the “selection of cover materials and structures for” a portable radio device that includes an internal antenna to “enhance antenna efficiency.” (Pohjonen 1). Pohjonen recognizes that an “outer cover should naturally cause as little attenuation of radio waves as possible”. (*Id.*). Pohjonen explains that antenna efficiency can be kept high by choosing the right

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material for the outer cover of the device, so as to allow radio waves to easily pass through. (*Id.*).

84. Pohjonen discusses radio waves and portable radios only (for example, the terms “portable radio device” , “radio frequency module”, or “antenna” appear in the Pohjonen specification and in the preambles of many the claims.) A POSA would have understood “radio waves” to mean the far-field radiation component of an electromagnetic wave, not the near-field region that is the focal point of Cook-524. On the contrary, Pohjonen uses the term “radiation” and its derivatives to describe the magnetic transfer of power, but not the term “near field” or anything similar. As a POSA would have known, it is the near-field component that is used for localized power transfer (e.g., a wireless charging pad or electric vehicle charger), not the far-field radiation component which typically carries information and data, as in a WiFi connection.

85. As to the term “enclosed in” that is part of claim 16, such a term appears just once in Pohjonen:

“the **radiating antenna element** is located within the smooth overall outline of the device, without the antenna causing any protrusions, and **enclosed inside** an essentially continuous outer cover of the device.” (Pohjonen 1; emphasis added).

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86. However, what is being described as “enclosed” in this passage is a radiating antenna element, not a resonator like the one claimed in the '719 patent. Pohjonen instead discloses the combining of materials (e.g., plastic and metal) to make an outer cover. As Pohjonen explains, this combining of materials might involve embedding the metal antenna parts within the plastic of the cover:

“The method of fig. 5 involves using at least some of **the antenna parts** manufactured in step 303 **as inserts to the injection moulding** step in either step 501 or step 502 or both.” (Pohjonen11)

Such combining of materials might also involve using low-loss materials just for patches on the cover, rather than using them for an entire enclosure:

“The method of fig. 5 covers both the separate manufacturing of a frame part (step 501) and the **low-loss thermoplastic patches** (step 502), and the combined manufacturing of a complete outer cover part in one step (step 501, in which case step 502 is omitted). Coating is again applied in step 302.” (*Id.*; emphasis added)

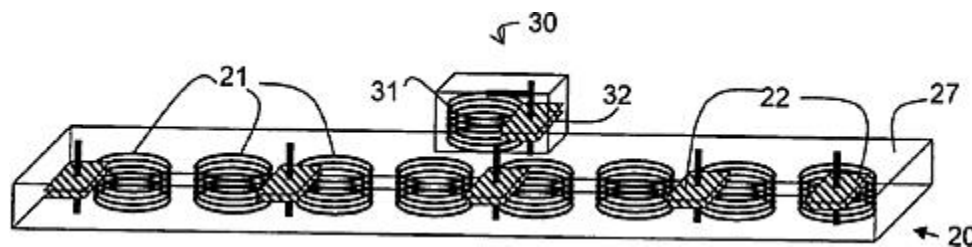
Lee

87. Lee, entitled “System and Method for Contact-Free Transfer of Power”, was filed on December 27, 2005 and published on June 28, 2007. The focus of the Lee application is “the inductive transfer of electric power between a substantially flat primary surface and a multitude of secondary devices”. (Lee, Abstract). A key

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feature of what Lee discloses is that “precise physical alignment between the primary surface and the secondary device” is not required. (*Id.*) Lee is distinguished from other resonator-based inductive-coupled power transfer devices in that it has a “local anti-resonance architecture...[that] will block primary current from flowing when no secondary device or devices are in proximity to the local RF power network”. (*Id.*) Lee also discloses “a novel multi-pole driving technique which produces an apparent traveling wave pattern across the primary surface.” (*Id.*) These are all concepts that do not appear in any other of Petitioner's prior-art references, nor do they appear in the '719 patent.

88. As shown in Lee Fig. 2 (a portion of which is reproduced below), Lee discloses a system that includes a primary unit and secondary unit that are magnetically (inductively) coupled to transfer power from the primary unit to the secondary unit. (*Id.* at Abstract, ¶¶ 3, 19, 54-57).



Lee Fig. 2

The primary unit includes an array of inductive field coils (L) and matching capacitors (C) that form parallel LC networks. *Id.* ¶¶ 54-55. Likewise, the secondary

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unit includes an inductive field coil and a matching capacitor. *Id.* 54-55, 57.

In one embodiment, Lee discloses the use of a “bank of switched capacitors” to adjust the “source impedance of the RF drive to match the impedance of the effective load of one or more secondary units” (Lee at [0023]). Lee also discloses that, “The **variable capacitor** means can be a **switched capacitor bank** under the control of an analog or digital controller, or could be MEMS based variable capacitors.” (*Id.* at [0027]; emphasis added).

89. An example of Lee's capacitor bank appears in Fig. 12 which shows “an isometric view of ... the ‘device adapter’.” (*Id.* ¶ 75). This adapter includes a “bank of switched capacitors 32b ... in parallel with the main capacitor 32a [which forms] a **variable and electronically adjustable capacitance...**”. Lee describes this capacitor bank as having a “... MOSFET switch [that] can be either ON, or OFF [so that] the switched capacitor bank 32b can **provide 24 or 16 different capacitance values** which are more or less linearly distributed with values from 0 pF to 1,500 pF.” (*Id.* ¶ 78; emphasis added.). In other words, the intent of the capacitor bank 32b in Lee Fig. 12 is to function as a single capacitor whose value can be varied via opening or closing the various MOSFET switches.

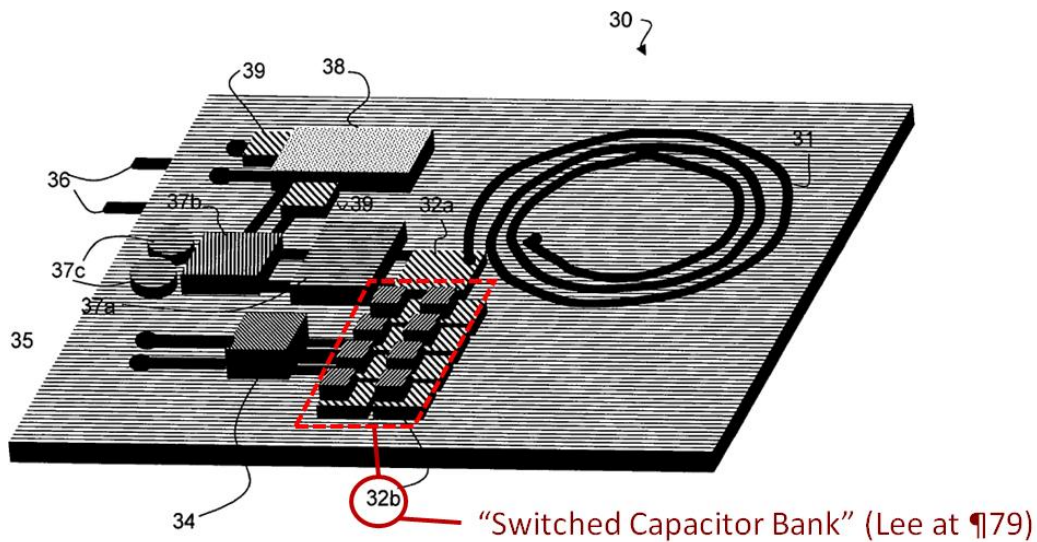
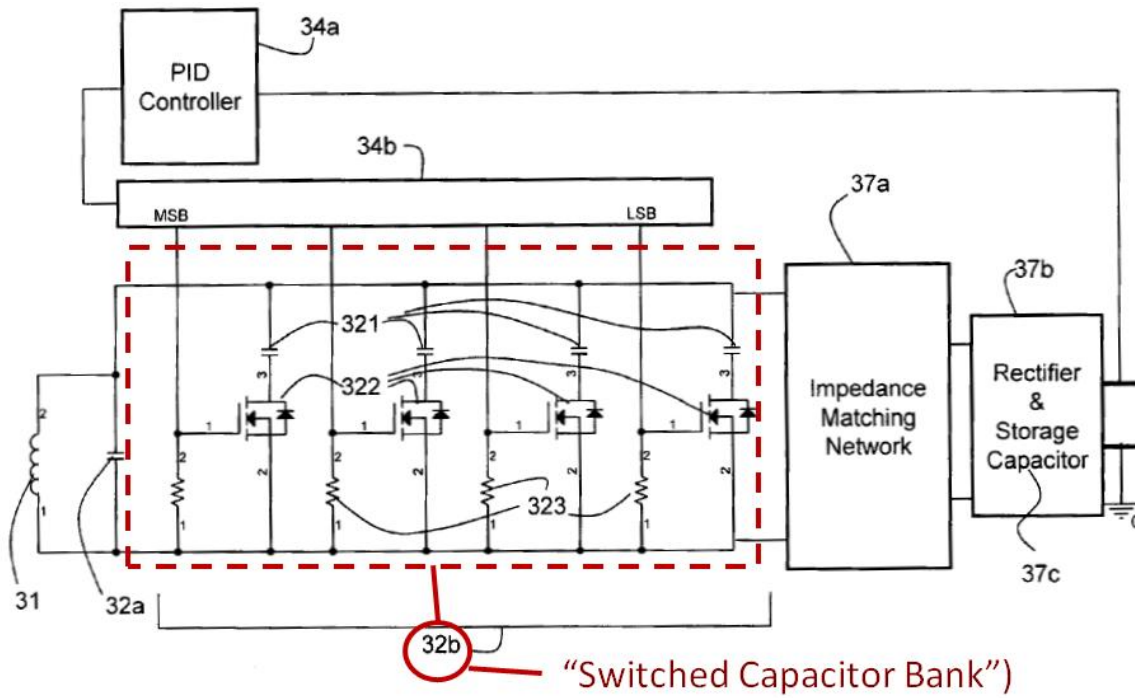


FIGURE 12

Lee Fig. 12, annotated

90. The details of the switched capacitor bank in Lee Fig. 12 are provided in Fig. 13: “A more detailed schematic view of the circuit elements in the device adapter.” (Lee a¶ 78). This figure, shown below, provides details about the electronic components of the switched capacitor bank 32b. The portion inside the dotted lines comprises the circuitry inside block 32b in Fig. 12:

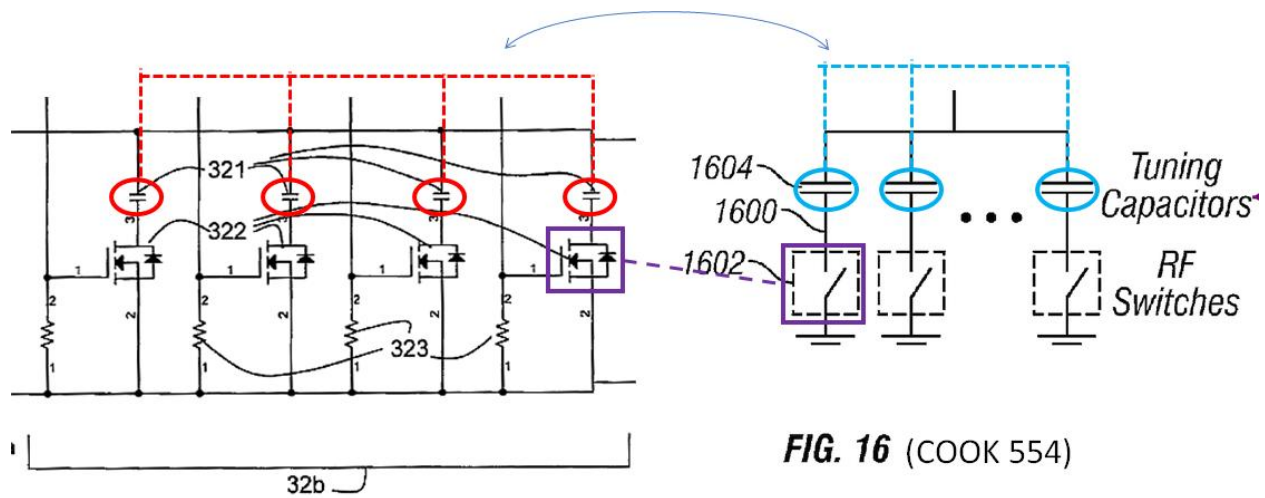
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**FIGURE 13**

Lee Fig. 13, annotated

91. One can easily see that circuit elements comprising the switched-capacitor bank of Lee are nearly identical to those found in Cook-554. These two

circuits are shown below side-by-side for comparison:



From Lee Fig. 12

92. From the above two figures, as well as the description of Fig. 12 in Lee, and in consideration of the explanations I have provided previously I conclude that capacitors 1604 and RF switches 1602 in Cook-554 Fig. 16 comprise a capacitor bank, not a network of capacitors.

B. Opinions Regarding Petitioner's Grounds 1-4

93. In my opinion, none of Petitioner's asserted grounds demonstrate the invalidity of either claim 16 or claim 17 of the '719 patent. In the following sections, I provide the bases of my opinions.

1. Grounds 1 and 2: Cook-554 Claim 17 is Not Supported by Cook Provisional

94. Petitioner asserts that "Cook-554 is entitled to the filing date of the Cook Provisional because Cook-554 was filed within one year of the Cook

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Provisional's filing, names at least one inventor in common, and includes a specific reference to the Cook Provisional." (Pet. 10). It has been explained to me, however, that Cook-554 is entitled to the earlier priority date only if Cook Provisional "...provides sufficient support for at least claim 17 in the Cook-554 patent..." (*Id.*)

In my opinion, as I further explain below, this is not the case.

Claim 17 of Cook-554 is a method claim that reads as follows (emphasis added):

Claim 17. A method comprising:

- a) receiving power via a resonant circuit from a non-modulated wireless magnetic field at an operating frequency and at a receive power level;
- b) converting the received power, so as to charge a battery, with a power converting circuit having an impedance value that is variable; and
- c) varying the impedance value of the power converting circuit to tune the resonant frequency of the resonant circuit **based on the received power level**.

95. Here "the resonant circuit" of element 17(c) refers to the antecedent resonator "receiving power" of 17(a), i.e., the resonator on the receiving end of the power transfer system. Element 17(c) requires that the impedance of the antecedent *receiving* power converter be varied based on the *received power level*.

96. Petitioner asserts that support for varying the impedance value as in claim 17 can be found in Cook Provisional. I disagree. After a detailed and careful

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reading of Cook Provisional, I find nothing therein that describes varying the impedance value based on received power level.

Petitioner's assertion that, "The Cook Provisional supports the final step in claim 17" is based on the following citations from Cook Provisional:

"varying the impedance value of the power converting circuit to tune the resonant frequency of the resonant circuit based on the received power level."

"[In] practical high-Q designs readjusting (tuning) of the resonance frequency is often compulsory." (Cook Provisional 051).

Petitioner also asserts that,

"The resonance frequency can be tuned using variable capacitance, variable inductance, or a combination, to 'create antenna load impedance that can be varied.' (CProv at pgs. 055, 044)." (Pet. 15)

Petitioner further admits that "tuning is generally needed to 'ensure that the receive antenna is operated at resonance', 57." (*Id.*)

97. While all of the above, as well as all other mention of resonance tuning that I found in Cook Provisional, explains the desirability of tuning the resonant frequency of one or both resonators to the frequency at which power is transmitted, I could find no reference to using received power at the receiving resonator as a basis for varying the impedance value to tune the resonant frequency.

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2. Ground 1: Claim 16 is *not* obvious over Cook-554, alone or with Pohjonen

98. Petitioner has failed to show that '719 claim 16 is obvious based on Cook-554, or Cook-554 with Pohjonen. My reasons for this opinion are severalfold. First, Cook-554 teaches resonator “integrated” with a portable electronic device, but Cook-554 does not teach or suggest a resonator that is *enclosed* in a low loss-tangent material. Specifically, Cook-554 does not teach a resonator “inside” a portable electronic device. Rather, in each of Figs. 4, 5, 7-10, and 22A-D, Cook-554 describes antennas as being “integrated” into a portable device. A POSA would understand “integrated” by its plain and ordinary meaning. The Wiley IEEE Dictionary defines this term as follows: “**integrate:** **1.** To make into a whole by uniting all the component parts. **2.** To incorporate into a large entity.” (Wiley 379). Neither of these definitions evokes the concept of being “enclosed in”.

99. Second, Petitioner asserts that a person of skill would have been motivated to enclose the resonator from Cook-554 into a portable device made from a low loss-tangent material “because it would protect Cook-554’s second resonator from damage during manufacturing or use while maintaining antenna efficiency.” (Pet. 18). In my opinion, Petitioner has not sufficiently explained the reasoning behind what I find to be an overly broad conclusion about protection. Cook-554

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mentions nothing about protection, and the only mention if it in Pohjonen relates to diamond coatings, not enclosures. *See*, for example:

“Diamond and (sic) is a good insulator at room temperature, which means that the coating does not alter the advantageous dielectric characteristics of the low-loss thermoplastic material. A **uniform coating of this kind** that covers a low-loss thermoplastic material also **protects it from moisture and other absorptive impurities**, which otherwise could weaken its dielectric characteristics over time. If needed the outermost coating can be painted or lacquered.”
(Pohjonen 10; emphasis added)

100. Third, Petitioner has failed to explain to what “damage” the antenna in Cook-554 antenna would be susceptible, such that a POSA would have been motivated to enclose the antenna in an outer cover.

101. Fourth, Petitioner has failed to explain how an outer cover would serve to protect an integrated second resonator “during manufacturing,” much less during consumer use.

102. Fifth, Petitioner has failed to explain or provide details as to how forming the outer cover out of a low loss-tangent material would serve to protect the integrated second resonator during manufacturing or consumer use. As a POSA would have known, there are a number of different materials, including non-magnetic metals and other polymer-based plastics, that are stronger and more

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durable than those cited by Petitioner. Moreover, there is no correlation between loss tangent and mechanical strength.

103. Sixth, Petitioner has failed to recognize the complex tradeoffs that would be inherent to the design of an outer cover for a portable device. In my opinion, these tradeoffs could in many cases lead a POSA away from enclosing either of Cook-554's resonators in a low loss-tangent material. As a POSA would have known and as is well known in the art, relative to dielectrics, metals generally provide greater strength and durability, as well as better thermal dissipation and better shielding from electromagnetic interference (EMI). The POSA would have known that dielectrics such as plastics provide no EMI shielding at all.

104. Lastly, Petitioner fails to explain why a POSA would have chosen to "enclose" the second resonator in a low loss-tangent material, as required by '719 claim 16. The benefit of using a low loss-tangent material is, at best, localized to the region of the covering where electromagnetic fields are emitted and electromagnetic waves pass.⁵ This concept is articulated in several prior art references, such as in

⁵ Here the **electromagnetic fields** refers to the near field of the resonator, and **electromagnetic waves** refers to the radiated far-field component.

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Dabov (Ex. 1016, e.g., Abstract, 3:63-65) and Zhang (Ex. 1015, e.g., 4:32-34 and 9:41-45)

105. For example, as shown in Dabov Fig. 9 (reproduced below), Dabov describes an electronic device including an outer shell formed of a housing and bezel, and in which an antenna cap is coupled to the housing at the location of an antenna assembly to “provide a radio-transparent outer surface for [the] antenna assembly.” (Dabov Fig. 9, 4:36-38, 9:36-39, 10:11-15, 27-32).

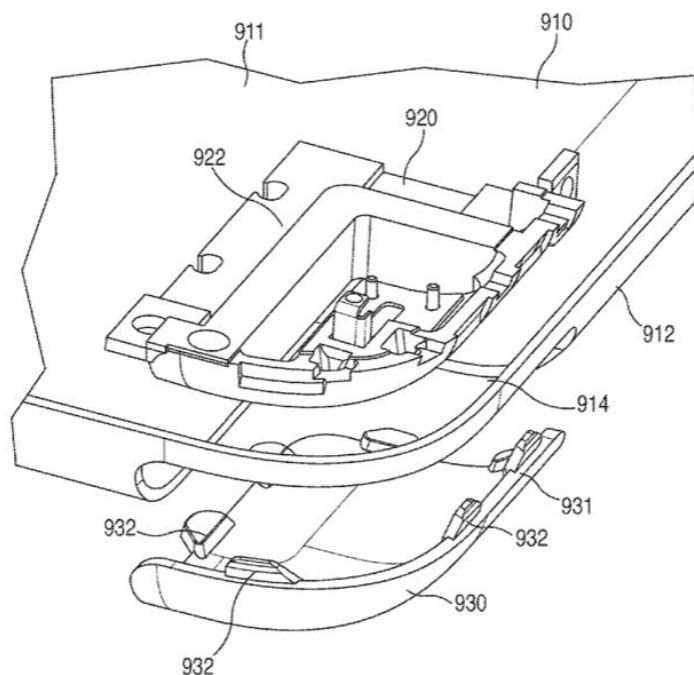


FIG. 9

Dabov, Fig. 9

106. Similarly, Zhang describes a handheld wireless device that includes a housing having a conductive portion, plus dielectric portions that “serve as caps that

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cover antennas that are mounted within [the] housing.” (Zhang 3:54-61, 8:37 – 9:9).

The dielectric portions in Zhang allow the resonating element portion of an antenna “to operate without interference from the metal sidewalls of the housing.” (*Id.* 9:10-14). This feature is shown in a number of figures in Zhang, including, e.g., Fig. 4A, reproduced below:

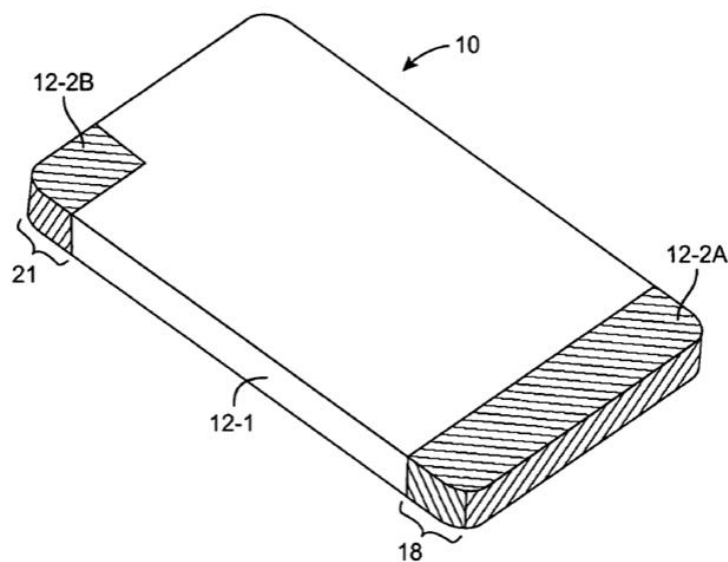


FIG. 4A

Zhang, Fig. 4A.

107. As I explained previously, I do not believe that Petitioner has explained the way in which any damage would occur or how the efficiency of the antenna would be “maintained.” I thus conclude that Petitioner’s case for motivation to combine Pohjonen with Cook-554 cannot be made based on any perceived need to protect the product from damage.

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108. Petitioner cites Cook-554 at 17:1-2 and 19:30-35 as a basis for the enclosing of a resonating antenna inside a low loss-tangent dielectric. Petitioner states,

“...Cook-554's embodiment, where a receiving resonator is 'integrated into a device' such as a mobile phone. That embodiment discloses each element of claim 16, including that at least one of the resonators is enclosed within a portable device housing in a part with “lower losses and better ...penetration of magnetic fields” and to “avoid a metallic housing.” (Pet. 9).

109. This citation that has been excerpted from Cook-554, 17:1-2 is misleading. One must look at the paragraph in its entirety, i.e., from 16:65 to 17:4. The entire paragraph reveals that eddy current losses, not dielectric losses, are the main drawback in using metal housings.

“Severe Q-degradation due to **eddy current losses** in all conducting parts of the device might be expected, however, since the entire electronics is in the interior of the loop, where the magnetic field is highest.” (Cook-554, 16:65 -17:1; emphasis added)

110. The full paragraph from Cook-554 beginning at 16:65 refers solely to eddy-current losses, not dielectric losses. The paragraph says nothing about putting a resonator inside a low-loss-tangent enclosure -- or one made from any kind of dielectric, for that matter. Rather, it simply teaches the avoidance of metal

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enclosures. As a POSA would have known, eddy-current losses are unrelated to the loss tangent of dielectric materials. Rather, eddy current losses are caused by ohmic conduction, not by dielectric absorption. When an electromagnetic field permeates a dielectric material, the loss tangent δ expresses the ratio of the real to the imaginary part of the permittivity of the dielectric or, in a few cases, the permeability of the magnetic material. Eddy currents are caused by ohmic conduction due to the current density $\mathbf{J}$ in conductors such as metal.⁶

⁶ By way of explanation, electromagnetic field waves are governed by two of Maxwell's Equations:

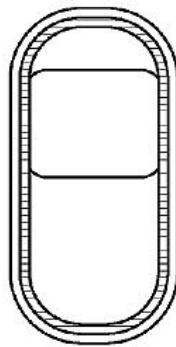
$$\begin{aligned}\nabla \times \mathbf{E} &= -\frac{\partial \mu \mathbf{H}}{\partial t} \\ \nabla \times \mathbf{H} &= \frac{\partial \epsilon \mathbf{E}}{\partial t} + \mathbf{J}\end{aligned}$$

Here $\mathbf{E}$ is the electric field, $\mathbf{H}$ the magnetic field, μ the magnetic permeability, and ϵ the dielectric permeability. The vector $\mathbf{J}$, if it exists at all, is the *current density*. Field propagation relates to the “cross product” $\mathbf{E} \times \mathbf{H}$, whereas eddy currents are caused exclusively by the current density $\mathbf{J}$ and are not affected by ϵ and μ .

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111. The second of Petitioner's citations, Cook-554 19:30-35, reads as follows:

"Another 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, e.g. in the keyboard part of a mobile phone (see FIG. 22B. This may be considered as the "compact" configuration." (e.g., Pet. 35)



*Compact Type:
Antenna Loop
Integrated into
Main Part*

FIG. 22B

Cook-554, Fig. 22B.

112. Figure 22B from Cook-554 is shown above. As this excerpt shows, Fig. 22B does not depict the claim 16 requirement that "at least one of the resonators is **enclosed** in a low loss tangent material". Rather, the citations and Fig. 22B instead show a mobile phone in which the loop antenna is "integrated into a main part" (Cook-554 19:30, 22B caption), specifically "a cover or a keyboard part" (*Id.*, 2:45-

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46). Thus, irrespective of the issue of a low loss-tangent material, (which is not discussed at all in Cook-554), no part of the antenna in Cook-554 is *enclosed*, as '719 claim 16 requires.

113. As Petitioner points out, Cook-554 does not “expressly refer to the ‘loss tangent’ of the material for its portable device housing,” (Pet. 9). Rather, Cook-554 merely hints at the need to reduce loss in designing a portable device. For example, the statement, “Eddy currents and dielectric losses in the surrounding of a receive antenna will deteriorate its Q-factor” (Cook-554, 6:29-30) This citation from Cook-554 says nothing about the selection of materials to mitigate dielectric losses. Moreover, while Cook-554 offers that, “This is particularly true if the antenna is integrated into a device,” (*Id.*, 6:31-32), the integration of an antenna into a device is not the same as *enclosing* a resonant antenna, as claim 16 requires.

114. In my opinion, a POSA would not have been motivated to combine Pohjonen with Cook-554. Specifically, the POSA would not have been drawn to or motivated to consider Pohjonen when contemplating the wireless power systems of Cook-554. (See, e.g., Cook-554 at 24:1; 1:64-67). Pohjonen focuses solely on, “A portable radio device” and “a radiating antenna element”, meaning the purpose of Pohjonen’s antenna is to radiate signals into the far field (e.g., WiFi or cellular data). As a POSA would have known, and as Cook-554 teaches, the radiated (i.e., far field)

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component is not useful for power transfer, because its energy density is much lower than that of the near field. The far-field radiation component of Pohjonen is very different from the near-field component utilized in Cook's wireless power transfer system.

115. The latter excerpt from Cook in fact discloses this difference:

“One embodiment uses an efficient power transfer between two antennas by **storing energy in the near field** of the transmitting antenna, **rather than sending the energy into free space** in the form of a travelling electromagnetic wave.” (Cook-554, 1:64-67; emphasis added)

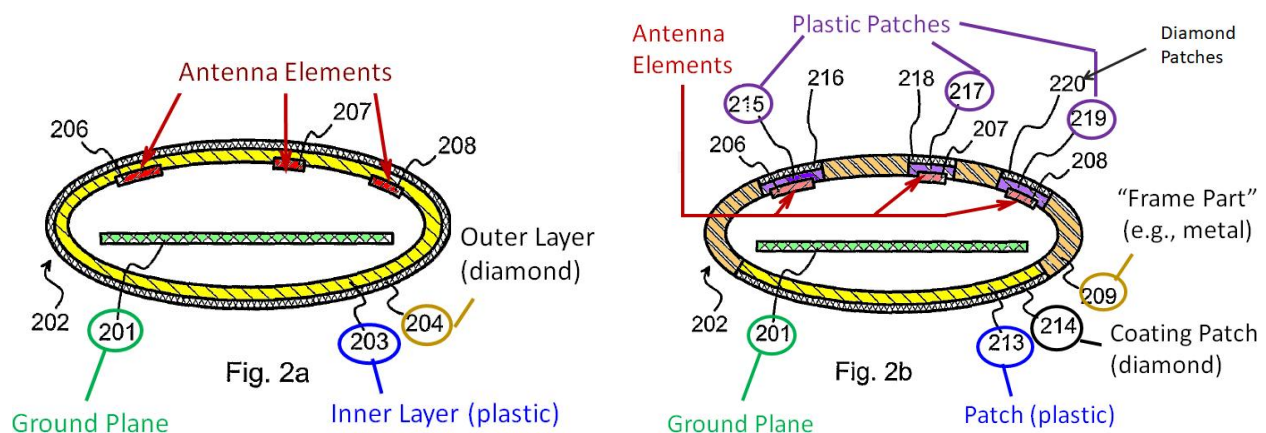
The above shows that Cook-554 does not focus on the design of devices, including their enclosures, to be used for far-field communication, e.g., cell phones and the like that rely on the radiated far field to convey information.

116. Additionally, at least three of four embodiments shown in Pohjonen clearly do not enclose the antenna in a low loss tangent material. The only embodiments disclosed in Pohjonen are those in Fig. 2, reproduced below. As Pohjonen explains, the overall structure 202 is “an outer cover” (Pohjonen, Abstract) or “cover part” (*Id.* at 4). Pohjonen explains that the outer cover part “comprises at least two layers. An inner layer 203 is made of a “thermoplastic material having a loss tangent value smaller than 0.005. An outer layer is made of artificial diamond,

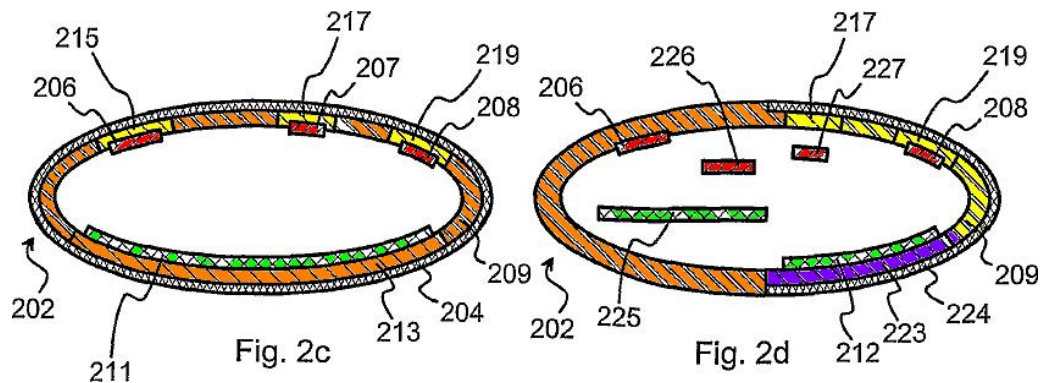
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diamond like carbon, or nanocomposite material.” (*Id.* at 7). In at least in the embodiments shown in structures 2B, 2C, 2D and 2E, this composite of parts comprising the outer cover does not satisfy the “enclosed in” requirement of claim 16, because the composite of parts does not cover the antenna on all sides.

117. The components of Pohjonen's “outer cover part” structures 2A, 2B, 2C and 2D are labeled below, according to their designations within the Application. None of the structures in at least 2B, 2C or 2D encloses an antenna, much less a resonator, in low-loss-tangent material. As I have noted above, this is also true for Cook-523 Figs. 12A-C and 13A-B. In both cases, the antenna is not “enclosed in” because it is not covered on all sides.



Pajonen Figs. 2a and 2b, annotated



Pajonen Figs. 2c and 2d, annotated

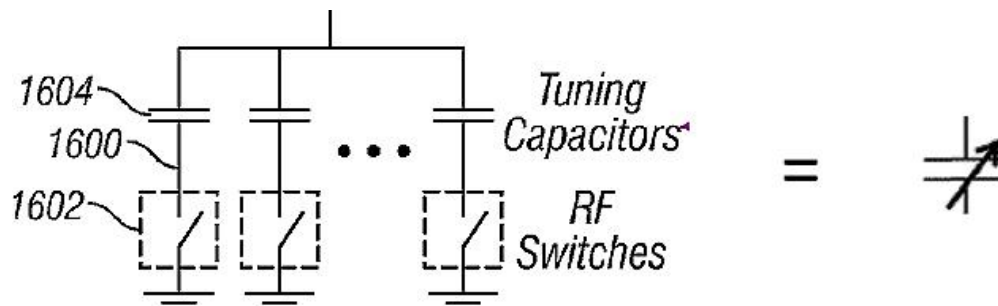
118. Given all of the above, it is my opinion that a) a POSA would not have looked to Pohjonen when contemplating the system of Cook-554, and b) in any case, Petitioner has failed to show that a POSA would have combined Cook-554 and Pohjonen to teach each and every element of claim 16; hence claim 16 is not obvious under Ground 1.

3. Ground 2: Claim 17 is not obvious over Cook-554

119. Petitioner's case for the obviousness of claim 17 under Ground 2 relies on, among other things, the "capacitor bank" of Cook's "power bridge". (See, e.g., Pet. 38). As I have explained previously, in the field of circuits and electronics, a "capacitor bank" has a special meaning and is not the same thing as the claimed "network of capacitors". As noted above, Petitioner attempts to argue that Cook-554 discloses the claimed "network of capacitors", but this argument rests solely on Cook's capacitor bank 1600 in Fig. 16. No other capacitor banks are disclosed in

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Cook-554. As I have explained previously, Cook's capacitor bank, shown again below, is the electronic equivalent of a single adjustable capacitor:



Cook's bank of switched capacitors = Single variable capacitor

120. As explained above (*see par. 56 supra*), the capacitor bank of Fig. 16 in Cook-554 has a structure that is different from that of the network of capacitors described in the '719 patent. As I also explained previously, a POSA would have understood that a network of capacitors provides two or more degrees of freedom for impedance matching, whereas a capacitor bank only has one degree of freedom for setting a resonant frequency. Each embodiment of a network of capacitors in the '719 patent is "a circuit topology of passive components including one or more capacitors that provides two or more degrees of freedom". The capacitor bank of Cook-554 does not meet these criteria, and it is used only for tuning the resonant frequency of the resonator. Given the disclosure of only the capacitor of Fig. 16 in Cook-554, a POSA would have understood the tuning and matching networks in

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Cook-554 Figs. 1, 2, 3, 13, and 15 to contain a single variable capacitor in the form of a switched- capacitor bank.

121. Irrespective of the lack of any network of capacitors in Cook-554, the circuit claimed in Claim 16 of the '719 patent requires that a network of capacitors be part of the resonator. The tuning network of the transmit power converter in Cook-554, (even though the switched capacitor bank is not a network of capacitors) does not form an impedance-matching network for the multi-turn loop. In the '719 patent, this function is performed by a network of capacitors. Said another way, the tuning network 1350 in Fig. 13 (yellow, below) resides inside the transmit power converter 1300 (red), and not in the Transmit Antenna Unit 1310 (blue). Thus, even if the Tuning Network could be interpreted as a "network of capacitors", it is not part of the resonator, as claim 17 requires: "...at least one of the resonators includes a coil of a plurality of turns of a conducting material connected to a network of capacitors." ('719 patent, claim 17). No such connection is shown in Cook-554 Fig. 13.

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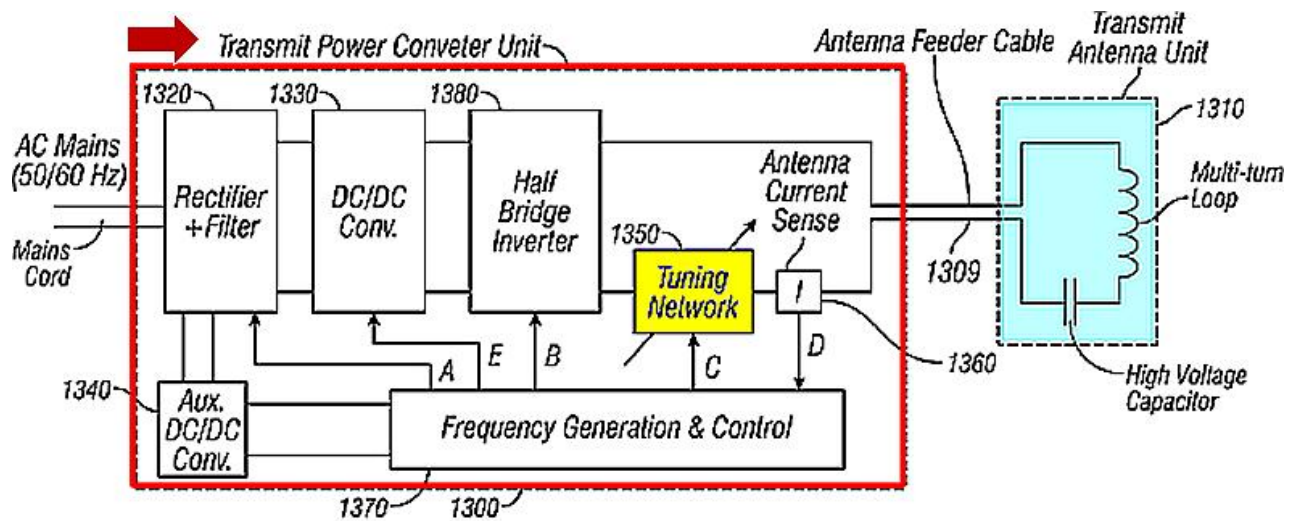


FIG. 13

Cook-554 Fig. 13, annotated

122. Similarly, the tuning and matching network 1530 on the receiver end in Cook-554 Fig. 15 (below, yellow), resides in the Receive Power Converter Unit 1510, and is not part of the Receive Antenna Unit 1310 (blue). Thus, again, the circuit of Fig. 15 fails to meet the “at least one of the resonators includes a coil of a plurality of turns of a conducting material connected to a network of capacitors” requirement.

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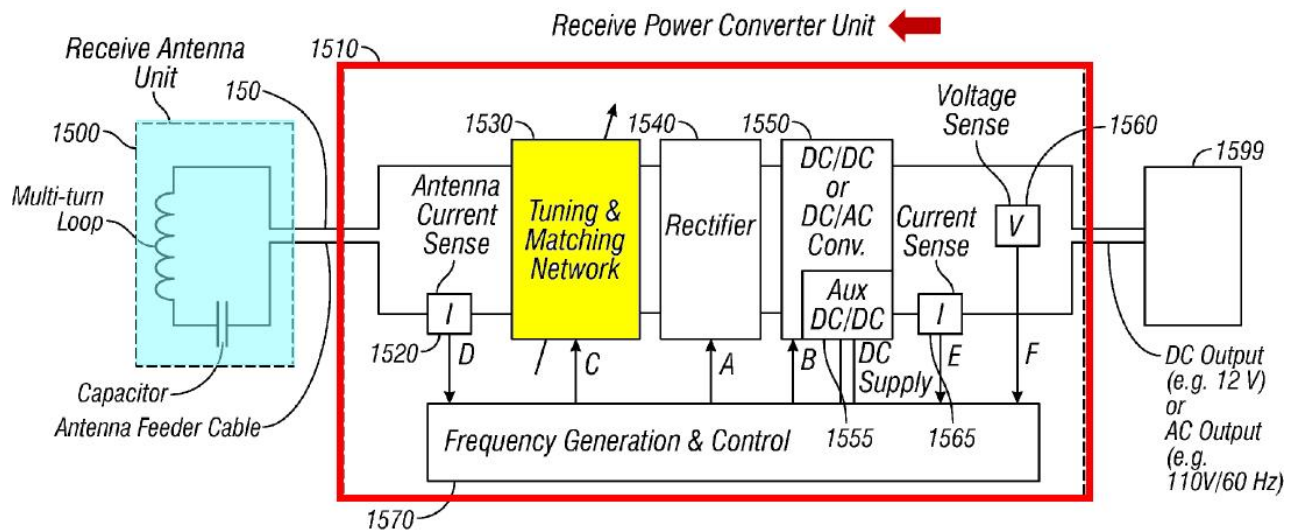


FIG. 15

123. Given all of the above, and especially in consideration of the absence of a network of capacitors in Cook-554, it is my opinion that Petitioner has failed to show invalidity of '719 claim 17 under Ground 2.

4. **Ground 3: Claim 16 is not obvious over Cook-523 and Pohjonen**

124. Ground 3 relies on the combination of Cook-523 with Pohjonen. As was the case with Ground 1, it is again my opinion that Petitioner has failed to provide adequate motivation for combining Cook-523 with Pohjonen. Cook-523 discloses many of the same features found in Cook-554, and Petitioner has again used these features in an attempt to show the invalidity of claim 16 under Ground 3 using this prior-art combination. As discussed in the context of Ground 1, however, Pohjonen relates to wireless communication via far-field radiation, not to resonant

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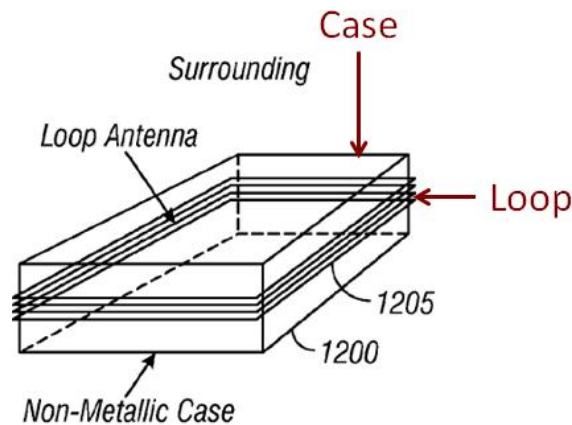
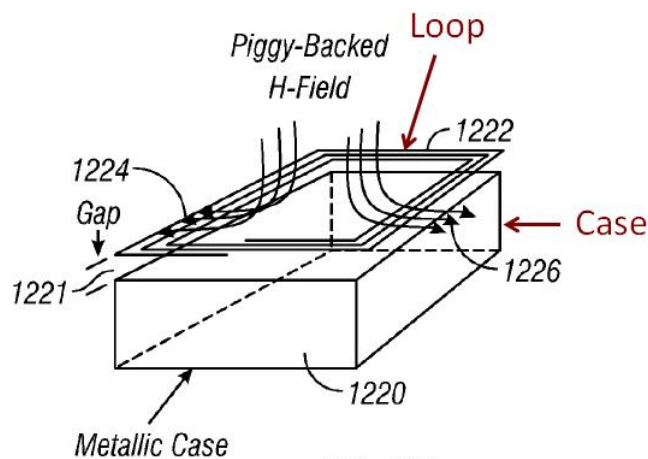
power transfer via the near field. Thus, for the same reasons that I articulated in my discussion of Ground 1, I do not believe a POSA considering Cook-523 would have looked to Pohjonen.

125. As also is the case with Cook-554 in Ground 1, Cook-523 teaches a resonator “integrated” with a portable device. Unlike the ’719 patent, Cook-523 does not teach or suggest a resonator surrounded by a low loss-tangent material. Rather, Cook-523 discloses an antenna integrated with a portable device having a non-metallic case (see FIG. 12A below), but instead of enclosing the antenna, the antenna surrounds the non-metallic case. This is the *opposite* of a non-metallic case enclosing the antenna. Specifically, Cook-523 discloses “a non-electrically conductive housing 1200” and “loop antenna 1205 surrounding the perimeter of the case and touching that perimeter.” (Cook-553, 13:19-21). This arrangement can be seen in Fig. 12A, shown below. To the extent that antenna 1205 may be a resonator (Cook-554 makes no mention of this), loop 1205 is *not* surrounded by the non-metallic case. Rather, the loop is wound around the exterior of the case. Thus, loop 1205 is indeed integrated with, but is not enclosed in, a non-metallic case.

126. Alternatively, in Cook-523 Fig. 12B, shown below, loop 1222 lies on top of the metal case 1220 but is not enclosed in the case; moreover, the case is not a dielectric having a low loss tangent. The same is true for Fig. 13A. In Fig. 12C,

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“deployable loop antenna” 1242 lies on top of clamshell 1240, but is not enclosed in the case, which in any case is not a dielectric having a low loss tangent.

**FIG. 12A****FIG. 12B**

Cook-523, Figures 12A and 12B, annotated.

127. In Fig. 13B, shown below, Cook-523 discloses an arrangement wherein a resonator is inside a metallic case. This case, however, does not *enclose* the antenna coil 1350 via metallic case 1355, because the case shown has open ends and an open gap on the top. These openings are included in the case for, respectively, the

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end fields of the ferrite rod, and “an area through which magnetic field H is received” (Cook-523, 13:44-45).

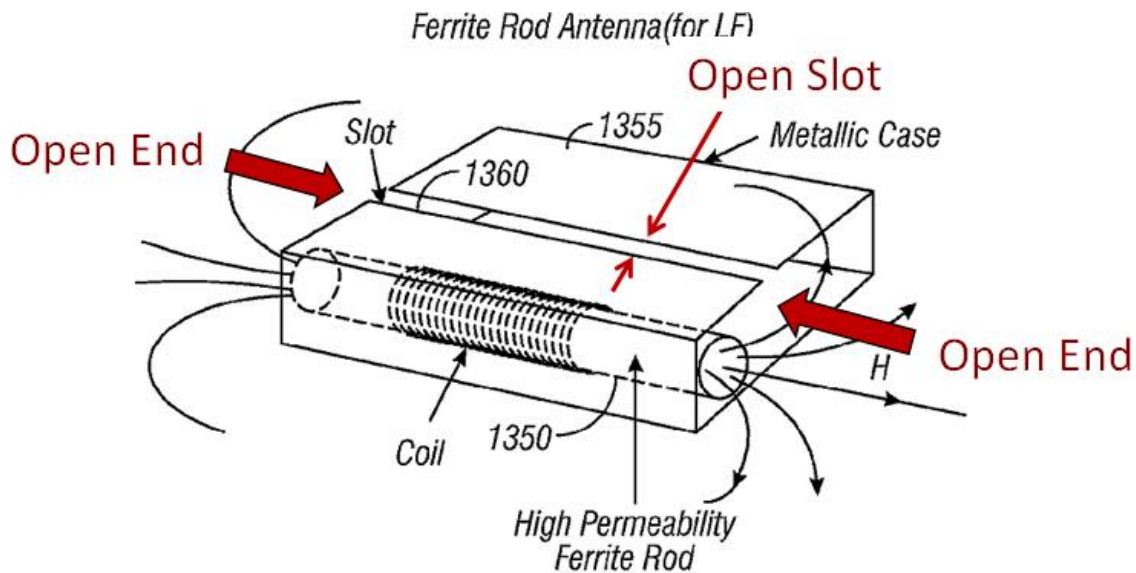


FIG. 13B

Cook-523, Figure 13B, annotated.

128. Petitioner also states that a POSA would have been motivated to enclose Cook-554's resonator in a portable device in a low loss tangent material “because it would protect Cook-554's second resonator from damage during manufacturing or use while maintaining antenna efficiency.” (Petition, p. 55). In my opinion, this argument is overly broad and is presented without sufficient reasoning and or rational underpinning to support the conclusion.

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129. As I explained in my critique of Ground 1, Petitioner's stated motivation again fails to recognize the more complex tradeoff between various factors in the design of an outer cover of a portable device, at least some of which would have led a POSA away from an attempt to surround the resonator in Cook-523 with low loss-tangent material.

130. Moreover, Petitioner's stated motivation fails to explain why a POSA would have wanted to "enclose" the second resonator with a low loss-tangent material, as required by '719 claim 16. In actuality, Cook-523 teaches an embodiment in which a resonator resides in the midst of the case structure but is not enclosed by the metallic case, especially at the open slot and the ends of the case where the field lines exit.

131. For all the above reasons, it is my opinion that Petitioner has failed to show, via Ground 3, that '719 claim 16 is obvious.

5. Ground 4: Claim 17 is not obvious over Lee and Cook-523

132. In making the case for obviousness in this ground, Petitioner again relies on the capacitor bank of Lee Fig. 12 in lieu of the requisite "network of capacitors".

133. In contrast to claim 17, the resonator in Fig. 12 of Lee does not include the capacitor bank. As I have previously explained, Lee discloses a secondary unit

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that includes a receiving coil and a main capacitor that form an LC network, and that includes a switched capacitor bank. A POSA would understand that the LC network in Lee is the resonator in the secondary unit, and that the resonator does not include the capacitor bank.

134. As I have also previously explained, Lee discloses a switched bank of capacitors in parallel that functions as one single, variable capacitor. The latter is significantly different from the claimed “network of capacitors”.

135. Lee also teaches that the secondary unit shown in Figs. 12 and 13 includes a receiving coil connected to a main capacitor and the bank of switched capacitors. I have previously discussed how this capacitor bank arrangement works, and why Lee's capacitor bank is the electrical equivalent of a single, variable capacitor used for tuning the resonant frequency. Additionally, I have explained why the main capacitor and the switched-capacitor bank in Lee do not comprise the “network of capacitors” required of '719 claim 17. Specifically, the main capacitor and bank of switched capacitors in Lee do not two or more degrees of freedom in terms of capacitor adjustments. The circuitry in Lee does not meet the definition and function of the claimed “network of capacitors”.

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VI. CONCLUSION

136. For the reasons set forth above, it is my opinion that the prior art cited by Petitioner does not render obvious claims 16 and 17 of the '719 Patent.

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



Dr. Mark N. Horenstein