

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re *Inter Partes* Review of:)
U.S. Patent No. 10,027,184)
Issued: Jul. 17, 2018)
Application No.: 15/170,397)
Filing Date: Jun. 1, 2016)

For: **Foreign Object Detection in Wireless Energy Transfer Systems**

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 10,027,184**

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1004	Curriculum Vitae of Mark Allen (“Allen CV”)
1005	U.S. Patent Application Publication No. 2010/0084918 A1 (“Fells”)
1006	U.S. Patent Application Publication No. 2009/0299918 A1 (“Cook”)
1007	U.S. Patent No. 6,075,433 (“Ono”)
1008	Chwei-Sen Wang, <i>Design Considerations for Inductively Coupled Power Transfer Systems</i> (2004) (Ph.D. dissertation, University of Auckland) (“Wang Thesis”)
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1010	Declaration of Ingrid Hsieh-Yee in Support of Petition for <i>Inter Partes</i> Review (“Hsieh-Yee Decl.”)
1011	U.S. Patent No. 8,749,334 B2 (“Boys”)
1012	U.S. Patent No. 9,774,086 B2 (“Cook-086”)
1013	U.S. Patent Application Publication No. 2010/0109445 A1 (“Kurs”)
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1017	Exhibit 6 to Complaint: Claim Chart, <i>WiTricity Corp. v. InductEV, Inc.</i> , No. 2:23-cv-01099-CMR (E.D. Pa. Mar. 21, 2023), ECF No. 1-8 (“Complaint Chart”)
1018	D. Ferrazzin, et al., <i>Hall Effect Sensor-Based Linear Transducer</i> , Proceedings of the 1999 IEEE, Int’l Workshop on Robot and Human Interaction (IEEE, Sept. 1999), 219-224 (“Ferrazzin”)

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1019	A.W. Green & J.T. Boys, <i>10kHz Inductively Coupled Power Transfer – Concept and Control</i> , Power Electronics and Variable-Speed Drives, Conf. Pub. No. 399 (IEE, Oct. 26-28, 1994), 694-699 (“Green”)
1020	Aiguo Patrick Hu, <i>Selected Resonant Converters for IPT Power Supplies</i> (Oct. 2001) (Ph.D. dissertation, University of Auckland) (“Hu”)
1021	Byung-Song Lee & Kyung-Hee Han, <i>Modeling and Analysis of IPT System Used for PRT</i> , Proceedings of the Eighth International Conference on Electrical Machines and Systems – ICEMS 2005, vol. 1 (ICEMS, Sept. 27-29, 2005), 839-842 (“Lee”)
1022	James E. Lenz, <i>A Review of Magnetic Sensors</i> , Proceedings of the IEEE, vol. 78, no. 6 (June 1990), 973-989 (“Lenz”)
1023	Excerpts from <i>McGraw-Hill Dictionary of Scientific and Technical Terms</i> (6th ed. 2003)
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1025	Chwei-Sen Wang, et al., <i>Investigating an LCL Load Resonant Inverter for Inductive Power Transfer Applications</i> , IEEE Transactions on Power Electronics, vol. 19, no. 4 (IEEE, July 2004), 995-1002 (“Wang-IEEE”)
1026	Excerpts from <i>Wiley Electrical and Electronics Engineering Dictionary</i> (2004)
1027	William H. Wilkinson, <i>Integrated Hall Effect Sensor</i> , Journal of the Microelectric Engineering Conference, vol. 3, iss. 1, art. 37 (1989), 215-220 (“Wilkinson”)
1028	Larry Dickerman & Jessica Harrison, <i>A New Car, A New Grid</i> , IEEE Power & Energy Mag. (Mar./Apr. 2010), 55-61 (“Dickerman”)
1029	U.S. Patent Application Publication No. 2010/0277121 A1 (“Hall”)
1030	RESERVED

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1031	SAE International, <i>SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler</i> , J1772 (rev. Jan. 2010) (“SAE Standards”)
1032	Excerpt from Frederick Emmons Terman, <i>Electronic and Radio Engineering</i> (4th ed. 1955) (“Terman”)
1033	Claire Weiller, <i>Plug-in Hybrid Electric Vehicle Impacts on Hourly Electricity Demand in the United States</i> , Energy Policy 39 (2011), 3766-3778 (“Weiller”)

I. Introduction

InductEV Inc. (“Petitioner”) requests *inter partes* review of claims 1-13 and 16 of U.S. Patent No. 10,027,184, titled “Foreign Object Detection in Wireless Energy Transfer Systems” (“’184 patent”) (Ex. 1001). According to USPTO records, the ’184 patent is assigned to WiTricity Corporation.

The challenged claims of the ’184 patent recite a “wireless energy transfer system” that transfers energy using “resonator[s],” and includes a “foreign object debris detection system” utilizing “magnetic field sensor[s].” *E.g.* ’184 patent cl. 1. None of these techniques were new. The ’184 patent concedes that wirelessly transferring energy could be accomplished using a “variety of known ... techniques,” including “an oscillating magnetic field between two coupled resonators.” *Id.* 1:20-53. It further concedes that nearly any type of known sensor, including “temperature sensors,” “electric field sensors,” “magnetic field sensors,” “weight sensors,” “pressure sensors,” or “optical sensors,” could be used to detect foreign objects. *Id.* 7:60-8:4.

Unsurprisingly given these admissions, the challenged claims are invalid. Prior to the ’184 patent, Fells (Ex. 1005) taught a wireless energy transfer system that detects foreign objects, and wirelessly charged a portable device using resonators when “no foreign objects [are] present,” meeting every limitation of challenged claims 1, 8, and 11. Fells [0191]. Certain claims further recite charging

a “vehicle,” but this too was well-known, as Cook (Ex. 1006) had already detailed using magnetically coupled resonators to wirelessly charge electric vehicles.

The remaining challenged claims recite trivial modifications of this same concept, such as specifying that foreign object detection or similar “status checks” should occur at various times including before the electric vehicle is in place (cl. 4), prior to beginning charging (cls. 3, 7, 8), or during charging (cls. 1, 16). Each of these would have been obvious prior to the ’184 patent — as would add-ons like an “enclosure” (cl. 12) — as they were well-known methods of preventing interference by foreign objects in a wireless charging system.

Accordingly, the Board should institute review and find all challenged claims unpatentable.

II. Identification of Challenges (37 C.F.R. § 42.104(b))

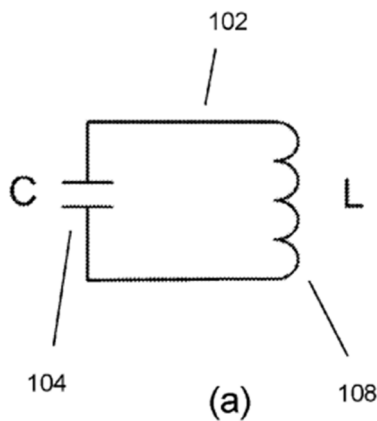
- Ground 1: Claims 1, 8, and 11 are unpatentable under 35 U.S.C. § 103 over Fells.
- Ground 2: Claims 2-7, 9-10, and 16 are unpatentable under 35 U.S.C. § 103 over Fells in view of Cook.
- Ground 3: Claim 12 is unpatentable under 35 U.S.C. § 103 over Fells alone or in view of Ono.
- Ground 4: Claim 13 is unpatentable under 35 U.S.C. § 103 over Fells in view of Cook and/or Wang Thesis.

III. Background

A. The '184 Patent (Ex. 1001)

The '184 patent relates to “wireless energy transfer and methods for detecting foreign object debris (FOD) on wireless power transmission systems.” '184 patent 1:16-19. The '184 patent does not purport to have invented any new type of wireless energy transfer, admitting that power can be transferred wirelessly using a “variety of known radiative, or far-field, and non-radiative, or near-field, techniques” including an “energy transfer source configured to generate an oscillating magnetic field,” such as a resonator. *Id.* 1:20-35, 2:45-47; Allen Decl. (Ex. 1003) ¶¶45-46.

Because such resonators were well-known, the '184 patent does not describe their construction or provide exemplary circuit diagrams, but incorporates by reference earlier patents explaining that a “resonator” can be, *inter alia*, “a capacitively-loaded inductor loop” as shown below.



Kurs (Ex. 1013) Fig. 6, [0030], [0135] (Fig. 6a shows “circuit model of electromagnetic resonator”), [0085]; ’184 patent 1:20-35 (incorporating Kurs by reference); Allen Decl. ¶¶54-57 (explaining resonators).

When power is transferred wirelessly “between two coupled resonators,” foreign objects located between the resonators may undesirably disrupt the wireless energy transfer, and the objects may heat or combust. ’184 patent 1:36-53, 2:1-13. To avoid such disruption, systems may turn off or otherwise limit the wireless power transfer upon detecting the presence of foreign objects. *Id.* 1:41-53; Allen Decl. ¶¶47-48.

The ’184 patent describes two ways of “detecting or mitigating the effects of FOD [foreign object debris] in the vicinity of the wireless energy transfer system.” *Id.* 2:14-16, 3:32-46. First, “passive mitigation techniques” may simply constitute placing a “cover” around the system to “keep FOD from entering the regions between resonators.” *Id.* 3:32-46.

Second, “active mitigation” techniques may measure “perturbations in the magnetic field” around the resonators using “sensors and/or gradiometers” that are “positioned in the magnetic field.” *Id.* 2:20-26, 4:33-38. The ’184 patent does not purport to have invented a new type of sensor, conceding that foreign object detection can be accomplished with “any combination of sensors,” including known “temperature sensors,” “electric field sensors,” “magnetic field sensors,” “weight

sensors,” “pressure sensors,” or “optical sensors.” *Id.* 7:60-8:4; Allen Decl. ¶¶49-53. The sensors may comprise “loops of wire” that “develop an oscillating voltage in the presence of an oscillating magnetic field,” such that a “read out amplifier” can detect “non-uniform” voltage across the loop, indicating the presence of a foreign object in the magnetic field. ’184 patent 2:26-34, 8:6-21. The system can then “decide whether to turn down or shut down the system if FOD is detected.” *Id.* 11:38-39.

The ’184 patent states that foreign object detection can be applied to electric vehicle charging, and can be repeated at various stages including (1) “without the vehicle present”; (2) “after the vehicle arrives” but before charging; and (3) “[d]uring ... charging.” *Id.* 11:22-50.

B. Prosecution History

The ’184 patent issued on July 17, 2018, from an application filed on June 1, 2016, and purports to claim priority to non-provisional application No. 13/608,956 filed on September 10, 2012, as well as provisional application No. 61/532,785 filed on September 9, 2011.

As detailed below, none of the prior art used in this petition was substantively discussed by the Examiner or Patent Owner during prosecution, and none of the combinations of references put forth in this petition were considered by the Examiner. *See generally* ’184 FH (Ex. 1002).

C. Person of Ordinary Skill in the Art

A person of ordinary skill in the art (“POSA”) at the time of the earliest claimed priority date (September 2011) would have had at least a bachelor’s degree in electrical engineering, microelectronics, or equivalent, and at least two to three years of industry or research experience. Allen Decl. ¶¶39-44. This description is approximate, and a higher level of education or skill might make up for less experience, and vice-versa. The grounds in this petition do not turn on this specific definition; the challenged claims are unpatentable from the perspective of any reasonable level of ordinary skill. *Id.*

D. Claim Construction

The prior art relied on in this petition discloses the subject matter of the challenged claims under any reasonable construction, including their plain meaning.¹ Allen Decl. ¶¶62-63.

IV. Ground 1: Claims 1, 8, and 11 Would Have Been Obvious Over Fells

Fells teaches every element of claims 1, 8, and 11. Out of an abundance of caution, Petitioner explains how certain elements would have been obvious even if they were not taught by Fells, and therefore styles this ground under 35 U.S.C. § 103.

¹ Petitioner reserves the right to argue alternative constructions in other proceedings, and where such a defense is available, that the claims are indefinite.

Realtime Data, LLC v. Iancu, 912 F.3d 1368, 1373 (Fed. Cir. 2019) (“anticipation is the epitome of obviousness.”).²

A. Fells (Ex. 1005)

U.S. Patent Application Publication No. 2010/0084918 (“Fells”) is prior art under pre-AIA 35 U.S.C. § 102(a), (b), and (e) because it was filed on October 2, 2009 and published on April 8, 2010.

During prosecution, the patent that issued from the Fells application (U.S. 8,446,046) was listed among more than 900 references submitted by Patent Owner in a single information disclosure statement. *See* ’184 FH 55-93. Neither Fells nor its issued patent, however, were discussed by the Examiner or Patent Owner.

Like the ’184 patent, Fells is directed to a “wireless power system.” Fells [0001], [0006]. In particular, Fells describes a “wireless power supply” that uses a resonator formed of a “primary coil” connected to “a capacitor” to wirelessly transfer power to a “portable device.” Fells [0191]; Allen Decl. ¶¶66-71 (providing overview of Fells). The power supply includes a “sense circuit” that “detects when an object is placed in (or removed from) the proximity of the wireless power supply,” and in response, closes a switch “allowing the circuits in the wireless power supply 200 to

² Unless otherwise stated, all emphases herein are added and internal quotation marks, citations, and footnotes are omitted.

receive power.”³ Fells [0191]. A “control element” of the power supply then determines “i) whether there is a valid device present, ii) if there is a valid device whether it desires power, [and] iii) whether there is a foreign object present.” *Id.* “If there is a valid device requiring power” and there are “no foreign objects present,” the “control unit 208 will activate the inverter 210 to supply current to the tank circuit, which includes the primary coil 212 and capacitor 214, to deliver power to the portable device.” *Id.*

B. Independent Claim 1

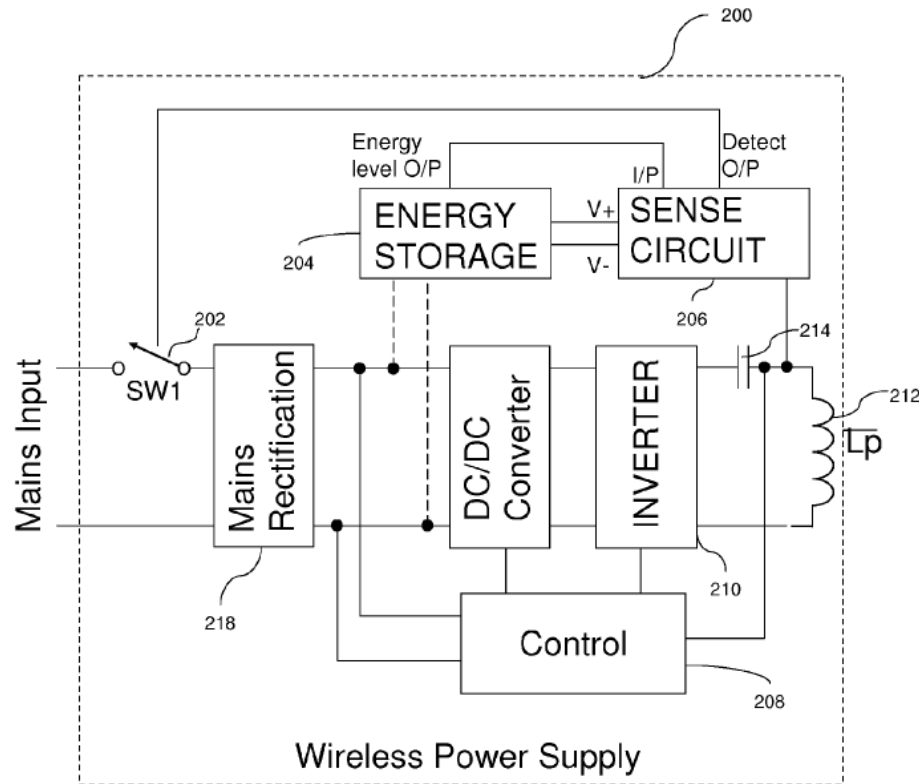
1. Element 1[pre]: Preamble

Claim 1’s preamble recites “[a] wireless energy transfer system with foreign object debris detection, the system comprising....” To the extent the preamble is limiting, Fells discloses it. Allen Decl. ¶¶96-101.

Fells, titled “Power System,” describes a “wireless power supply” that “deliver[s] power” to a “portable device,” while detecting whether “there is a foreign object present.” Fells Title, [0191]; Allen Decl. ¶¶66-71, 97-101. The wireless power supply comprises “a capacitor [214] ... a primary coil [212] ... and a control unit [208],” as well as a “sense circuit [206],” as shown below.

³ Throughout this petition, capitalization is normalized when quoting from Fells.

Fig. 2



Fells Fig. 2, [0191]; Allen Decl. ¶¶98.

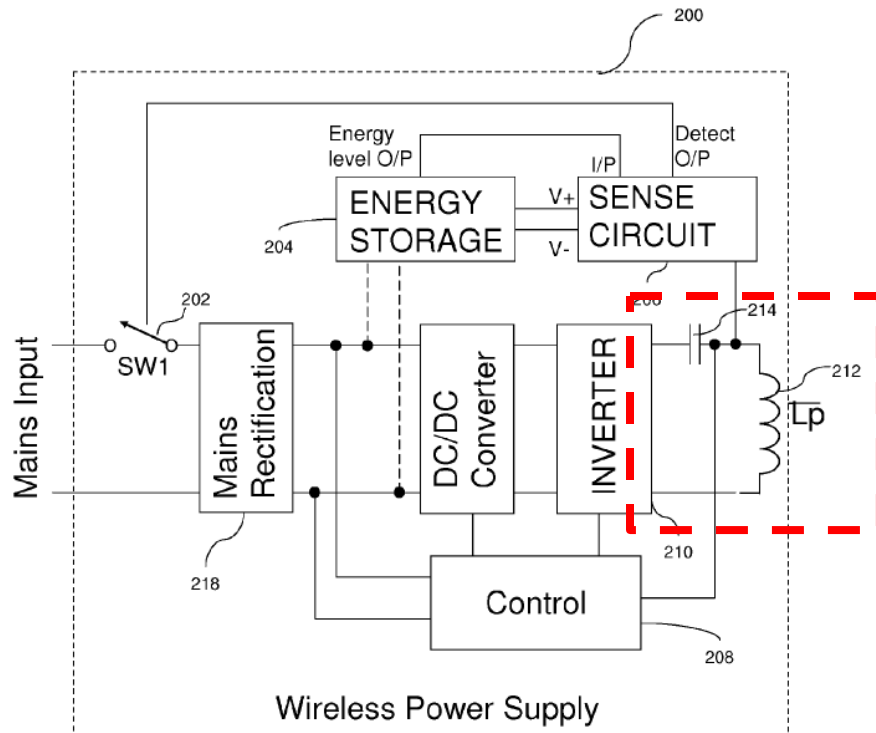
In operation, the sense circuit “detects when an object is placed in (or removed from) the proximity of the wireless power supply,” and the control element then “determines i) whether there is a valid device present, ii) if there is a valid device whether it desires power, [and] iii) whether there is a foreign object present.”). Fells [0191]; Allen Decl. ¶¶100-101. If “no foreign objects [are] present,” the control unit will “supply current to the tank circuit, which includes the primary coil 212 and capacitor 214,” which then wirelessly “deliver[s] power to” a “portable device.” Fells [0191]; Allen Decl. ¶¶100-101.

2. Element 1[a]: Source Resonator

Fells discloses “a wireless energy transfer source comprising a source resonator configured to generate an oscillating magnetic field.” Allen Decl. ¶¶102-111.

Fells’ “wireless power supply 200” corresponds to the claimed “wireless energy transfer source.” Fells [0191], Fig. 2; Allen Decl. ¶103. The wireless power supply includes a source resonator circuit formed by “capacitor 214” connected to an inductor, “primary coil 212,” as shown in the annotated box below:

Fig. 2



Allen Decl. ¶103 (annotating Fells Fig. 2); Fells [0191].

Fells explains that “primary coil 212 and capacitor 214” together form a “tank circuit,” which a POSA would have understood is a resonator. Fells Fig. 2, [0191], [0198]; Allen Decl. ¶¶103-108; *see also McGraw-Hill Dictionary* (Ex. 1023) 2101 (“tank circuit” is “[a]lso known as electrical resonator”); *Wiley Dictionary* (Ex. 1026) 771 (defining “tank circuit” as “[a] resonant circuit”); Pernia (Ex. 1015) 17:66-18:4 (“inductance in series with a capacitance” is a “resonant LC tank”); McCorquodale (Ex. 1014) at 2:51-63, 18:18-35 (describing “an inductor (L) and a capacitor (C) coupled to form an LC-tank” as a “resonator”). This understanding is confirmed by Fells, which refers to capacitor 214 as a “resonant capacitor,” and describes “primary coil 212” along with a capacitor together as a “resonant LC tank.” Fells [0206], [0198].⁴

⁴ The specific phrase “resonant capacitor” and “resonant LC tank” appears in a discussion of the capacitor 214 and primary coil Lp 212 in Figures 5 and 30. Fells [0198]-[0200], [0273]. A POSA would understand that description applies equally to the capacitor 214 and primary coil Lp 212 in Figure 2 and other figures where those components appear in the same arrangement, because “[l]ike reference numerals are used throughout [Fells’] figures to designate similar components.” Fells [0190]; Allen Decl. ¶108.

Fells' tank circuit resonator is driven by alternating current supplied by the inverter. Fells Fig. 2, [0189] ("The inverter 110 generates an AC voltage which is applied to the tank circuit"), [0191] (same), [0108] (confirming that "mains" is AC); Allen Decl. ¶109; *see also* Wiley (Ex. 1026) 391 (defining "inverter" as "chang[ing] a DC voltage to an AC voltage"). If a valid device requires power, and there are no foreign objects present, the control unit "will activate the inverter 210 to supply current to the tank circuit, which includes the primary coil 212 and capacitor 214, to deliver power to the portable device." Fells [0191]; *see also id.* [0192] (describing power provided to portable device), [0195] (same), [0248] (same); Allen Decl. ¶109.

A POSA would have understood that when Fells' tank circuit resonator receives alternating current from the inverter and "deliver[s] power to the portable device," it does so by generating an oscillating magnetic field. Fells [0191], Fig. 2, [0295] (Fells "generate[s]" ... "magnetic field"); Allen Decl. ¶¶110-111. That is the nature of an inductor: passing alternating current through an inductor (primary coil 212) produces an oscillating magnetic field. Allen Decl. ¶¶110-111 (explaining how inductors generate magnetic fields); Nilsson (Ex. 1024) 186 ("The behavior of inductors is based on phenomena associated with magnetic fields. The source of the magnetic field is charge in motion, or current. If the current is varying with time, the magnetic field is varying with time."). This oscillating magnetic field is what allows Fells' portable device to wirelessly receive power from the tank circuit

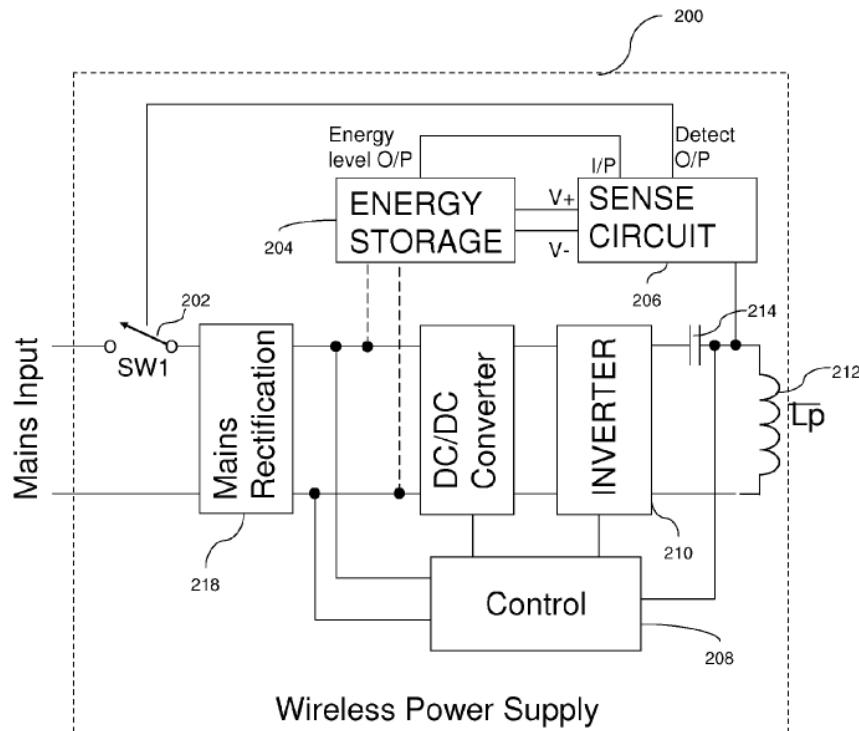
resonator. Fells [0189]-[0191]; Allen Decl. ¶¶110-111. The “Background” section of the ’184 patent confirms the same: known “wireless charging systems” between “two coupled resonators” operated by use of an “oscillating magnetic field.” ’184 patent 1:36-41.

3. Element 1[b]: Foreign Object Detection

Fells discloses “a foreign object debris detection system.” Allen Decl. ¶¶112-115.

Fells’ “sense circuit,” “control element,” and related circuitry correspond to the claimed “foreign object debris detection system.” Fells [0191]; Allen Decl. ¶¶113.

Fig. 2



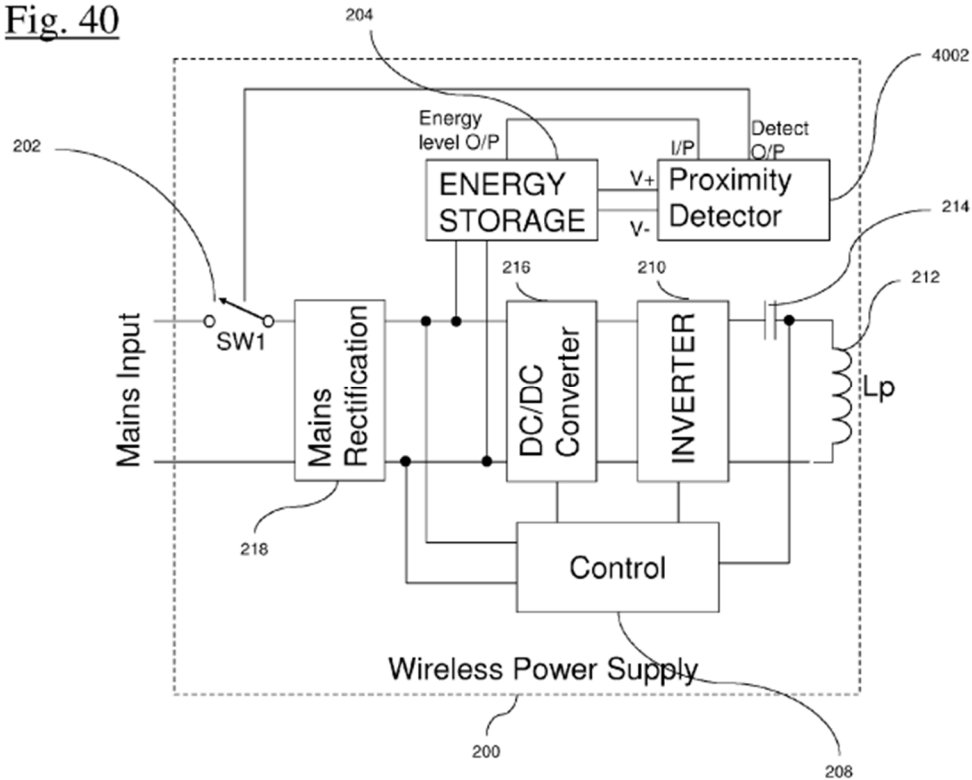
Fells Fig. 2. The sense circuit “detects when an object is placed in (or removed from) the proximity of the wireless power supply.” *Id.* [0191]; *see* Fells [0192]-[0195] (further describing detection). When detected, a switch “is closed allowing the circuits in the wireless power supply 200 to receive power.” *Id.* The control element then determines (1) “whether there is a valid device present”; (2) if so “whether [the device] desires power”; and (3) “whether there is a foreign object present.” *Id.* If “there is a valid device requiring power and no foreign objects present,” the control unit “activate[s] the inverter 210 to supply current to the tank circuit ... to deliver power to the portable device.” *Id.*; Allen Decl. ¶¶114-115.

4. Element 1[c]: Magnetic Field Sensor

Fells discloses “at least one magnetic field sensor.” Allen Decl. ¶¶116-121.

Specifically, Fells discloses that sense circuit 206 of the wireless power supply can “act[] as a proximity detector,” as shown below in Fig. 40. Fells [0288]; Allen Decl. ¶117.

Fig. 40



Fells Fig. 40; *id.* [0182] (“Fig. 40 shows an embodiment of Fig. 2 using a proximity sensor”); Allen Decl. ¶118 (explaining that Fig. 40 is the same circuit as Fig. 2). The proximity detector “detect[s] that a device or foreign object has been placed in the vicinity of the wireless power supply 200.” Fells [0288].

The proximity detector can be constructed using “any ... sensor capable of detecting [the] presence of an object,” including a “Hall Effect sensor” or “an inductive proximity sensor.” Fells [0289]-[0290], cl. 11 (“detecting a change in magnetic field indicative of presence of an object”). Each of these sensors discloses the claimed “magnetic field sensor.” Allen Decl. ¶¶119-121.

First, Fells' "proximity detector" may be a "Hall effect sensor," which senses "a change in magnetic field" and produces "a change in voltage in response." Fells [0289]-[0290]. A POSA would have recognized a "Hall effect sensor" as a well-known type of magnetic field sensor. Allen Decl. ¶120; *see* Ferrazzin (Ex. 1018) 219 ("A Hall effect sensor is essentially a transducer that responds with an output voltage proportional to the local magnetic field"); Wilkinson (Ex. 1027) 215 ("Hall Effect sensors . . . produce a voltage proportional to the magnetic field through the circuit."); Lenz (Ex. 1022) 973, 979-980 (listing Hall effect sensor among "the most common technologies used for magnetic field sensing").

Second, Fells' "inductive proximity sensor" can be "formed using another coil in the wireless power supply 200 which is independent of the coil used to transfer power." Fells [0288]-[0289], [0291] (an "inductance bridge"). A POSA would have understood that a coil used as an "inductive proximity sensor" is a magnetic field sensor, as inductors respond to changes in magnetic fields. Allen Decl. ¶121; *see generally* Nilsson 186 ("The behavior of inductors is based on phenomena associated with magnetic fields."). Sensing the change in magnetic field through this "inductive proximity sensor" is what allows the proximity detector to "detect[] that a device or foreign object has been placed in the vicinity," as well as detecting if the foreign object "is removed." Fells [0288]-[0289]; Allen Decl. ¶121. This aligns with the description of magnetic field sensors in the '184 patent: "sensors ...

may comprise loops of wire ... that generate an electrical signal proportional to the amount of magnetic flux crossing its surface.” ’184 patent 2:20-42; Allen Decl. ¶121.

5. Element 1[d]: Readout Circuit

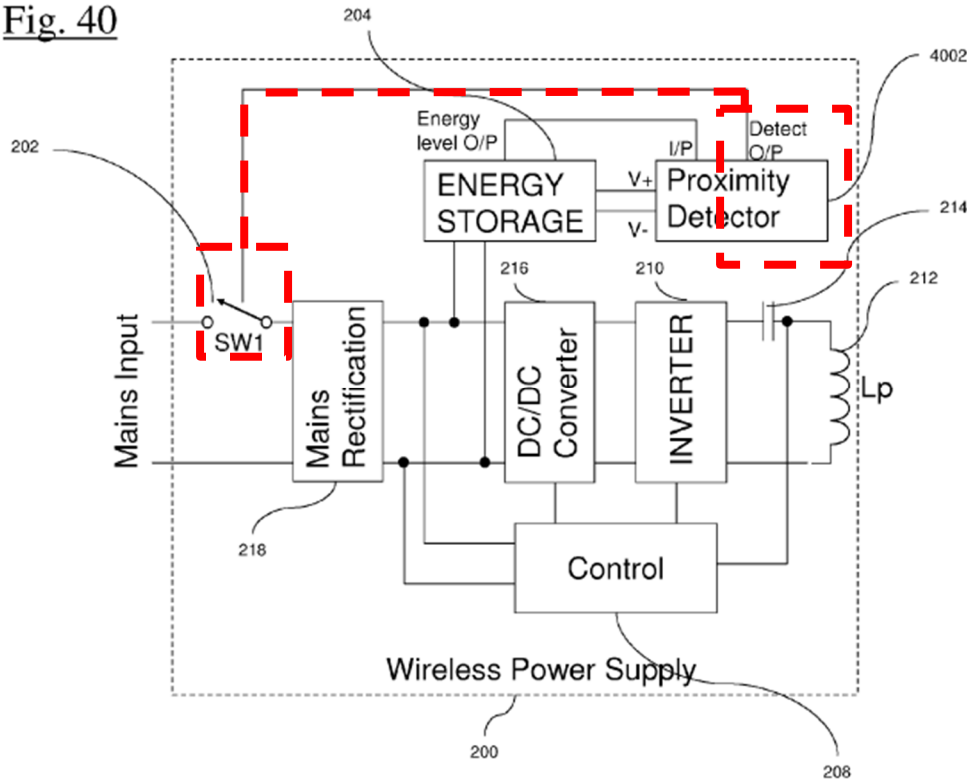
Fells discloses, or renders obvious, “at least one readout circuit configured to measure one or more electrical parameters of at the at least one magnetic field sensor.” Allen Decl. ¶¶122-129.

When Fells’ “sense circuit ... acts as a proximity detector,” the electrical parameters of the Hall effect sensor or inductive proximity sensor change in response to changes in the magnetic field. Specifically, for the Hall effect sensor, “there is a change in voltage” and for the inductive proximity sensor, there is a “change in inductance.” Fells [0288]-[0289], [0193]; Allen Decl. ¶123. A POSA would have understood that this voltage or inductance change (the claimed “electrical parameter”) is measured by circuitry (the claimed “readout circuit”), which uses the sensor’s voltage or inductance change to “detect” that “an object is placed in (or removed from) the proximity of the wireless power supply.” Fells [0191]; *see also id.* cl. 11 (“detecting includes ... detecting a change in magnetic field indicative of presence of an object”), cl. 56 (same); Allen Decl. ¶123.

For example, as shown below, the proximity detector generates an output signal (“Detect O/P”). The circuitry within the proximity detector that generates that

output signal, and/or the switch (“SW1”) that controls the circuit in response to that output signal, constitute readout circuitry.

Fig. 40



Id. ¶¶123-124 (annotating Fells Fig. 40); *see* Fells [0288]-[0289], [0191]. This is consistent with the ’184 patent, in which “readout circuitry” is any element that “measure[s] the voltage and/or the current” from sensors. ’184 patent 2:31-53; Allen Decl. ¶124.

The above is sufficient to demonstrate this claim element, which does not require any particular type of readout circuitry, but only that some such circuitry exists. A POSA would have further understood, however, that because the “proximity detector” is a “sense circuit,” it would be constructed with the same well-

known circuitry used to build the other sense circuits of Fells, such as a “comparator” or “microcontroller” that compares the output of the magnetic field sensor to a reference value. Fells [0289], [0258] (“The Fig. 2 embodiment includes ... a sense circuit 206 that includes an integrated microprocessor”), [0182] (Fig. 40 is further “embodiment of Fig. 2”); Allen Decl. ¶¶125-126; *see also* Fells Figs. 4-6 (showing circuitry configurations of sense circuit), [0197]-[0202] (describing same), [0257]-[0259] (same), [0263] (same).

To the extent not already taught in Fells, it would have been obvious for a POSA to implement Fells’ “proximity detector” by using an amplifier as a readout circuit to measure either the voltage change of the disclosed Hall effect proximity sensor, or the inductance change of the disclosed inductive proximity sensor, outputting the Detect O/P signal. Allen Decl. ¶¶127-129. Fells explains that “greater sensitivity” can be obtained in the sense circuit by “using amplifiers” or “higher voltage levels.” Fells [0266]. A POSA would have desired, and known how to, obtain this increased sensitivity in proximity detection by connecting an operational amplifier to the output of the proximity detector, resulting in “higher voltage levels.” Allen Decl. ¶128; *see* Fells [0288]-[0290], [0191]. By designing Fells’ “detection circuit” to monitor the output of the amplifier, rather than the output of the sensor itself, the circuit would detect foreign objects that otherwise would have been too small or distant to create a measurable voltage or inductance change in the absence

of the amplifier. Allen Decl. ¶¶128-129; Fells [0011]; *see id.* [0191] (describing that sense circuit “detects when an object is placed in (or removed from) the proximity of the wireless power supply”). Connecting amplifiers in this manner was within the skill of a POSA, as Fells describes the same arrangement in its other embodiments. Allen Decl. ¶129; Fells [0197]-[0202], [0257]-[0259], [0263], Figs. 4-6.

6. Element 1[e]: Position of Magnetic Field Sensor

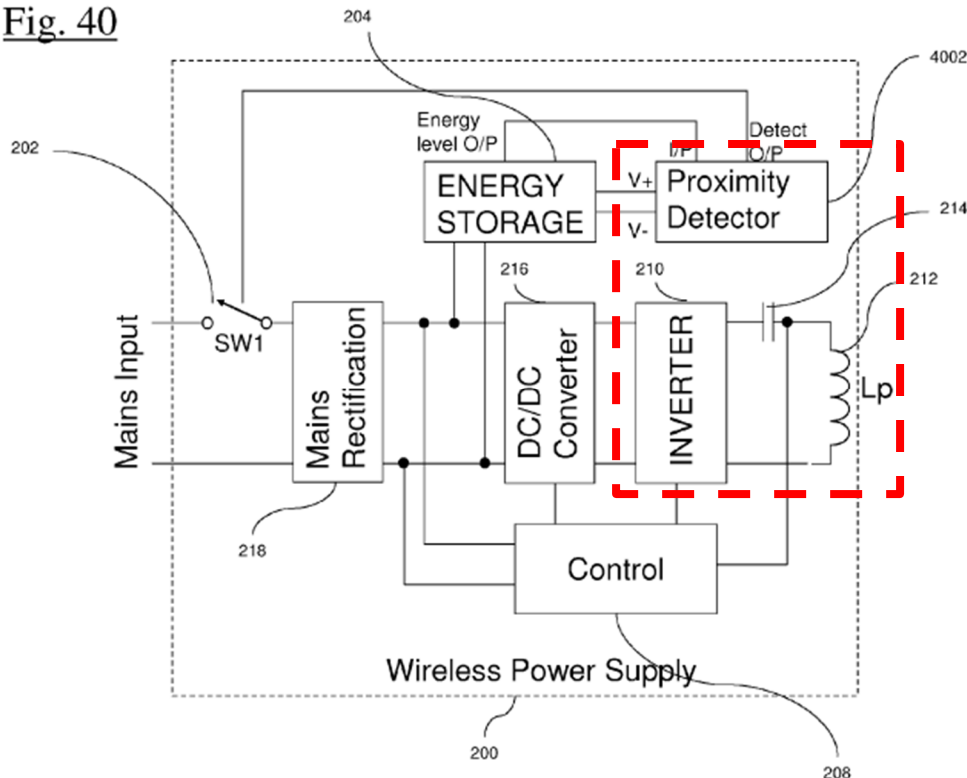
Fells discloses, or renders obvious, “wherein the at least one magnetic field sensor is positioned within the magnetic field of the wireless energy transfer system.” Allen Decl. ¶¶130-135.

Fells’ proximity detector operates by providing a “change in voltage [or inductance] in response to a change in magnetic field.” Fells [0289]. The position of the proximity detector is “within the magnetic field” as claimed because the detector’s ability to provide a “change in voltage in response to a change in magnetic field,” as Fells describes, requires that the detector be within the magnetic field. Allen Decl. ¶131. In other words, a POSA would have understood the Hall effect sensor produces the described “change in voltage ... in response to a change in magnetic field” because the sensor was within the magnetic field of the wireless energy transfer system. Allen Decl. ¶131; *see also McGraw-Hill* (Ex. 1023) (defining “Hall effect” as “[t]he development of a transverse electric field in a

current-carrying conductor *placed in a magnetic field*”). The same is true of the inductive proximity sensor, which a POSA would have understood detects the proximity of foreign objects because the sensor “coil” is placed within the magnetic field. Fells [0289]; Allen Decl. ¶131.

Fells’ diagrams confirm this understanding. As shown below, Fells’ proximity detector is located near to, and within the same circuit as, primary coil Lp 212 that produces the magnetic field, and therefore the sensors that make up the proximity detector will be within the magnetic field that emanates from the coil in order to detect foreign objects. Fells Figs. 40, 2 (also showing sense circuit located near to and within the same circuit as the primary coil); Allen Decl. ¶132.

Fig. 40



Allen Decl. ¶132 (annotating Fells Fig. 40).

Even aside from Fells' diagrams, a POSA would have understood from Fells' disclosure that its proximity detector is within the magnetic field generated by the primary coil – otherwise it would not be able to accomplish its stated purpose of detecting “foreign object[s]” in the “vicinity” of the wireless power supply. Fells [0288]; Allen Decl. ¶¶131-133. Specifically, one of the purposes of Fells' proximity detector is to detect foreign objects that “would get hot or hinder power transfer” if they are within the magnetic field generated by the primary coil. Fells [0002]. If the proximity detector was not also within the magnetic field generated by the primary coil — i.e., within the “proximity” of the primary coil — the detector would not be close enough to detect the concerning foreign objects. Allen Decl. ¶¶131-133.

To the extent Fells does not teach this, it would have been obvious in view of a POSA's knowledge to implement Fells such that its proximity detector is positioned within the magnetic field of its wireless power supply, for the same reasons explained above. Allen Decl. ¶135. The proximity detector detects foreign objects in its “proximity,” and its purpose is to prevent foreign objects from interfering with the transfer of power — which would occur if the foreign objects were within the magnetic field of the primary coil. Fells [0002], [0288]. Thus, to the extent not already taught in Fells, an obvious solution to ensure that all foreign objects are properly detected would have been to also place the proximity detector

within the magnetic field of the primary coil, so that it can detect foreign objects in this same region. Allen Decl. ¶135.

7. Element 1[f]: Verification of Foreign Object Debris

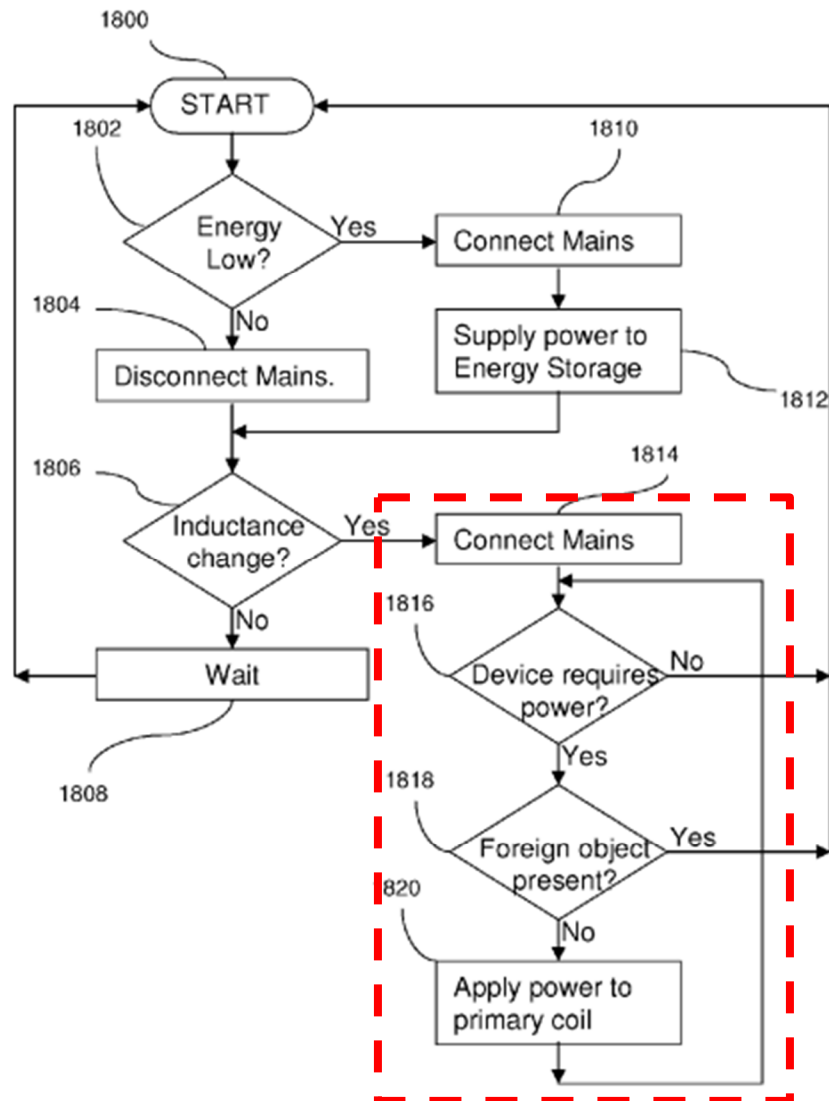
Fells discloses, or renders obvious, “wherein the foreign object debris detection system is configured to verify that foreign object debris has not moved onto or over the source resonator during generation of the oscillating magnetic field.” Allen Decl. ¶¶136-150.

As described for Element 1[b], Fells’ sense circuit and control circuit check whether “there is a valid device requiring power and no foreign objects present,” and if so, power is wirelessly transferred to the portable device. Fells [0191], *supra* Element 1[b]. The system is “able to work if both a foreign object and a valid device are placed at the same time,” or alternatively “if multiple foreign objects are placed at the same time but removed at different times and vice versa” — confirming that the system continually verifies that a foreign object has not been placed onto the resonator during transfer of power, i.e., during generation of the oscillating magnetic field as claimed. Fells [0195]; Allen Decl. ¶137.

Other portions of Fells confirm the same. For example, Figure 18 is an “example flow diagram of wireless power supply operation” and describes that “the system checks to see if there is a foreign object present 1818,” and if not, “the system delivers power to the primary coil 1820 to supply power to the portable device.”

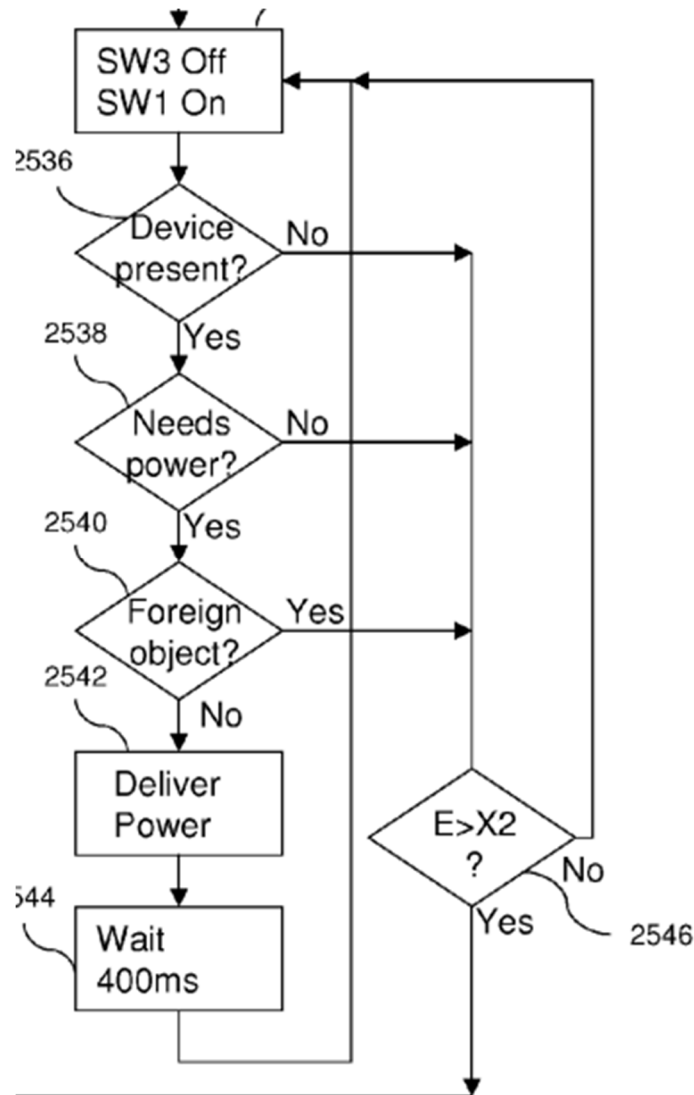
Fells [0160], [0248]. The system then “*continues to check* that the device is still requiring power 1816 and only goes back to the start 1800 when the device no longer requires power *or if a foreign object 1818 is placed on the wireless power supply.*” *Id.* [0248]. In other words, as shown below, the system enters a loop of continually checking for the presence of foreign objects (step 1818) while powering the primary coil to generate the magnetic field that charges the portable device (step 1820).

Fig. 18



Allen Decl. ¶139 (annotating Fells Fig. 18). Each check verifies that no foreign object is “present” “on” or “in proximity to” the resonator. Fells [0191]-[0194], [0248], Allen Decl. ¶140. This repeated checking continues until either a foreign object is detected, or the device no longer requires power. Fells Fig. 18, [0248]; Allen Decl. ¶¶138-140.

The “flow diagram of wireless power supply operation” of Figure 19 similarly discloses repeatedly “detect[ing] ... that there are no foreign objects present” while “deliver[ing] full power to the primary coil.” Fells [0161], [0250]-[0253], Fig. 19; Allen Decl. ¶141. Figure 25 shows the same: after “deliver[ing] power,” a check for “foreign object[s]” is made every “400ms” until either a foreign object is detected, the device is removed, or the device is fully charged. Fells Fig. 25, [0262]-[0263]; Allen Decl. ¶152.



Fells Fig. 25 (excerpted).

A POSA would have understood these teachings of repeatedly checking for foreign objects while delivering power to apply to Fells' proximity detector embodiment at least because the proximity detector embodiment is a particular hardware configuration for Fells' "wireless power supply," and Figures 18, 19 and 25 are exemplary flow diagrams of "wireless power supply operation" that a POSA would have understood could be applied. Fells [0160]-[0161], [0167], [0248]-

[0252], [0262]-[0263]; Allen Decl. ¶143. Additionally, Fells explains that Figure 18 “illustrat[es] the operation of an ultra low power system,” which a POSA would have found applicable to the “ultra low power” proximity detector embodiment. Fells [0248], [0182] (proximity detector is “an embodiment of Fig. 2”); [0144] (Fig. 2 is “an ultra low power wireless power supply”); Allen Decl. ¶143.

Moreover, Fells teaches that “foreign objects may be detected using a method disclosed in GB2414121,” which is incorporated by reference. Fells [0192]. That reference, Stevens (Ex. 1016), similarly teaches repeated checking for foreign objects during power generation, as shown below.

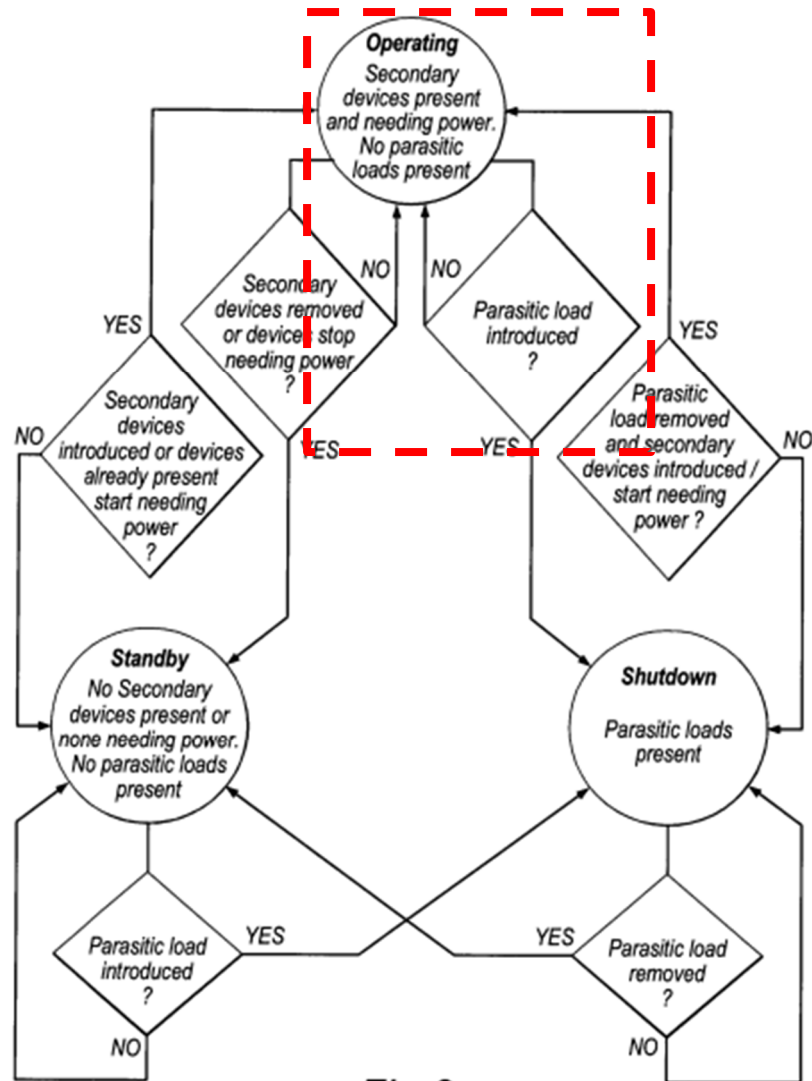


Fig 8

Allen Decl. ¶144 (annotating Stevens Fig. 8). While “[o]perating,” the system provides power to devices that are “present and need[] power,” so long as there are “[n]o parasitic loads present.” Stevens Fig. 8. Parasitic loads indicate the presence of “foreign objects.” *Id.* 2:18-20. While providing power, the system continually checks whether “[p]arasitic load [is] introduced” – i.e., whether a foreign object has been detected – and enters a “[s]hutdown” state if so. *Id.* Fig. 8. Because Stevens is incorporated by reference, Fells’ instruction to a POSA to use Stevens’ method of

continuous foreign object checking is “effectively part of [Fells] as if it were explicitly contained therein.” *Advanced Displays Sys., Inc. v. Kent State Univ.*, 212 F.3d 1272, 1282 (Fed. Cir. 2000). A POSA would have understood for this reason as well that Fells’ proximity detector embodiment checks for foreign objects during power supply. Allen Decl. ¶¶144-145.

To the extent not already taught in Fells, it would have been obvious to a POSA to implement Fells’ proximity detector embodiment in the manner described in Fells’ flow diagrams and in the incorporated Stevens reference – i.e. checking for foreign objects during charging, and shutting off the power transmission if a foreign object on or near the resonator is detected. Allen Decl. ¶¶146-150. It was within a POSA’s knowledge and skill to check for foreign objects not just at the outset of the charging sequence but also during power generation, as shown by similar loops in Fells’ Figures 18, 19, and 25. Fells [0248]-[0252], [0262]-[0263], Figs. 18-19, 25; Stevens Fig. 8. And it was desirable to do so, as foreign objects were known to “get hot or hinder power transfer” and “otherwise interfere with the system.” Fells [0002], [0189] (“foreign objects ... adversely affect operation”). A POSA would have specifically sought to monitor for and avoid foreign objects during power generation, as this is when the primary coil is on and the greatest possibility for interference exists. Allen Decl. ¶¶148-150.

Accordingly, implementing Fells’ proximity detector embodiment in a

manner that checks for foreign objects during the provision of power would have been nothing more than the obvious application of a known technique (continuously checking for foreign objects during charging) to a known piece of prior art (Fells' proximity detector embodiment) to gain predictable improvement (reduction of system interference during charging due to foreign objects). *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 401, 416 (2007).

* * *

For these reasons, claim 1 of the '184 patent is unpatentable over Fells.

C. Claim 8

Fells discloses “[t]he system of claim 1, wherein the foreign object debris detection system is configured to verify that foreign object debris has not moved onto or over the source resonator prior to generation of the oscillating magnetic field.” Allen Decl. ¶¶152-153.

Fells' wireless power supply determines “whether there is a foreign object present” (i.e. on or over the source resonator) prior to initially “deliver[ing] power to the portable device” (i.e. generating the claimed oscillating magnetic field). Fells [0191]. The determination that there are “no foreign objects present” is a precondition to the “control unit ... activat[ing] the inverter 210 to supply current to the tank circuit,” which generates the oscillating magnetic field. Fells [0191]; Allen Decl. ¶153. Fells' “example timing diagrams” confirm this: if “there are foreign

objects present ... the system will not power up.” Fells [0194]-[0196], Fig. 3. The sense circuit then “[p]eriodically ... powers up” to see if a “change” has occurred indicating that “the [foreign] object is removed,” all before initiating power transfer. Fells [0194], Fig. 3; Allen Decl. ¶153; *see also* Fells Fig. 18 (checking whether a foreign object is present before applying power to the primary coil), Fig. 19 (same), Fig. 25 (same); *supra* Element 1[f] (explaining that these diagrams apply to the proximity detector embodiment).

D. Claim 11

Fells discloses “[t]he system of claim 1, wherein the foreign object debris detection system is integrated into the wireless energy transfer source.” Allen Decl. ¶¶154-155.

As explained for Elements 1[a]-[b], Fells’ “sense circuit” and “control element 208 in the wireless power supply 200” (along with related circuitry) correspond to the claimed “foreign object debris detection system,” and are part of (“in”) and therefore integrated into the “wireless power supply,” which is the claimed wireless energy transfer source. Fells [0191], [0288], Fig. 2, Fig. 40; Allen Decl. ¶155; *infra* Claim 12 (further explaining that the dotted lines of Fells’ figures indicate “integrated” components).

V. Ground 2: Claims 2-7, 9-10, and 16 Would Have Been Obvious Over Fells In View of Cook

As discussed above, Fells taught or rendered obvious every element of claims 1, 8, and 11. To the extent Patent Owner argues that Fells alone does not disclose or render obvious these claims, in addition to the remaining claims discussed below, those claims would have been obvious over Fells in view of Cook.

Fells teaches wirelessly charging “portable device[s],” but does not specify what those devices may be. Cook discloses the use of a similar wireless charging system to charge an electric vehicle. As detailed below, a POSA implementing Fells’ wireless power supply would have considered it obvious in view of Cook to use an electric vehicle as the device charged by Fells.

A. Cook (Ex. 1006)

Cook is prior art under pre-AIA 35 U.S.C. § 102(a), (b), and (e) because it was filed on May 28, 2008, and published on December 3, 2009. Cook was one of hundreds of references listed in an applicant-submitted IDS, but was not substantively addressed during prosecution, and was not considered in combination with Fells. *See generally* ’184 FH.

Like the ’184 patent and Fells, Cook teaches “[w]ireless delivery of power to a mobile powered device.” Cook Title; *see* Allen Decl. ¶¶72-79 (overview of Cook). Cook describes a “system that automatically detects the presence of an automobile [and] can operate wirelessly to recharge the battery therein.” *Id.* Abstract. As shown

below, “[c]harger 150” consists of “a coil 152, a capacitor 154, and a charging circuit 156,” which produces a “signal of appropriate frequency for magnetic transmission” 156,” which produces a “signal of appropriate frequency for magnetic transmission” and generates a “magnetic field ... 158.” *Id.* [0013].

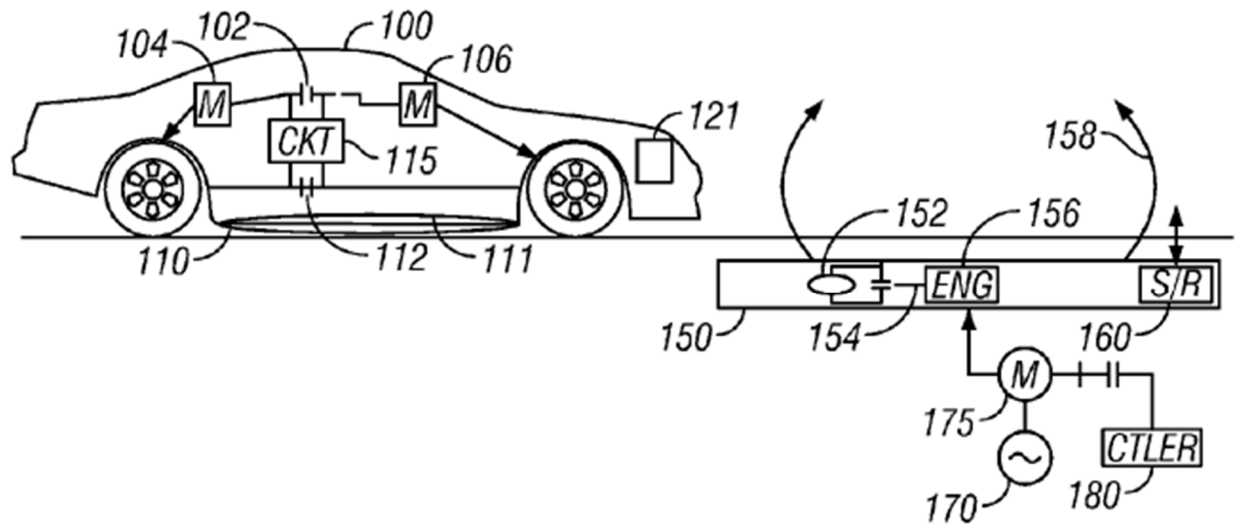


FIG. 1

Cook Fig. 1.

The automobile includes a “magnetic resonant antenna ... 110” constructed of “an inductive loop 111 in parallel with a capacitor 112,” which “forms an LC circuit.” Cook [0011]. When the automobile-mounted antenna “comes into range of” the charger, “it receives a magnetic signal ... and the receiving circuit 115 converts that power into output current.” *Id.* The received power “can be used for directly driving the motors” or “for charging the battery 102.” *Id.*

B. Motivation to Combine Fells with Cook

Fells teaches that its system can charge “portable device[s],” but does not provide any examples of, or limitations on, the types of “portable devices” that can

be charged. Fells [0001]. Fells explains that wireless charging is “more convenient” than “plug[ging] in a traditional power cable,” which a POSA would have understood to be true for any device that needs to be frequently plugged or unplugged, including electric vehicles. Fells [0001]; Allen Decl. ¶157. A POSA would have considered it obvious to use an electric vehicle, in particular, as the charged device in Fells because wireless electric vehicle charging systems were already well-known, and increasing in popularity. Allen Decl. ¶¶157-160. Cook, for example, described “wireless delivery of power to a mobile powered device,” and specifically singled out “automobile[s]” as exemplary devices to be charged. Cook Title, [0002], [0008], Fig. 1. Cook explained that, as car makers introduced electric and hybrid vehicles into the market in the 2008 time frame, “it may be desirable to wirelessly deliver power to an electric powered mobile device, such as an automobile.” *Id.* [0006]-[0008]. Cook also explained in incorporated-by-reference Cook-086 that systems for wireless charging can be used for “[m]yriad applications,” from powering or charging “client devices” and “cellular phones” to “powering or charging electric cars.” Cook [0001]; Cook-086 (Ex. 1012) 23:61-24:19; Allen Decl. ¶160.

A POSA would have been further motivated to implement Fells to charge electric vehicles because the POSA would have known that wirelessly charging vehicles provided high reliability and low maintenance. Allen Decl. ¶¶161-166; *see*,

e.g., Green (Ex. 1019) 694 (wireless energy transfer to “electric vehicles” was “very advantageous” because “magnetic coupling is ... immune to dirt, dust and the environment ... spark free, robust and reliable”); Lee (Ex. 1021) 839 (“[t]he ability to transmit power without contact enables high reliability and easy maintenance ... [and] has found application in many fields such as electric vehicles”); Wang-IEEE (Ex. 1025) 995 (“[t]he advantages” of “contact-less battery charging across large air-gaps for electric vehicles” include “safety, reliability, low maintenance and long product life”); Hu (Ex. 1020) 6-7 (“contactless battery charging” of “electric vehicle ... reduce[s] or eliminate[s]” maintenance requirements “without compromising long life and reliable operation”).

In addition to the reliability, lack of maintenance, and convenience of wireless charging, a POSA would have recognized that Fells’ foreign object detection made its charging scheme particularly well-suited for vehicles. Allen Decl. ¶167 As compared to small handheld devices, electric vehicle charging requires (1) a larger battery; (2) longer charging times; and (3) more variation in the charging environment (i.e., at home, in a parking lot, at an outdoor charging station). *Id.* Each of these factors increases the likelihood that undesirable foreign objects may enter the magnetic field of the charging system: (1) larger batteries may require larger coils to charge them, creating larger areas that foreign debris could interfere with; (2) longer charge times expose the charging area to debris for longer; and (3) less-

controlled environments will run a higher risk of incoming debris (road-side trash, rain, dirt, dust) as compared to charging in the user's home. *Id.* Therefore a POSA would have been particularly motivated to implement Fells' foreign object monitoring to prevent foreign objects from interfering with the wireless charging of a vehicle, and potentially creating an unsafe environment should debris heat or burn. Allen Decl. ¶167; Fells [0002] (foreign objects "may get hot or otherwise interfere with the system").

A POSA would have had a reasonable expectation of success in implementing Fells to charge an electric vehicle as contemplated by Cook, as the charging systems of Fells and Cook use the same well-known components and principles of operation. Allen Decl. ¶¶168-170. Fells describes a "wireless power system" using "a capacitor," a "primary coil," and a "control unit" to transfer power. Fells [0191]. The "wireless power supply" consists of a coil and "resonant capacitor" that form a "tank circuit" resonator that wirelessly delivers power to a coupled "portable device." *Id.* [0191], [0189]. The "portable device" in turn includes a "secondary coil 116, and sometimes a resonant capacitor which couples to the primary coil 112." *Id.* [0189], Fig. 1. Cook likewise describes "wireless delivery of power" from a "charger" consisting of a "coil ... capacitor ... and a charging circuit" to a "magnetic resonant antenna" in an "automobile." Cook [0011]-[0013]. The automobile-mounted antenna is a resonant "LC circuit" formed "from an inductive loop ... in

parallel with a capacitor,” and receives power from the resonant charger that “produce[s] a magnetic field.” Cook [0011]-[0013]; *see also* Cook [0001], cls. 6, 8, 13 (confirming that charger is “resonant”); Cook-086 23:59-24:18. Fells and Cook are analogous both to each other and to the ’184 patent, which similarly describes transferring wireless energy “between two resonators” and detecting foreign object debris. ’184 patent 1:16-53, 5:5-45.

A POSA would have understood that Fells’ power supply could be used with Cook’s vehicle even though Fells depicts its resonant circuit with the inductor and capacitor in series, while Cook’s resonant vehicle antenna placed them in parallel. Allen Decl. ¶¶171-173; Fells Figs. 2, 40; Cook [0011]. Such “[s]eries primary and parallel secondary” circuits were one of the “fundamental compensation topologies” well-known to a POSA for coupled wireless power transfer systems. Wang Thesis (Ex. 1008) 24; *see also* Terman (Ex. 1032) 64, Fig. 3-11 (depicting coupled resonators with series primary and parallel secondary); Allen Decl. ¶171. A POSA would have further known that the teachings of Fells’ series LC resonator could be applied to Cook’s parallel LC resonator, because “parallel” resonance is “analogous” to “series” resonance. Terman 50-51; *see id.* 52-53 (“working rules” for series resonance “also apply” to “parallel resonance” and “[t]he only difference is that the signs of the phase angles are now reversed”); Wang Thesis 20-25 (providing circuit diagrams and derived formulas for both series and parallel resonators); Allen Decl.

¶172. Alternatively, it also would have been within a POSA's skill to modify Fells' power supply to use a parallel resonator configuration, or to modify Cook's vehicle to use a series configuration, if design considerations made doing so beneficial. Allen Decl. ¶¶173, 175; Wang Thesis 21 (“[b]oth series and parallel secondary compensation improve the power transfer capability”).

Moreover, because Fells integrates its foreign object detection system directly into its “wireless power supply,” rather than into its receiving portable device, a POSA would be able to use Cook's electric vehicle with a “magnetic resonant antenna” as Fells' “portable device” to receive resonant magnetic power from Fells' wireless power supply without needing to modify the vehicle to accomplish Fells' foreign object detection. Cook [0011]; Fells [0191], Fig. 2; Allen Decl. ¶174.

Alternatively, a POSA would have been able to integrate Fells' power supply into Cook's system using Fells' “retrofit” kit. As Fells explains, rather than being built from the ground up, its “power system” can be “retro-fitted” as an “aftermarket accessory” used to “upgrade” existing “wireless power systems,” including those “from the same manufacturer or from a different (third-party) manufacturer.” Fells [0233], Fig. 12; Allen Decl. ¶175. Fells instructs a POSA how to implement its invention in this retrofit fashion, including adding a “replacement DC Power Supply,” “voltage regulator,” and “thermistor” as needed, which a POSA would have been able to apply to Cook's system. Allen Decl. ¶175; Fells [0233]-[0244]

(describing “retrofitting third-party systems” to utilize Fells “sense/control circuit” when “retrofitted to the existing wireless power supply”).

Lastly, a POSA would have understood that Fells’ wireless power supply could and would have been used to charge an electric vehicle despite the fact that Fells refers to its system as “low power.” Allen Decl. ¶¶176-179. As Fells explains, what makes its system “low power” is not the amount of power being transferred when the primary coil is on (which Fells does not even quantify). Rather, it is the inclusion of the sense circuit that makes the power supply “low power” because it allows the system to spend most of its time in “standby” or “ultra low power” mode in which the primary coil, and all other circuitry beyond the sense circuit, are off and do not draw power. Allen Decl. ¶¶176-179; Fells [0191] (“In the ultra low power mode, the only power drawing element is the sense circuit”); *see* Fells [0001], [0004], [0191]-[0195]. This remains true when Fells is implemented to charge an electric vehicle, as in Cook: “[t]he current and/or voltage during the standby sensing would typically be much lower than during power transfer.” Fells [0295]; Allen Decl. ¶¶176-179. In fact, Fells’ sense circuit and “ultra low power” mode become even more beneficial when used to charge vehicles, because the amount of power that would otherwise be wasted by having the circuitry on at all times is higher in a higher-power vehicle charging apparatus. Allen Decl. ¶179.

C. Independent Claim 16

1. Element 16[pre]: Preamble

To the extent the preamble is limiting, Fells disclose “[a] method of detecting foreign object debris in a wireless energy transfer system.” Allen Decl. ¶¶181-182.

As explained for Claim 1, Fells teaches a “power system” in which a “wireless power supply” detects “foreign objects” and “deliver[s] power to [a] portable device.” Allen Decl. ¶182; *supra* Elements 1[pre], 1[a]-1[b].

2. Element 16[a]: Health/Status Check

Fells discloses “performing a health and/or status check of a source resonator of the wireless energy transfer system.” Allen Decl. ¶¶183-196.

As explained for Claim 1, Fells teaches a resonant tank circuit consisting of “capacitor 214” connected to “primary coil 212,” which corresponds to the claimed “source resonator.” Fells Fig. 2, [0191]; *supra* Element 1[a].

When there are “no devices requiring power” and the system is not currently “delivering power,” Fells’ “wireless power supply” performs a “sense circuit calibration” (also called a “calibration inductance measurement”) that corresponds to the claimed “health and/or status check” of the source resonator. Fells [0196]; Allen Decl. ¶¶184-191 (detailing calibration check); *see also* ’184 patent 10:53-55, 11:42-45 (explaining that “health and status” checks include “diagnostic tests” performed when a vehicle is not present). This calibration is a status check of the source resonator, for example, because it prepares for the arrival of a future device

or vehicle to be charged by the resonator (by checking the current induction status) and establishes a baseline induction measurement that the sense circuit will compare future induction measurements to, in order to determine when to activate the resonator. Allen Decl. ¶188; Fells [0196] (“This is the inductance measurement that subsequent measurements will be compared to in order to trigger the sense circuit”).

Fells also performs additional health and/or status checks, such as validation checks, as part of the calibration inductance measurement: the calibration “take[s] longer than a normal measurement” because the system “make[s] sure that the calibration measurement is a valid one.” Fells [0196]; Allen Decl. ¶187. Baseline inductance for the calibration can be measured by “numerous ... techniques” including measuring the inductance across primary coil Lp 212, which is “the same coil ... used for the transfer of power.” Fells [0259]; Allen Decl. ¶188.

In addition and in the alternative, Fells discloses an energy storage check that corresponds to the claimed health and/or status check. Allen Decl. ¶¶192-196. The wireless power supply contains an “energy storage element,” which can be a “supercapacitor” or “battery,” and “is monitored so that it does not deplete fully, preventing operation of the sense circuit.” Fells [0245]-[0246], Fig. 16; Allen Decl. ¶¶193-194. In addition, the sense circuit itself “periodically monitors the energy in the energy storage element,” and “recharge[s]” the storage element if its energy falls “below a certain threshold.” Fells [0246]; *see id.* [0191]. The system may provide,

as “an output,” a signal “indicative of the energy level of the energy storage element.” *Id.* [0245]. Checking that the energy storage element is not fully depleted provides the health and/or status of the resonator, as the resonator is incapable of being turned on by the sense circuit if the energy storage element is depleted. Fells [0191]; *see also id.* [0255] (energy storage unit can directly power resonator, in which case energy storage level directly indicates resonator status). Allen Decl. ¶¶195-196.

3. Element 16[b]: Foreign Object Verification

Fells discloses “verifying that no foreign object debris has moved onto or over the source resonator.” Allen Decl. ¶¶197-207.

As explained for Elements 1[a]-1[b], Fells’ wireless power supply has a sense circuit that “detects when an object is placed in ... the proximity of the wireless power supply.” Fells [0191], *supra* Elements 1[a]-1[b]. To perform this detection, the sense circuit “[p]eriodically ... powers up to see if an inductance change has occurred since the previous measurement.” Fells [0194]; Allen Decl. ¶198. These periodic checks verify that no foreign object debris has moved onto the resonator, because when a “foreign object has been placed on the wireless power supply ... an inductance change will be detected at the next sense point.” Fells [0194]; Allen Decl. ¶198. The system will then “look to see if [there] is a valid device, whether it requires power and whether there are foreign objects present.” Fells [0194].

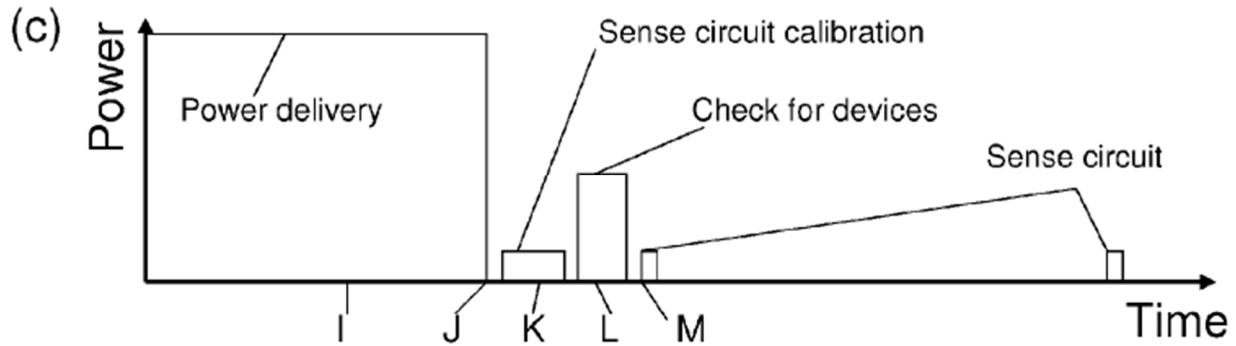
If the system determines that the detected object causing the inductance change “is foreign, the system will not power up, but will remain in ultra low power mode.” Fells [0194]; Allen Decl. ¶199. Only if “there is a valid device requiring power and no foreign objects present” will the system “activate the inverter 210 to supply current to the tank circuit ... to deliver power to the portable device.” Fells [0191]; *supra* Elements 1[a]-[b]; Allen Decl. ¶199.

Claim 16 does not require that its steps be performed in any particular order, as the claim does not recite any order, and nothing in the claim or specification requires as a matter of logic or grammar that the steps must be performed in a specific order. *Altiris, Inc. v. Symantec Corp.*, 318 F.3d 1363, 1370 (Fed. Cir. 2003). Patent Owner appears to agree, for example because the infringement allegations in its district court Complaint do not address any ordering of the steps of this claim. *See generally* Complaint Chart (Ex. 1017).

To the extent Patent Owner argues that the steps of this claim must be performed in the order written, however, this element is still met because a check for foreign debris occurs after the health and/or status check, and before a vehicle is positioned over the source resonator. *Supra* Element 16[a]; *infra* Element 16[c]; Allen Decl. ¶¶200-207 (explaining timing).

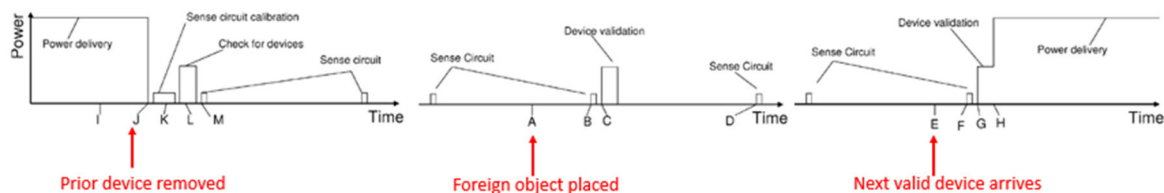
For example, as shown below in Figure 3(c), the checks for proximity, valid devices, and/or foreign objects (points L and M) occur after the prior device has

finished charging and been removed (point J) and after the “sense circuit calibration” (point K), but before the next vehicle has arrived to be charged (not shown to the right). Fells [0194]-[0196]; Allen Decl. ¶¶201-204.



Fells Fig. 3; Allen Decl. ¶¶201-204; *see also* Fells Figs. 18, 19, 25 (showing that the system detects an inductance change caused by a foreign object prior to arrival of a valid device).

This can also be seen by combining Fells’ timing diagrams showing the previous device being fully charged and removed (Fig. 3(c)), a foreign object being placed (Fig. 3(a)), and then a new device arriving to be charged (Fig. 3(b)):



Allen Decl. ¶¶205-206 (annotating Fells’ Fig. 3(a)-3(c)). At each “sense circuit” check, the device “[p]eriodically ... powers up to see if an inductance change has occurred.” Fells [0194]. If no foreign object is detected, no inductance change

occurs and the system remains in the low power state. Fells [0194]. When a foreign object is placed at point A and then present at point B, the sense circuit check “detect[s]” the “inductance change” caused by the foreign object. *Id.* As a result, at point C, “the system will look to see ... whether there are foreign objects present.” *Id.* Because there are, the system “will not power up.” *Id.* This foreign object detection happens after the “sense circuit calibration” (point K), but before a valid device arrives (i.e., the next vehicle pulls over the resonator) (point E). Fells [0194]; Allen Decl. ¶¶205-206. Therefore, at least in this scenario, the system checks for foreign objects after performing the status check, but before a vehicle arrives. Allen Decl. ¶¶205-206. *See Power Integrations, Inc. v. Fairchild Semiconductor Int’l, Inc.*, 843 F.3d 1315, 1336-37 (Fed. Cir. 2016) (“prior art that sometimes meet[s] the claim elements are sufficient to show obviousness”).

This same ordering is true for the energy storage unit status check. The energy storage unit “is monitored so that it does not deplete fully, preventing operation of the sense circuit,” and instead can be “recharged” as necessary. Fells [0246]. Thus, the energy storage status check occurs before the “operation of the sense circuit” to detect foreign objects, which is a precondition to the system then “look[ing] to see ... whether there are foreign objects present.” Fells [0194], Fig. 3; Allen Decl. ¶207. And the periodic operation of the sense circuit, in turn, occurs before the arrival of

the vehicle, as the sense circuit detects the oncoming vehicle. Fells [0194], Fig. 3; Allen Decl. ¶207.

4. Element 16[c]: Positioning Vehicle Over the Source Resonator

Fells in view of Cook renders obvious “positioning a vehicle over the source resonator.” Allen Decl. ¶¶208-212.

Fells describes a “wireless power system” that generates an oscillating magnetic field to transfer energy to a “portable device,” but does not specify that the device is a vehicle. Fells [0189]; *supra* Element 1[a]. Cook similarly discloses a system for “wirelessly deliver[ing] power to an electric powered mobile device,” but further specifies that the device can be “an automobile,” as shown below.

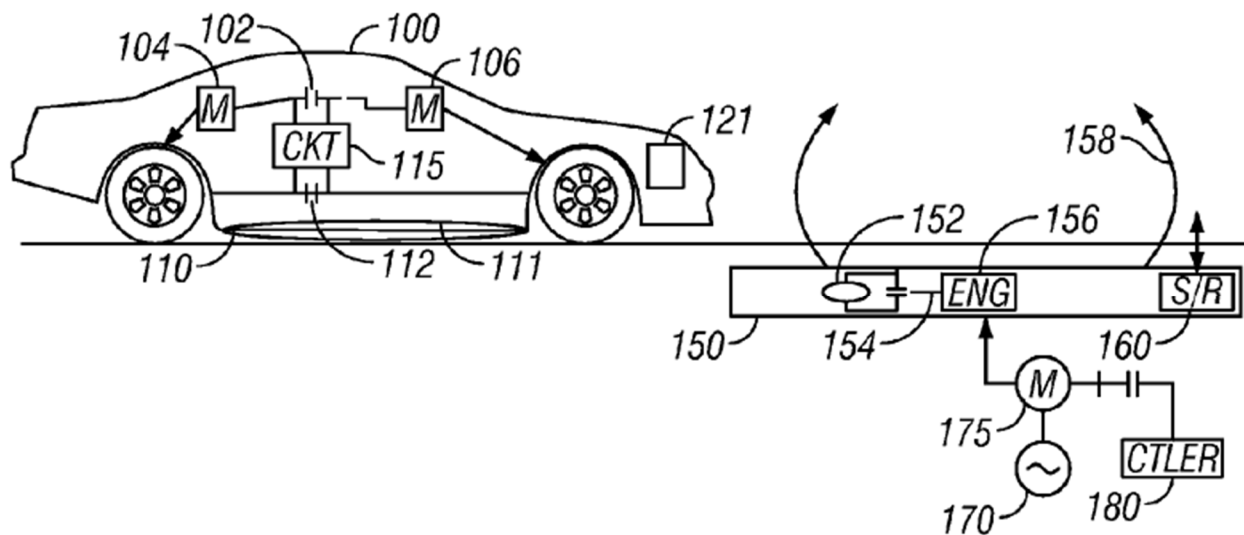


FIG. 1

Cook Fig. 1, [0008], [0009] (“electrically powered automobile”).

As explained above, it would have been obvious to implement Fells' wireless power supply to charge an electric vehicle as its "portable device," as in Cook. Allen Decl. ¶¶209-210, 157-179; *supra* Motivation to Combine. In this arrangement, the automobile includes a "magnetic resonant antenna," also called an "LC circuit." Cook [0011]. When the vehicle is within "range of the magnetic field" provided by an active resonant charger, the vehicle "may receive power from that magnetic field, and hence be charged." Cook [0011]-[0013]; Allen Decl. ¶211. The received power can either "directly driv[e] the motors" of the vehicle, or "charg[e] the battery." Cook [0011]. That is the same arrangement described with reference to the portable device in Fells, and thus Cook's vehicle can receive power from the wireless power supply of Fells in the same manner. Allen Decl. ¶211; Fells [0189]-[0191]; Cook [0011]-[0013]; *supra* Motivation to Combine.

Both Fells and Cook require that the device receiving charge be physically near to the transmitting coil. Fells [0191] (in "the proximity of the wireless power supply"); Cook [0013] ("into range of the magnetic field"); Allen Decl. ¶212. Accordingly, a POSA would have implemented Fells in the well-known manner described by Cook, placing the charger "within the ground near a parking space," such that the vehicle to be charged in the parking space is over the coil and within range of magnetic field 158. Allen Decl. ¶212; Cook [0012], Fig. 1; *see also* Cook-086 23:59-24:18 (wireless power systems can be adapted for "powering or charging

electric cars” by “placing or building in a transmitter in the floor of a garage, and placing a receiver on the bottom of the car”). Thus, a POSA implementing Fells in view of Cook to charge electric vehicles would position the vehicle over the source resonator to be charged. Cook [0012]; Allen Decl. ¶212; *supra* Motivation to Combine.

5. Element 16[d]: Foreign Object Verification

Fells in view of Cook renders obvious “verifying that no foreign object debris has moved onto or over the source resonator.” Allen Decl. ¶¶213-216.

This element is obvious for the same reasons as Element 16[b]. *Supra* Element 16[b]; Allen Decl. ¶214. To the extent Patent Owner contends the steps of Claim 16 are required to be performed in the order written, Fells in view of Cook renders obvious verifying that no object debris is present after the vehicle is positioned over the source resonator, but before generating an oscillating magnetic field, as detailed below. Allen Decl. ¶¶215-216.

As explained for Element 16[c], it would have been obvious to position the electric vehicle of Cook over Fells’ wireless power supply to be charged, in order to bring the vehicle “into range of [the] wireless charging circuit.” Cook [0010]-[0013], Fig. 1; Allen Decl. ¶215; *supra* Element 16[c]. Driving the vehicle over the resonator will trigger Fells’ proximity-detecting sense circuit, which “detects that an object has been placed on (or in proximity to) the wireless power supply.” Fells

[0191]; Allen Decl. ¶215. Prior to the arrival of the vehicle, the sense circuit has been “[p]eriodically ... power[ing] up to see if an inductance change has occurred,” indicating the arrival of either a foreign object or a vehicle to be charged. Fells [0194]; *supra* Element 16[b]. If a foreign object is detected, rather than a vehicle to be charged, the system “will not power up.” Fells [0194]; *supra* Element 16[b]; Allen Decl. ¶215.

When the vehicle parks on top of the resonator and is detected by the sense circuit, a switch “is closed allowing the circuits in the wireless power supply 200 to receive power.” Fells [0191]; Allen Decl. ¶216. The “control element ... in the wireless power supply 200 then determines i) whether there is a valid device present, ii) if there is a valid device whether it desires power, [and] iii) whether there is a foreign object present.” Fells [0191]. Because a vehicle desiring power has arrived, the control element confirms that “no foreign objects [are] present, then ... activate[s] the inverter 210 to supply current to the tank circuit ... to deliver power to the portable device.” Fells [0191]. This check can occur immediately prior to initiating power transfer. *See* Element 1[f]; Fells [0191]-[0195], Figs. 18, 29, 25; Allen Decl. ¶¶136-150. Thus, after the vehicle arrives triggering the sense circuit, but before generating a magnetic field, the control element verifies that no foreign object debris exists. *See also* Element 1[f]; Fells [0248], Fig. 18 (foreign object

detection occurs after initial sense circuit detection, but before charging), Fig. 19 (same), Fig. 25 (same); Allen Decl. ¶¶216, 136-150.

6. Element 16[e]: Generating an Oscillating Magnetic Field

Fells in view of Cook renders obvious “generating an oscillating magnetic field using the source resonator to transfer energy wirelessly to the vehicle to charge a battery of the vehicle.” Allen Decl. ¶¶217-218.

As described for Element 1[a], Fells’ power supply transfers power to a portable device by generating an oscillating magnetic field. *Supra* Element 1[a]. That remains true when Fells is implemented to use Cook’s electric vehicle as the “portable device” receiving energy. *Supra* Element 16[c], Motivation to Combine; Allen Decl. ¶218. As Cook explains, the electric vehicle contains a “receiving circuit” that “converts” the power received via electromagnetic resonance from the charger “into output current.” Cook [0011]. That would be equally true when receiving power from Fells’ wireless power supply. Fells [0189] (“portable device” to be charged contains “battery and charging circuit”); Allen Decl. ¶218. The power transmitted from Fells’ power supply to Cook’s electric vehicle via oscillating magnetic field “can be used ... for charging the battery” of the vehicle when parked over the resonator. Cook [0011]; Fells cl. 9 (describing charging battery); Allen Decl. ¶218.

7. Element 16[f]: Foreign Object Verification

Fells in view of Cook renders obvious “verifying that no foreign object debris has moved onto or over the source resonator during the transfer of energy.” Allen Decl. ¶¶219-220.

As described for Element 1[f], Fells teaches (or in the alternative, renders obvious) checking to ensure that no foreign objects are present during the transfer of energy from the wireless power supply to the portable device. *Supra* Element 1[f]; Fells [0194]-[0195], [0248]-[0251], [0262]-[0263], Figs. 18, 19, 25. That would remain true, for the same reasons, when Fells is implemented such that the receiving device is Cook’s electric vehicle. Allen Decl. ¶¶220, 135-150.

D. Claims Dependent From Claim 1

1. Claim 2

Fells in view of Cook renders obvious “[t]he system of claim 1, wherein the wireless energy transfer source is configured to generate the oscillating magnetic field to transfer energy to a vehicle.” Allen Decl. ¶¶221-222.

As described for Element 16[c], it would have been obvious to implement Fells to charge an electric vehicle, as in Cook. *Supra* Element 16[c], Motivation to Combine. When doing so, Fells’ resonant tank circuit generates an oscillating magnetic field that transfers energy to the vehicle. *Supra* Element 16[e] (Fells generating oscillating magnetic field), Element 1[a] (same); Allen Decl. ¶222.

2. Claim 3

Fells in view of Cook renders obvious “[t]he system of claim 2, wherein the foreign object debris detection system is configured to verify that foreign object debris has not moved onto or over the source resonator prior to a transfer of energy from the source resonator to the vehicle.” Allen Decl. ¶¶223-224.

As described for Elements 16[b] and 16[d], Fells’ “sense circuit” and “control element” verify that “no foreign objects [are] present” prior to “deliver[ing] power to the portable device.” Fells [0191], Allen Decl. ¶¶224, 198-207, 214-216; *supra* Elements 1[a], 16[b], 16[d]. This would remain true when Fells is implemented with Cook to charge an electric vehicle: Fells’ power supply determines that “no foreign objects [are] present” prior to “the inverter 210 ... supply[ing] current to the tank circuit ... to deliver power to” the vehicle. Fells [0191]; Allen Decl. ¶224.

3. Claim 4

Fells in view of Cook renders obvious “[t]he system of claim 3, wherein the foreign object debris detection system is configured to perform a health and/or status check of the wireless energy transfer source before the vehicle is positioned over the source resonator.” Allen Decl. ¶¶225-227.

As described for Element 16[a], Fells conducts two health and/or status checks of the resonator: a “sense circuit calibration,” and a status check of the energy storage element, either of which meet this limitation. *Supra* Element 16[a]; Allen

Decl. ¶¶226, 184-196. Both checks occur before the vehicle to be charged is positioned over the source resonator: the sense circuit calibration occurs before the vehicle to be charged arrives, in order to detect its arrival, while the energy storage check happens periodically in advance of any vehicle or foreign object being detected, to make sure that such detection can occur. *Supra* Element 16[b]; Fells [0194]-[0196], Figs. 3, 18, 19, 25; Allen Decl. ¶¶226, 200-207.

Moreover, a POSA would have understood that Fells' statement "it is possible that a device may have been placed on the unit just before the calibration measurement was made" also conveys the opposite: it is "possible" that no device was placed on the unit until after the calibration measurement was made. Fells [0196]; Allen Decl. ¶227. At least in the latter case, no vehicle was "placed on the unit ... before the calibration measurement was made," and the status check therefore occurs before the next vehicle arrives at the charger – i.e. "before the vehicle is positioned over the source resonator" as claimed. Fells [0196]; Allen Decl. ¶227; *Power Integrations*, 843 F.3d at 1336-37.

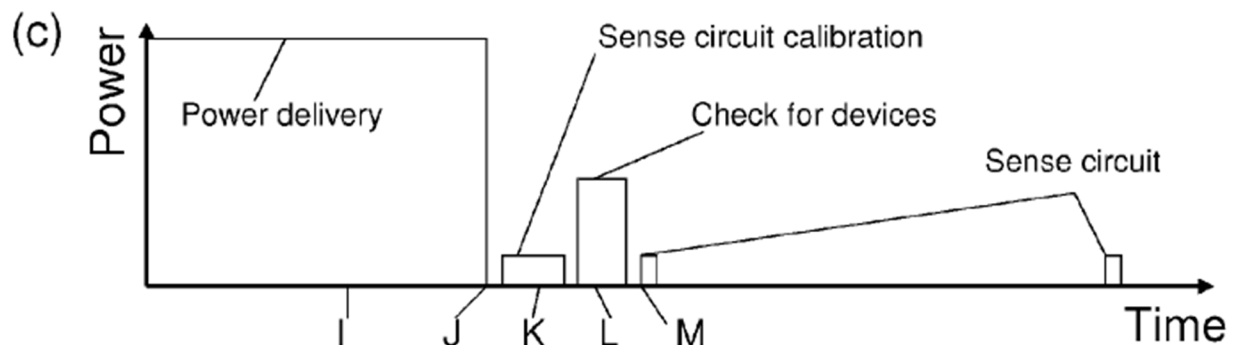
4. Claim 5

Fells in view of Cook renders obvious "[t]he system of claim 4, wherein the foreign object debris detection system is configured to perform the health and/or status check less frequently than the verification that foreign object debris has not

moved onto or over the source resonator prior to a transfer of energy from the source resonator to the vehicle.” Allen Decl. ¶¶228-230.

A POSA would have understood that Fells’ calibration status check occurs less frequently than its “periodic” checks to “sense for another device being placed in proximity,” which trigger or include a foreign object check. Fells [0196]; Allen Decl. ¶¶229-230. The calibration status check occurs once after a previous charging is complete, while the sense circuit checks for newly arrived devices or foreign objects are performed repeatedly until a new vehicle arrives to be charged. Fells [0191]-[0196], Fig. 3; Allen Decl. ¶¶229-230.

For example, as shown in Figure 3(c) below, the system checks the calibration only once (point K), while at least twice (and more times not shown to the right in this figure) during the same period checking for changes in inductance that may correlate to new devices or foreign objects (two separate points M). Fells [0196], [0191]; Allen Decl. ¶¶229-230.



Fells Fig. 3; *see id.* [0194] (explaining that if “foreign object has been placed on the wireless power supply 200, an inductance change will be detected” at the next point labeled “sense circuit”). The combination of Fells with Cook to specifically charge electric vehicles would not change this functionality. Allen Decl. ¶230.

5. Claim 6

Fells in view of Cook and/or a POSA’s knowledge renders obvious “[t]he system of claim 4, wherein the foreign object debris detection system is configured to periodically perform the health and/or status check and the verification that foreign object debris has not moved onto or over the source resonator prior to a transfer of energy from the source resonator to the vehicle.” Allen Decl. ¶¶231-238.

Fells’ status checks are each performed periodically. Fells’ calibration check is performed again each time the system has finished charging a device (whether that be because the device is fully charged, or because it was removed), thereby setting the appropriate calibration level for the next detected object. Fells [0196] (conducting check once “there are now no devices requiring power”); Allen Decl. ¶233. Similarly, the energy storage element “is monitored” at intervals that allows for recharging, and also “periodically monitor[ed]” by the sense circuit. Fells [0246]; Allen Decl. ¶233.

Fells’ verification that no foreign objects exist also occurs “periodically”, as “low power inductance measurements ... to sense for another device being placed

in proximity” are expressly taught to be made “periodically.” Fells [0194]-[0196]; Fig. 3(a)-3(c); Allen Decl. ¶234. The combination of Fells with Cook to specifically charge electric vehicles would not change this functionality. Allen Decl. ¶234.

In the alternative, to the extent not already disclosed in Fells, it would have been obvious to implement Fells in view of the knowledge of a POSA such that the calibration check, the energy storage element check, and the check for foreign objects prior to the transfer of energy were each performed periodically. Allen Decl. ¶¶235-238. Doing so would have been obvious to try, or at most an obvious design choice. *KSR*, 550 U.S. at 42103 (“[w]hen ... there are a finite number of identified, predictable solutions, a [POSA] has good reason to pursue the known options within his or her technical grasp”); *CRFD Rsch., Inc. v. Matal*, 876 F.3d 1330, 1347 (Fed. Cir. 2017) (each of “two predictable choices” was obvious modification as “simple design choice”).

Fells’ status checks and foreign object checks are each designed to provide ongoing monitoring against disruptive events: miscalibration of the resonator, depletion of the energy storage element, or the arrival of a foreign object or vehicle to be charged. Allen Decl. ¶¶235-236; *supra* Element 16[a], Claims 4-5. A POSA would have understood that performing checks “periodically” was one of a finite number of identified, predictable solutions for ongoing monitoring against

disruptions, along with monitoring continuously, or monitoring sporadically. Allen Decl. ¶¶235-236.

A POSA would have known how to — and been particularly inclined to — implement such checks periodically, as was well known. For example, Fells discloses nearly a dozen separate examples of “periodically” monitoring for disruptions. *See, e.g.*, Fells [0194] (“[p]eriodically, the sense circuit 206 powers up to see if an inductance change has occurred ...”), [0196] (“low power inductance measurements are periodically made to sense for another device”), [0200] (“periodically take measurements...”), [0222] (“periodically check to see if the counter has overflowed”), [0238] (“the false trigger counter is periodically reinitialised”), [0246] (“the sense circuit 206 periodically monitors the energy in the energy storage element”), [0250] (“sense circuit 206 periodically looks for a change”), [0251] (“system periodically ‘pings’ ... the system by modulating the primary coil”), [0260] (“[microprocessor] periodically reads the value of the peak detector”), [0279] (“the devices are detected by periodically applying power”), [0293] (“periodically send out short pings of energy...” and “periodically listen for pings of information”), Fig. 25 (checking every “400ms”); Allen Decl. ¶237.

Importantly, the ’184 patent provides no explanation of why performing status checks or foreign object checks periodically would allegedly have been inventive. A POSA would have recognized that it was not. Allen Decl. ¶¶237-238. In fact, the

specification of the '184 patent provides no disclosure of status checks or object detection checks being performed periodically, much less any explanation of how or why that would occur. *See generally* '184 patent. Because “the alleged novelty of the ['184 patent] ... is not related” to periodic checks, the specification “is silent” on how or why to implement periodic checks, and doing so was “well known in the art,” it “would have been obvious” to implement periodic status checks and foreign object detection checks in Fells, as one of a limited number of “finite, predictable solutions for solving the same problem.” *Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1339-41 (Fed. Cir. 2020).

6. Claim 7

Fells in view of Cook renders obvious “[t]he system of claim 2, wherein the foreign object debris detection system is configured to verify that foreign object debris has not moved onto or over the source resonator after the vehicle is positioned over the source resonator and prior to a transfer of energy from the source resonator to the vehicle.” Allen Decl. ¶¶239-240.

This limitation is taught for the reasons explained for Element 16[d], which similarly addresses “verifying that no foreign object debris” is present after the step of “positioning a vehicle,” but before the step of “generating an oscillating magnetic field ... to transfer energy.” *Supra* Element 16[d], Element 1[f]; Fells [0194], [0248],

Fig. 18 (foreign object detection occurs after initial sense circuit detection, but before charging), Fig. 19 (same), Fig. 25 (same); Allen Decl. ¶240.

7. Claim 9

Fells in view of Cook renders obvious “[t]he system of claim 1, wherein the wireless energy transfer source is a component of a vehicle charging station.” Allen Decl. ¶¶241-242.

As explained for Element 16[c] and Claim 2, it would have been obvious to implement Fells to charge an electric vehicle, in which case Fells’ wireless power supply serves as a vehicle charging station. *Supra* Element 16[c], Claim 2, Motivation to Combine; Allen Decl. ¶242. The ’184 patent imposes no restrictions on what constitutes a “vehicle charging station” beyond that it provides power to an “electric vehicle” – which Fells’ charger does when combined with Cook. ’184 patent 10:61-67, 11:40-45; Allen Decl. ¶242.

8. Claim 10

Fells in view of Cook renders obvious “[t]he system of claim 9, further comprising a device module configured to be mounted on an electric vehicle.” Allen Decl. ¶¶243-244.

Cook’s “automobile” “includes at least one magnetic resonant antenna ... formed from an inductive loop 111 in parallel with a capacitor.” Cook [0011], Fig. 1 (showing coil mounted on vehicle); Allen Decl. ¶244. The automobile-mounted

antenna has a “receiving circuit” that “receives a magnetic signal” from the charger and “converts that power into output current.” Cook [0011]; Allen Decl. ¶244. When Fells is implemented to charge electric vehicles, it would use this same arrangement, which constitutes a device module. Allen Decl. ¶244; *supra* Element 16[c], Claim 2, Motivation to Combine.

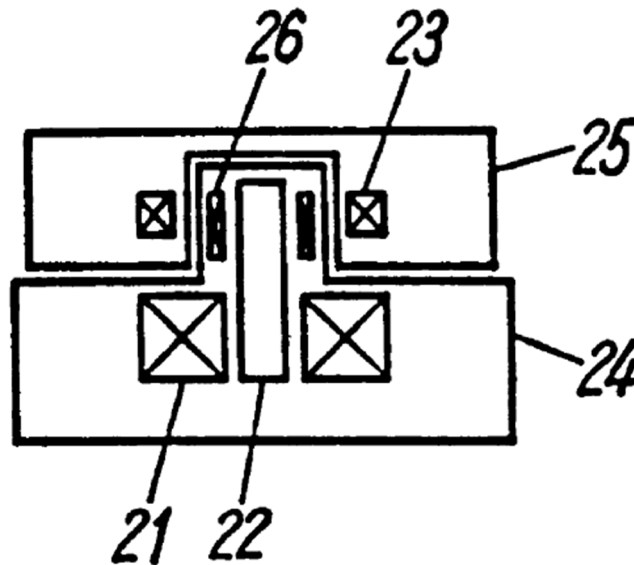
VI. Ground 3: Claim 12 Would Have Been Obvious Over Fells Alone or In View of Ono

A. Ono (Ex. 1007)

Ono is prior art under pre-AIA 35 U.S.C. § 102(a), (b), and (e) because it was filed on March 12, 1999, and issued on June 13, 2000. Ono was not considered during prosecution of the '184 patent. *See generally* '184 FH.

Like Fells and the '184 patent, which are analogous art, Ono is directed to a “non-contact type power supply unit,” in which “electric power is transmitted from [a] primary coil to [a] secondary coil.” Ono 2:40-53; Allen Decl. ¶¶80-82 (overview of Ono). Because the presence of “foreign objects” near the power transmitting coils can result in “abnormal heating,” Ono teaches “installing a detector coil” for “the detection of foreign objects.” *Id.* 1:50-64, 4:3-14, 4:29-36. “[B]y monitoring the voltage of the detector coil ... it can be known” whether a nearby object “is the secondary coil or some foreign object,” and in the latter case, power transmission can be turned down or stopped. *Id.* 4:3-47.

Ono further teaches that the primary coil and detector coil are mounted inside of a “primary enclosure 24,” while the secondary coil is in a separate “secondary enclosure 25.” *Id.* 4:25-26. As shown below, the “detector coil 26” is within the “primary enclosure 24,” along with “primary coil 21.” *Id.* 4:3-47.



Id. Fig. 2.

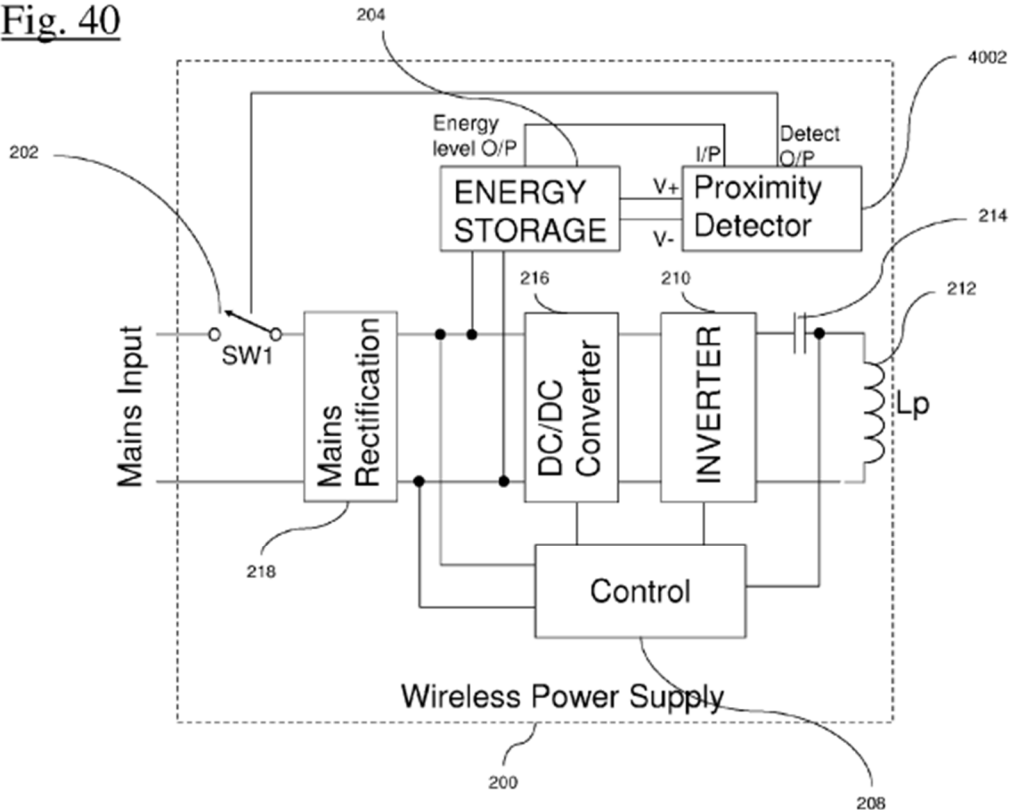
B. Claim 12

Fells, alone or in view of Ono, teaches or renders obvious “[t]he system of claim 1, further comprising an enclosure housing at least a portion of the wireless energy transfer source, wherein the foreign object debris detection system is integrated into the enclosure.” Allen Decl. ¶¶245-249.

Fells teaches that its resonant tank circuit (a portion of the claimed wireless energy source) and its control unit and sense circuit/proximity detector (the claimed

foreign object debris detection system) are all integrated into the enclosure of the “wireless power supply,” as shown for example in Figure 40 below.

Fig. 40



Fells Fig. 40, [0295] (disclosing “shielding” components); Allen Decl. ¶246. A POSA would have understood that the dotted lines in Fells’ diagrams indicate an “integrated” enclosure encompassing all components within the dotted lines. Allen Decl. ¶246; see Fells Figs. 44-45, [0186]-[0187] (describing Figs. 44-45 as showing “embodiment of Fig. 2 integrated into another electronic device”), [0301] (dotted line represents where “the wireless power supply is integrated with another piece of electronic equipment”).

To the extent Patent Owner contends that Fells does not teach an enclosure, a POSA implementing Fells would have considered it obvious to place Fells' wireless power supply, including the proximity detector, control unit, and tank circuit, within a primary enclosure as taught by Ono. Ono Fig. 2, 3:64-4:26; Allen Decl. ¶247. A POSA would have been motivated to do so because an enclosure was a well-known method of encasing electronic components to prevent them from malfunctioning, including for wireless charging systems and foreign object detection systems. Allen Decl. ¶248; *see, e.g.*, Ono Fig. 2, 4:3-47 ("primary enclosure" containing "primary coil" and "detector coil" for "detection of foreign objects"); Cook-086 16:59-62 ("shield ... disposed around the antenna" would "mitigat[e]" interference caused by "close-by objects or humans" due to their "stray capacitance"); Boys (Ex. 1011) 8:19-42 ("charging pad" for charging "vehicle" is within "outer housing"), Figs. 2-3. For example, a housing would protect the coil of Fells' wireless power supply from environmental contaminants such as dirt, lint, and debris, while also shielding the coil and related circuitry from damage that could cause electrical shorts (i.e., water intrusion, or physical breaking of components), and shielding nearby users from the threat of electrical shock. Allen Decl. ¶249. A POSA would have placed the proximity detector, control unit, and primary coil all in the same enclosure, as they are part of the same circuit and hardwired together. *See e.g.*, Fells Figs. 2, 40; Allen Decl. ¶249.

VII. Ground 4: Claim 13 Would Have Been Obvious Over Fells In View of Cook and/or Wang Thesis

A. Wang Thesis (Ex. 1008)

Wang Thesis, titled *Design Considerations for Inductively Coupled Power Transfer Systems*, is prior art under pre-AIA 35 U.S.C. § 102(a) and (b) because it was published in 2004, and received, cataloged, indexed, and made publicly available at the University of Auckland Library no later than October 2005. Wang Thesis Cover Pages; Hsieh-Yee Decl. (Ex. 1010) ¶¶18-37. Wang Thesis was not considered during prosecution of the '184 patent.

Like Fells, Cook, and the '184 patent, which are analogous art, Wang Thesis teaches the use of “[i]nductively coupled power transfer (ICPT) systems” to “transfer electric power from a primary source (power supply) to one or more secondary loads (pickups)” with “no physical contact between the primary and secondary,” such as in a “contact-less electric vehicle battery charger.” Wang Thesis Abstract i; Allen Decl. ¶¶83-92 (overview of Wang).

Wang is a doctoral thesis that first provides an “Introduction” and “Overview” of wireless power transfer systems, then “develop[s] a general load model” for such systems, and uses that model to develop a “design methodology.” *Id.* Contents v-vii. The thesis “facilitate[s] the design of an ICPT system” that “deliver[s] power from a stationary primary source to one or more movable secondary loads ... over large air gaps via magnetic coupling” by providing “equivalent circuits of series and

parallel compensated” resonators for both the primary and secondary, as well as deriving the “operating conditions for maximum power transfer.” Wang Thesis 47-52 (secondary), 61-62 (operating conditions), 62-66 (primary).

Chapters three and four set forth and test a “design methodology” for such systems, and then use that methodology to “design ... a contact-less electric vehicle battery charging system” that “delivers 30kW” of power across an “air gap.” *Id.* 71-75, 77-109. As the thesis explains, “optimisation and design of an ICPT system relies strongly on experience and experimental verification,” but “suitable design choices” can be made by varying “the operating frequency, the primary current, the electromagnetic structure, the primary and secondary compensation, the pickup regulator, and the high frequency switching power supply.” *Id.* 77. A POSA can design a wireless resonator-based vehicle charging system “to achieve the desired power” by adjusting “four major design factors: the operating frequency (ω_0), the primary current (I_p), the magnetic design factor ($k^2 L_p = M^2 / L_s$) and the secondary quality factor (Q_{s0})” according to the provided formula:

$$P = V_{oc} I_{sc} Q_{s0} = \omega_0 I_p^2 (k^2 L_p) Q_{s0} = \omega_0 I_p^2 \left(\frac{M^2}{L_s} \right) Q_{s0}$$

Wang Thesis 77-78; *see id.* 79-80 (providing flowchart of “design procedure”); Allen Decl. ¶¶89-92. Using this “design methodology,” Wang Thesis designs a

“contact-less electric vehicle battery charger” that “delivers 30kW” of energy. *Id.* 71-72, 105-110.

B. Claim 13

Fells in view of Cook and/or Wang Thesis renders obvious “[t]he system of claim 1, wherein the wireless energy transfer source is configured to deliver a power of more than 3.3 kW to a wireless power receiving device.” Allen Decl. ¶¶250-258.

As described for Claims 2 and 16, it would have been obvious to a POSA to use Fells’ wireless power supply to charge an electric vehicle, as in Cook. *Supra* Motivation to Combine Fells with Cook, Element 16[c], Claim 2. Although neither Fells nor Cook quantifies the power provided by their systems, a POSA would have been motivated to design Fells’ system to provide power in excess of 3.3kW (as described, for example, in Wang Thesis) in order to charge the battery of the electric vehicle in a reasonable amount of time. Allen Decl. ¶¶251-258 (explaining why and how a POSA would implement Fells with >3.3kW).

Wang Thesis discloses a “design procedure” for wireless resonator-based charging systems “with the aim of achieving a controllable power transfer capability over a specified operating range with minimum total cost.” Allen Decl. ¶252; Wang Thesis 77. Wang Thesis teaches a POSA how to “achieve the desired power” in a resonator-based wireless charging system by adjusting “four major design factors: the operating frequency (ω_0), the primary current (I_p), the magnetic design factor

($k^2 L_p = M^2 / L_s$) and the secondary quality factor (Q_{s0})” according to the provided formula:

$$P = V_{oc} I_{sc} Q_{s0} = \omega_0 I_p^2 (k^2 L_p) Q_{s0} = \omega_0 I_p^2 \left(\frac{M^2}{L_s} \right) Q_{s0}$$

Wang Thesis 77-78; *see id.* 79-86. As shown below, by starting with the “electromagnetic structure” and “compensation topology” of the Fells/Cook system, a POSA could and would have used Wang Thesis’ “design procedure” to select the remaining variables, such as the operating frequency and primary current, to “achieve” their “desired” level of power from the system. Wang Thesis 77; Allen Decl. ¶¶252-253.

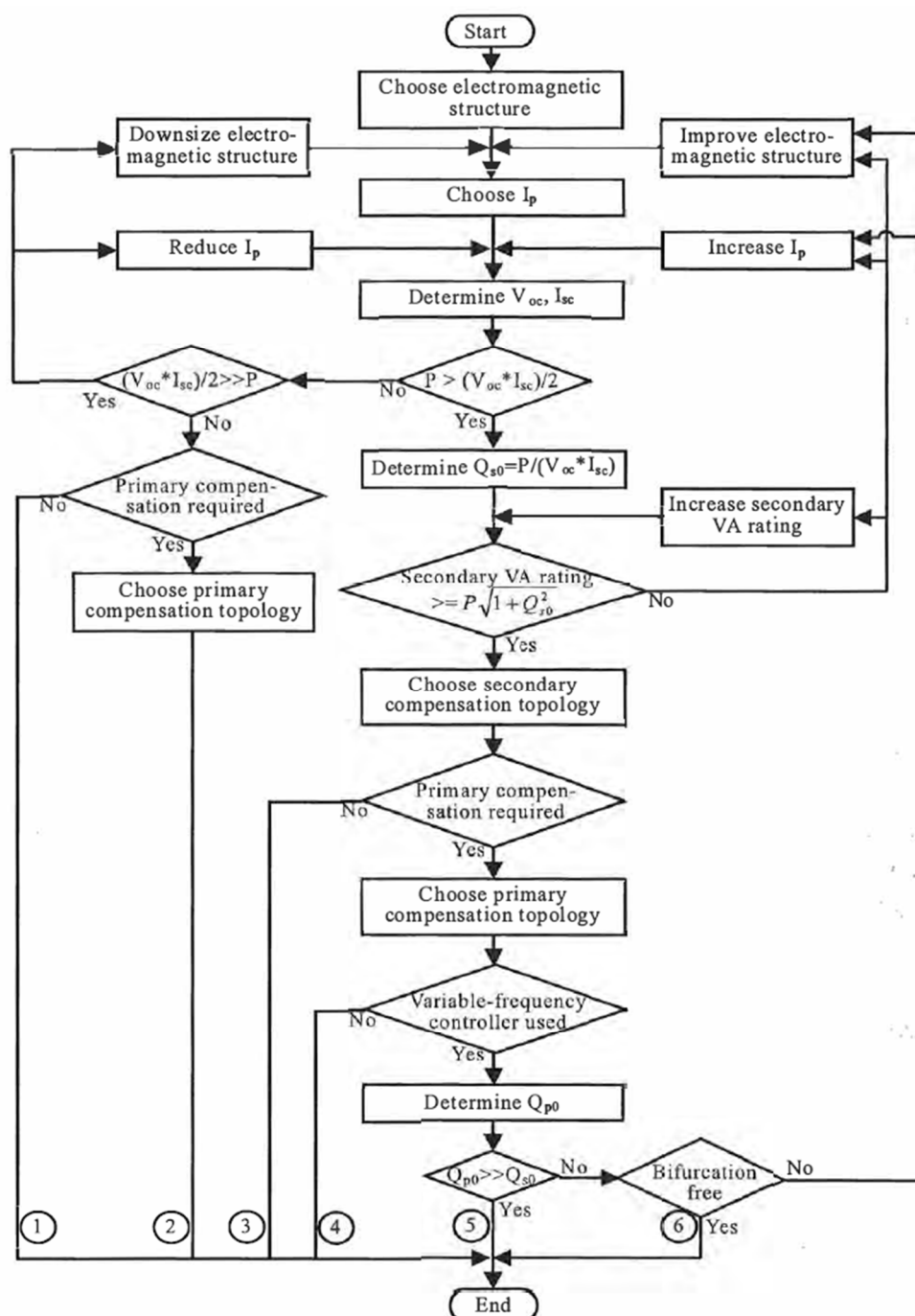


Fig. 4-2. A design procedure of ICPT systems.

Wang Thesis 80. For example, as proof of its own design methodology, Wang Thesis “designed” a “contact-less electric vehicle battery charging system” that “delivers **30kW** across a 45mm air gap.” *Id.* 71-72 (“Rated power (P): 30kW”).

A POSA would have desired to implement Fells’ power supply using Wang Thesis’ design procedure to obtain power at least in excess of 3.3kW (if not higher) because such power ratings were common for vehicle chargers at the time. Allen Decl. ¶254. As shown below, a POSA would have known in the 2010 timeframe that “Level 2” electric vehicle chargers provided power in excess of 3.3kW in order to shorten charging times, while higher “charge power” systems provided even faster charging times. *Id.* ¶¶254-255.

table 3. Typical set of charging options developed for an EV.				
EVSE	Utility Service	Usage	Charge Power (kW)	Time to Charge
Level 1	110 V, 15 A	Opportunity	1.4	18 hours
Level 2	220 V, 15 A	Home	3.3	8 hours
Level 2	220 V, 30 A	Home/Public	6.6	4 hours
Level 3	480 V, 167 A	Public/Private	50–70	20–50 min

Dickerman (Ex. 1028) 59; *see id.* (charging systems with less than 3.3kW of power “may not be the customer’s preferred charging method” due to their extended charging times); Weiller (Ex. 1033) 3767 (“‘Fast-charging’ a vehicle battery at 4 kW on a low voltage grid”); SAE Standards (Ex. 1031) 9 (standard for “AC Level 2” electric vehicle charger is up to 80 amps at 240V, totaling 19.2kW).

A POSA would also have recognized that transmitting power in excess of 3.3kW was advantageous in order to charge an electric vehicle in a reasonable time frame, such as overnight, which electric vehicle consumers would expect. Allen

Decl. ¶¶256-257; *see* Hall (Ex. 1029) [0531] (“plugging in at night” is “traditional non-wireless recharging practice[]”). Commercially available electric vehicles in the 2010-2011 timeframe had battery capacities as high as 28 or even 53 kilowatt-hours. Dickerman 57. Only by providing more than 3.3kW of power could these vehicles be charged in a reasonable overnight timeframe. Allen Decl. ¶¶256-257.

Accordingly, a POSA would have been motivated to implement Fells’ power supply to charge an electric vehicle at power levels in excess of 3.3kW in order to charge the vehicle in an overnight timeframe, and would have been able to do so utilizing the design methodology for contact-less electric vehicle battery charging systems described in Wang. As described above, Fells’ description of its invention as “low power” refers to the existence of “standby” mode, and not to the amount of power transferred during charging, and so is not an impediment to this combination. *See* Motivation to Combine Fells and Cook; Allen Decl. ¶¶258, 176-179.

VIII. The Board Should Reach the Merits of This Petition

Discretionary denial is unwarranted. Should Patent Owner allege otherwise in its POPR, InductEV reserves the right to reply to address Patent Owner’s arguments and the law and facts as they stand at that time.

A. Section 325(d) does not warrant denial

Step 1 of the *Advanced Bionics* test is not satisfied here at least for Grounds 3 and 4 because Ono and Wang Thesis were never presented to the Patent Office.

Advanced Bionics, LLC v. Med-El Elektromedizinische Geräte GMBH, IPR2019-01469, Paper 6 at 8 (Feb. 13, 2020) (precedential) (“*Advanced Bionics*”).

Moreover, Step 2 of *Advanced Bionics* is not satisfied with respect to any ground because although Fells and Cook (or similar publications) were listed on the face of the '184 patent, the record is silent regarding the Examiner's analysis of relevant teachings from any of them. *Cf. Volkswagen Grp. of Am., Inc. v. Mich. Motor Techs. LLC*, IPR2020-00452, Paper 12 at 32-33 (Sept. 9, 2020) (error to overlook relevant teachings in a prior-art reference). The record shows no consideration of these references at all, only Patent Owner's single 900-reference IDS. Furthermore, this petition presents Fells and Cook as obviousness grounds, including in combination, and is supported by the declaration of Dr. Allen that explains why a POSA would have combined the teachings of Fells and Cook, none of which was presented during prosecution.

B. *Fintiv* does not warrant denial

Under the current facts, *Fintiv* is not applicable. This petition was filed seven months after service of the complaint in the corresponding district court litigation, and no trial date has been scheduled. If Patent Owner argues otherwise, InductEV will seek permission to reply to address the facts and law as they stand at that time.

IX. Mandatory Notices under 37 C.F.R. § 42.8

A. Real Parties-in-Interest

The real party-in-interest is InductEV, Inc.

B. Related Matters

WiTricity asserted the '184 patent in the following district court case pending in the Eastern District of Pennsylvania: *WiTricity Corp. v. InductEV, Inc.*, No. 2:23-cv-01099-CMR. Petitioner has also filed IPR petitions challenging U.S. Patent Nos. 8,461,719 (IPR2023-01182) and 8,912,687 (IPR2023-01208), and expects to file in the near future an IPR petition challenging U.S. Patent No. 8,466,654, each of which are asserted in the district court case.

C. Grounds for Standing

Petitioner certifies that the '184 patent is available for *inter partes* review and that InductEV is not barred from requesting this proceeding.

D. Lead and Backup Counsel and Service Information

Pursuant to 37 C.F.R. §§ 42.8(b)(3), 42.8(b)(4), and 42.10(a), Petitioner designates the following lead counsel:

- David A. Zucker (Reg. No. 74,095), david.zucker@lw.com, Latham & Watkins LLP; 555 Eleventh Street, NW, Ste. 1000, Washington, D.C. 20004-1304; 202.637.2219 (Tel.); 202.637.2201 (Fax).

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Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney from Petitioner is attached. Petitioner consents to electronic service.

E. Fee for *Inter Partes* Review

The Director is authorized to charge the fee specified by 37 C.F.R. § 42.15(a) to Deposit Account No. 506269.

X. Conclusion

For the reasons set forth above, Petitioner InductEV respectfully requests *inter partes* review of the challenged claims of the '184 patent.

Respectfully submitted,

Dated: October 27, 2023

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CERTIFICATE OF COMPLIANCE WITH 37 C.F.R. § 42.24

I hereby certify that this Petition complies with the word count limitation of 37 C.F.R. § 42.24(a)(1)(i) because the Petition contains a total of 13,862 words, which is the sum of 13,774 words calculated by Microsoft Word's word-count feature and 88 words hand-counted in the figures. This total excludes the cover page, signature block, and the parts of the Petition exempted by 37 C.F.R. § 42.24(a)(1).

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CERTIFICATE OF SERVICE

The undersigned certifies that a complete copy of this Petition for *Inter Partes* Review of U.S. Patent No. 10,027,184 and all Exhibits and other documents filed together with this Petition were served on the official correspondence address for the patent shown in Patent Center via Priority Mail Express on October 27, 2023:

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