

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re *Inter Partes* Review of:)
U.S. Patent No. 8,466,654)
Issued: Jun. 18, 2013)
Application No.: 12/498,159)
Filing Date: Jul. 6, 2009)

For: **Wireless High Power Transfer Under Regulatory Constraints**

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 8,466,654**

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1002	File History for U.S. Patent No. 8,466,654 B2 (“’654 FH”)
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1004	Curriculum Vitae of Mark Allen (“Allen CV”)
1005	U.S. Patent No. 5,617,003 (“Odachi”)
1006	U.S. Patent No. 7,952,322 B2 (“Partovi”)
1007	U.S. Patent No. 5,669,470 (“Ross”)
1008	Chwei-Sen Wang, <i>Design Considerations for Inductively Coupled Power Transfer Systems</i> (2004) (Ph.D. dissertation, University of Auckland) (“Wang”)
1009	U.S. Patent No. 5,821,638 (“Boys-638”)
1010	Declaration of Ingrid Hsieh-Yee in Support of Petition for <i>Inter Partes</i> Review (“Hsieh-Yee Decl.”)
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1013	U.S. Patent Application Publication No. 2010/0231163 A1 (“Mashinsky”)
1014	Malik Elsammany Elbuluk, <i>Resonant Converters: Topologies, Dynamic Modeling and Control</i> (Sept. 22, 1986) (D.Sc. dissertation, Massachusetts Institute of Technology) (“Elbuluk”)
1015	U.S. Patent No. 8,159,183 B2 (“Choi”)
1016	U.S. Patent Application Publication No. 2007/0182367 A1 (“Partovi App.”)

1017	O.H. Stielau & G.A. Covic, <i>Design of Loosely Coupled Inductive Power Transfer Systems</i> , Proceedings of the PowerCon 2000 International Conference on Power System Technology, vol. 1 (Dec. 2000), 85-90 (“Stielau”)
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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”)
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I. Introduction

InductEV (“Petitioner”) requests *inter partes* review of claims 1, 4-10, 12-16, and 18-19 of U.S. Patent No. 8,466,654, titled “Wireless High Power Transfer Under Regulatory Constraints” (“’654 patent”) (Ex. 1001). According to USPTO records, the ’654 patent is assigned to WiTricity Corporation.

The challenged claims recite wirelessly transmitting power from a “transmitting antenna” to a “receiving antenna,” and “align[ing]” those antennas by moving one or the other to a position that results in better “coupling,” such as when charging a vehicle. *E.g.* ’654 patent cls. 1, 8, 13. There was nothing novel about this. The ’654 patent explains that “efficiently coupl[ing] energy” from a “transmitter” coil to a “receiver” coil via a magnetic field was already known. *Id.* 1:15-22. And the ’654 patent does not recite any new methods of coupling or alignment, stating only that the two coils should be “coaxially aligned” for “close proximity coupling.” *Id.* 5:57-65. The challenged claims recite nothing more than the well-known concept of moving one antenna to achieve better alignment or coupling with a second antenna.

Unsurprisingly given this lack of innovation, the challenged claims are invalid. Odachi (Ex. 1005) teaches a wireless vehicle charger in which the transmitting antenna is mounted on a “movable support arm,” which detects and moves to “the target position ... where the [transmitting antenna] is just aligned

with” the vehicle-mounted receiving antenna. Odachi 4:16-32, 11:50-59. Ross (Ex. 1007) teaches a similar system that instead moves the receiving antenna: the vehicle-mounted coil is “auto-position[ed]” to “provide the maximum possible coupling efficiency between the two coils.” Ross 9:44-54, 12:33-62. These pre-existing systems, in combination with well-known elements like “capacitors” or antenna “arrays,” demonstrate that the challenged claims would have been obvious to one of skill in the art.

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

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

- Claims 13 and 15 are unpatentable under 35 U.S.C. § 102 over Odachi
- Claims 1, 7, and 18 are unpatentable under 35 U.S.C. § 103 over Odachi in view of Wang
- Claims 4-6 are unpatentable under 35 U.S.C. § 103 over Odachi in view of Wang and Partovi
- Claims 8-10, 12-14, 16, and 19 are unpatentable under 35 U.S.C. § 103 over Ross in view of Wang

III. Background

A. The '654 Patent (Ex. 1001)

The '654 patent relates to the “transfer of energy between [a] transmitter 104 and receiver 108” that are “coupl[ed]” with “matched or nearly matched resonance” between the two. '654 patent 3:14-23. Such “magnetically resonant transfer of power between antennas” was admittedly already known in the art. *Id.* 1:15-28; Allen Decl. ¶¶45-48. The '654 patent uses this known technique to charge a “battery electric vehicle” using a “primary coil” (located, e.g., “buried into ... a parking lot”) coupled to a “secondary” coil located “on a vehicle,” such that “the primary coil ... delivers the charging power to the vehicle,” as shown below.¹ '654 patent 5:20-56, Fig. 5.

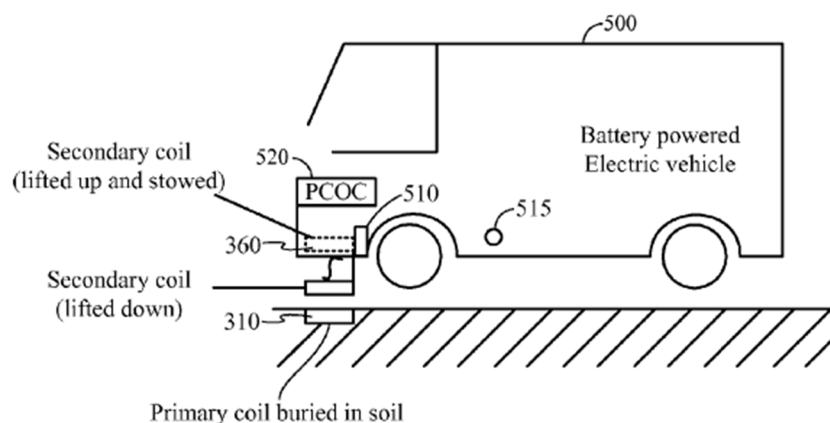


FIG. 5

¹ Unless otherwise stated, all emphases are added and internal quotation marks, citations, and footnotes are omitted.

The '654 patent is directed to nothing more than the idea of “align[ing]” the primary coil with the secondary coil in order to achieve “better” coupling between coils. '654 patent 6:17-20. To achieve better coupling, the patent states that the coils should be “coaxially aligned” and in “close proximity” to each other. '654 patent 5:46-65; Allen Decl. ¶¶49-53. But it was already well-known that “the power transfer capability” of a wireless charging system is significantly influenced by the “relative position between the primary and secondary,” such that aligning coils improves power transfer. Wang (Ex. 1008) 83; *see also e.g. id.* 191 (“misalignment” such as “air gap, offset, and skew angle” affect efficiency of wireless vehicle charger); Odachi 6:1-27 (“alignment” of “the relative position” of antennas allows “the electromotive force induced in the secondary coil” to be “greatest”); Ross 6:25-39 (“maximiz[ing] the alignment between the coils... mak[es] the power transfer ... more efficient”); Allen Decl. ¶53.

To achieve alignment, the '654 patent states that a “guidance system” can “assist the driver ... to accurately position the vehicle.” '654 patent 5:21-6:14. Moving the vehicle provides “coarse positioning,” and a “vehicle-mounted subsystem” then provides “fine alignment” by moving the secondary coil using an “x-y offset control,” such that the secondary coil is “aligned to the primary [coil].” *Id.* 6:15-41. Alternatively, the primary coil can be moved to achieve fine alignment,

and/or the “fine positioning control” can occur on the “z axis” in addition to the “x-y” axes. *Id.* 5:66-67; 6:30-41.

B. Prosecution History

The '654 patent issued on June 18, 2013 from an application filed on July 6, 2009, and claims priority to provisional application No. 61/078,812 filed on July 8, 2008.

During prosecution, the Examiner did not consider Odachi, Wang, or Ross, or any of the combinations of references put forth in this petition. *See generally* '654 FH (Ex. 1002).

With respect to Ground 2, although the Examiner did not consider Ross, they considered another patent by the same inventor (Ex. 1011, “Ross-090”). The Examiner rejected certain proposed claims of the '654 patent as anticipated by Ross-090, or obvious over Ross-090 in combination with other references not used in this petition. The Examiner claimed that Ross-090 did not teach certain elements such as an “alignment controller configured to detect coupling...” and ultimately allowed the claims in response to further amendment. '654 FH 154-159, 175-193.

As explained in Ground 2 and Section VIII, the Examiner’s statements and decision to allow the patent over Ross-090 during prosecution do not apply to Ross here, or were error. For example, the Examiner stated that Ross-090 does not “disclose an alignment controller ... to adjust the position ... of said transmitting

antenna.” ’654 FH 155. This petition does not argue that Ross adjusts the transmitting antenna, but only that Ross adjusts the receiving antenna (which is all that is required for the challenged claims). *See* Ground 2. To the extent the Examiner claimed that Ross-090 does not disclose an “alignment controller that detects coupling” more broadly, ’654 FH 159, that was material error and is inapplicable to Ross, as explained in Ground 2 and Section VIII.

C. Person of Ordinary Skill in the Art (“POSA”)

A POSA at the time of the earliest priority date (July 2008) 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 in the field of wireless energy transfer. This description is approximate, and a higher level of education or skill might make up for less experience, and vice-versa. The grounds in this petition do not turn on this specific definition; the claims are unpatentable from the perspective of any reasonable level of ordinary skill. Allen Decl. ¶¶39-44.

D. Claim Construction

The prior art in this petition discloses the subject matter of the challenged claims under any reasonable construction, including their plain meaning.² Allen

² Petitioner reserves the right to argue alternative constructions in other proceedings, and where such a defense is available, that the claims are indefinite.

Decl. ¶¶58-59.

IV. Ground 1a: Claims 13 and 15 Are Unpatentable Over Odachi

Odachi teaches every element of claims 13 and 15.

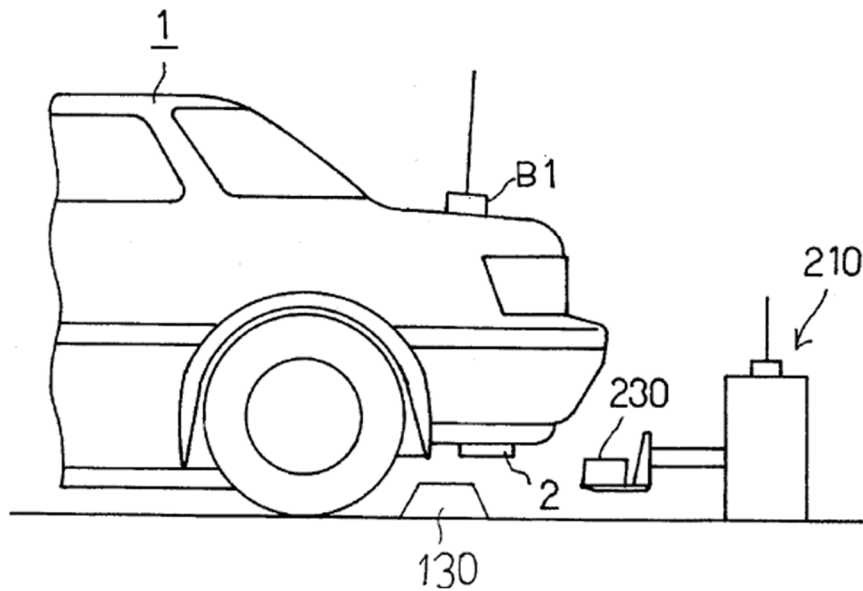
A. Odachi (Ex. 1005)

U.S. Patent No. 5,617,003 to Odachi (“Odachi”) is prior art under pre-AIA 35 U.S.C. § 102(a), (b) and (e) because it was filed on March 22, 1996 and issued on April 1, 1997, before the ’654 patent’s claimed priority date.

Like the ’654 patent, Odachi “charg[es] a battery of an electric vehicle through inductive coupling.” Odachi Abstract. A “primary inductive device” consisting of a “primary coil connected to a power source” supplies power to a “secondary inductive device ... mounted on the bottom of the vehicle.” *Id.* In operation, a “magnetic circuit is formed” between the primary and secondary inductive devices such that “an electric current flows in the primary coil 14 to induce a secondary current in the secondary coil,” charging the vehicle battery. *Id.* 4:34-47, 8:40-54; Allen Decl. ¶¶62-64 (overview of Odachi).

In order to be charged, the vehicle is parked near “wheel stops 130,” as shown below. Odachi 8:1-15.

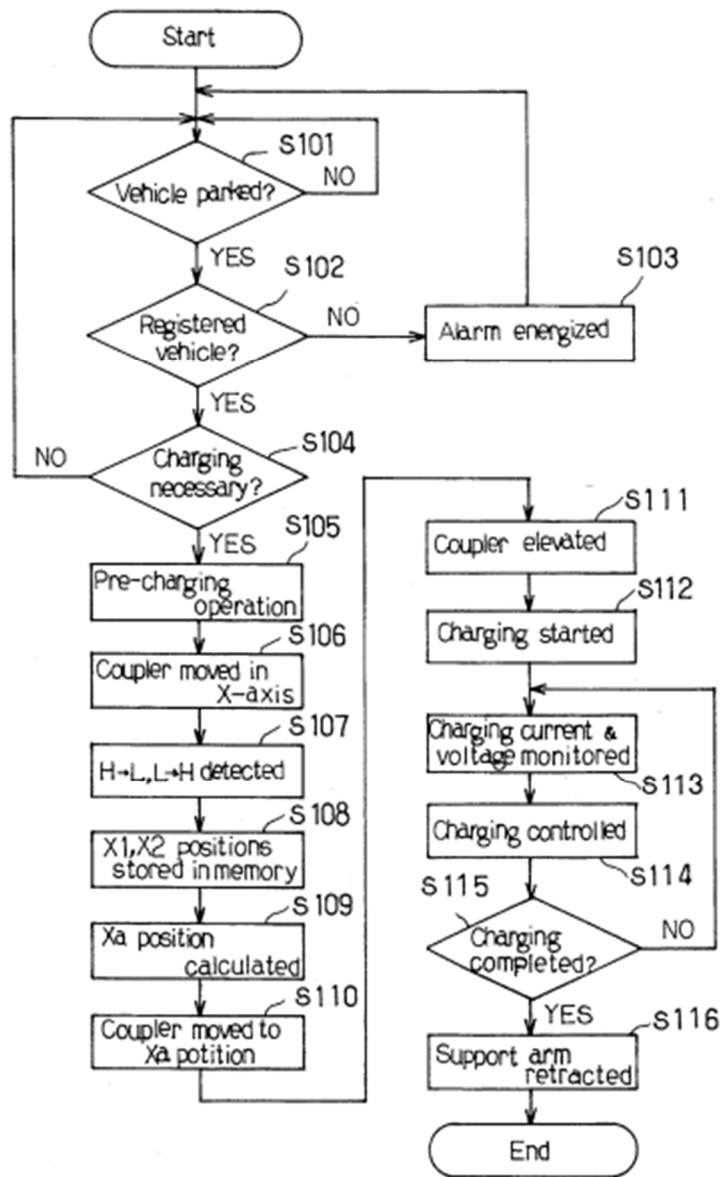
Fig. 6



Id. Fig. 6. The receiving antenna (“secondary inductive device 2”) mounted on the bottom of the vehicle is thus positioned near the transmitting antenna (“primary inductive device or coupler 230”), which is mounted on a “support arm” of “ground battery charger 210.” *Id.* 8:16-54; *see* 4:16-28, 7:27-38; Allen Decl. ¶¶65-66.

After parking, a “positioning apparatus” moves the support arm to better align the two antennae, as described with reference to Figures 11 and 14 below. Odachi 8:55-62; Allen Decl. ¶¶65-77 (explaining flow chart).

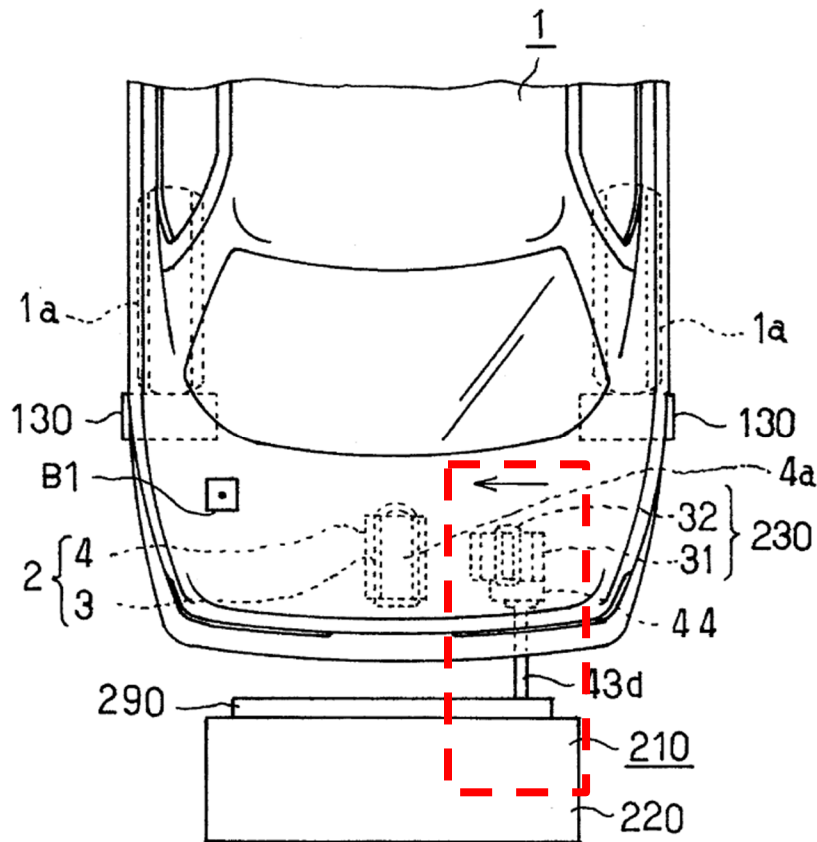
Fig. 14



Odachi Fig. 14. Starting at steps S101-S104, the vehicle is parked, registered, and charging is determined to be necessary. Odachi Fig. 14, 10:36-11:17; Allen Decl. ¶¶66-68. Then a “pre-charging operation” (S105) sets the controller into “positioning mode,” which “suppl[ies] a check current I_{RMS} to the primary coil.” *Id.*

1:6-17, 10:64-11:17, Fig. 14. Alternatively, a “voltage V_{RMS} which is induced across the secondary coil on the vehicle” can be used. Odachi 13:39-64; Allen Decl. ¶69.

At steps S106-S108, the controller “starts the X-axis motor” to “move the support arm 43d [on which the primary coil is mounted] leftward from its operative home position E1 at a constant speed,” as shown below. *Id.* 11:6-59; Figs. 11, 14.



Allen Decl. ¶70 (annotating Odachi Fig. 11).

As the support arm and primary coupler move leftward, monitoring circuits measure the changing magnitude of I_{RMS} or V_{RMS} . Odachi 11:6-59, 6:1-27, 13:39-64; Allen Decl. ¶¶70-73. As the support arm completes its sweep, these

measurements are used to calculate a “target position XA” (S109), and the primary coupler is then moved to position XA (S110), such that it is “aligned with the secondary inductive receptacle 2 along the X-axis.” Odachi 11:6-59, 7:10-13. The same process can then be repeated along the Y-axis. *Id.* 14:19-34 (alignment “in the vehicle longitudinal direction”); Allen Decl. ¶¶74. The support arm can also be aligned in the “Z-axis” direction.” Odachi 11:60-12:7, 13:3-9; Allen Decl. ¶¶75. After alignment is complete, the vehicle is charged via inductive coupling. Odachi 12:8-43; Allen Decl. ¶¶76-77.

B. Claim 13

1. Claim Element 13[pre]: Preamble

To the extent the preamble is limiting, Odachi teaches “[a] method, comprising....” Allen Decl. ¶¶100-101.

Odachi discloses a “method and apparatus” for electric vehicle charging using “inductive coupling,” as detailed for the following elements. Odachi Abstract; Allen Decl. ¶101.

2. Claim Element 13[a]: Guiding a Receiving Antenna into a First Alignment Position

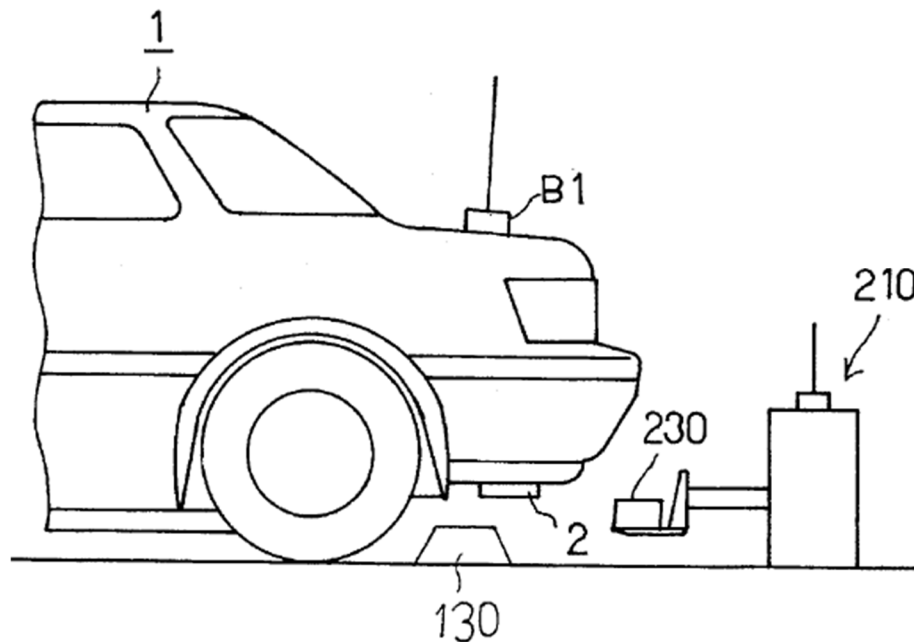
Odachi teaches “guiding a receiving antenna of a vehicle to a first alignment position relative to a transmitting antenna.” Allen Decl. ¶¶102-109.

Specifically, Odachi discloses an “electric vehicle” that has on its “bottom” “a secondary inductive device or receptacle 2 comprised of a core 3 and a coil 4.”

Odachi 8:1-15; *see* 4:6-15 (secondary inductive device is “power receiving”). This “secondary inductive device” corresponds to the claimed receiving antenna. Allen Decl. ¶103.

As shown below, “the vehicle 1 to be charged is parked in the garage 140” by a driver “with its rear wheels 1a placed in contact with the stops 130.” Odachi 8:1-15, 12:43-52 (describing “the parking operation by the driver”).

Fig. 6



Odachi Fig. 6; *see* Fig. 7 (showing same arrangement); Allen Decl. ¶104. A “ground battery charger 210 ... including a primary inductive device or coupler 230 comprised of a core 31 and a coil 32” is located “behind the stops.” Odachi 8:16-28. The primary inductive device “engage[s] with the secondary inductive receptacle

230 [to] form a magnetic circuit,” charging the vehicle via induction. Odachi 8:40-54, 12:8-26; Allen Decl. ¶105.

The primary inductive device (claimed transmitting antenna) is mounted on a movable “support arm 43d” (shown above, not labeled). Odachi 8:16-28; Allen Decl. ¶105. A “wireless transmitter” on the vehicle sends “a parking signal” indicating “that the vehicle 1 has been parked properly,” and primary inductive coupler 230 is brought to “its rightmost, operative home position.” Odachi 10:36-11:17; Allen Decl. ¶¶105-108; *see* Element 13[b] *infra*.

A POSA would have understood that a driver positioning the vehicle against the wheel stops and parking in charging position constitutes guiding the secondary inductive device mounted underneath the vehicle (the claimed receiving antenna) to a first alignment position relative to the primary inductive device (the claimed transmitting antenna in its “home position”). Allen Decl. ¶¶106-109; Odachi 8:1-15, 9:52-65 (wheel stops are positioned to ensure that the vehicle coil is within charging range when parked), 11:60-12:7 (same), Figs. 6-7, 11, 14.

3. Claim Element 13[b]: Moving Antenna to Improve Alignment

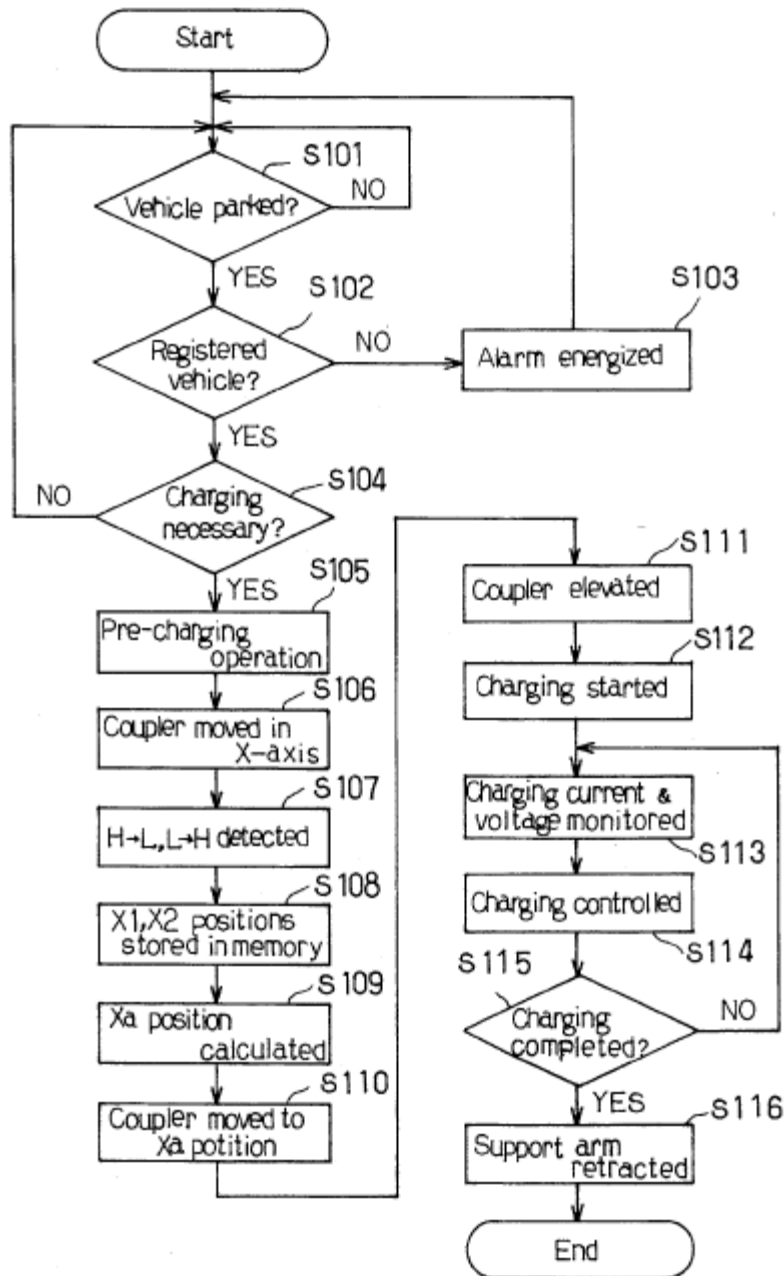
Odachi teaches “responsive to detecting a degree of coupling in the first alignment position between the receiving antenna and the transmitting antenna that is measured at the receiving antenna, moving one of the receiving antenna and the transmitting antenna from the first alignment position to a second alignment position

to improve alignment of the receiving antenna with the transmitting antenna and improve the degree of coupling.” Allen Decl. ¶¶110-125.

As detailed below, Odachi detects a degree of coupling by measuring V_{RMS} , which is the induced voltage across the secondary coil. That measurement is used to calculate a target position XA at which the primary inductive device is better aligned with the secondary inductive device for improved coupling, and Odachi then moves its primary inductive device (the claimed transmitting antenna) from its home position (claimed first alignment position) to position XA (claimed second alignment position). Allen Decl. ¶111; *see* ¶¶112-125.

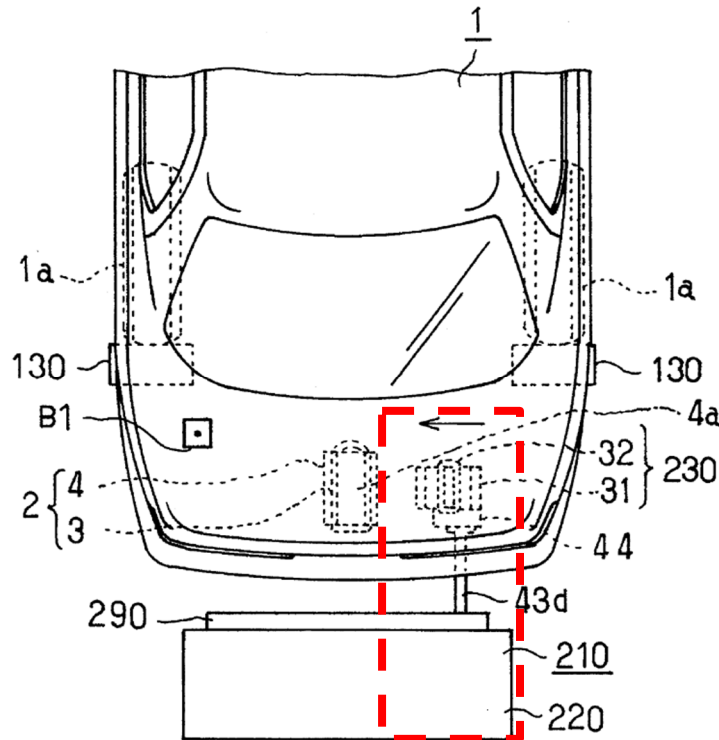
Specifically, Odachi teaches a “control unit” including a “controller” that controls the positioning of the primary inductive device. Odachi 9:66-10:12, 11:6-59. Figure 14 below details the operation of Odachi’s positioning apparatus.

Fig. 14



Odachi Fig. 14; *see* 4:1-2, 10:31-12:42 (describing steps); Allen Decl. ¶¶112-113; ¶¶65-77 (further explaining Fig. 14); *supra* Section IV.A (explaining same flow chart).

After “pre-charging operation[s]” are complete, the controller “starts the X-axis motor 41c” to “move the support arm 43d leftward from its operative home position E1 at a constant speed.” Odachi 11:6-59, Fig. 11; Allen Decl. ¶¶114-115



Allen Decl. ¶115 (annotating Odachi Fig. 11). As the support arm moves leftward, a circuit “monitors the check current I_{RMS} flowing in the primary coil 32” at each position of the support arm, and produces a “high-level” or “low-level” signal. Odachi 11:6-59, Fig. 4, 5:54-6:45; Allen Decl. ¶¶116-118. The controller records positions X1 and X2 “where changes occur in the signal from H to L and vice versa.” *Id.*

Alternatively, rather than monitoring I_{RMS} , positions X1 and X2 can “be determined by monitoring a voltage V_{RMS} which is induced across the secondary coil

on the vehicle by application of an AC voltage across the primary coil.” Odachi 13:39-64; *see* Fig. 5 (showing H and L signals generated from V_{RMS}), 3:1-5 (“monitoring means for detecting a change of electric current or voltage induced in the secondary coil”); Allen Decl. ¶119. As the support arm sweeps leftward, V_{RMS} (like I_{RMS}) is measured at each position, including the starting operative home position E1, to determine positions X1 and X2. Odachi Figs. 4-5, 10:64-11:42, 13:39-64; Allen Decl. ¶120.

A POSA would have understood that because V_{RMS} is the voltage “induced across the secondary coil” by the primary coil, monitoring V_{RMS} constitutes detecting the degree of coupling between the two coils, measured at the receiving antenna. Odachi 13:39-64, Fig. 5; Allen Decl. ¶120. V_{RMS} goes up when the coils are better coupled, and down when the coils are less-well coupled, and scales proportionally with the amount of power being transferred to the secondary coil. Odachi 13:39-64, Fig. 5; Allen Decl. ¶120. Thus, Odachi’s voltage measurement is a mechanism of detecting coupling, matching the mechanism described in the ’654 patent: “a measurement of the amount of power that is transferred to the receiving antenna.” ’654 patent cls. 18-19, 6:9-14; Allen Decl. ¶120; *Adasa Inc. v. Avery Dennison Corp.*, 55 F.4th 900, 910-911 (Fed. Cir. 2022) (prior art “need not disclose the elements in the very same terms used by the patent”).

After X1 and X2 are determined, Odachi's controller calculates the midpoint between them, which represents the "target position XA where the coupler is just aligned with the secondary inductive receptable 2 along the X-axis" – i.e., the position where coupling between the primary coil and secondary coil is strongest. Odachi 11:43-59; 13:53-64; 6:34-45; Allen Decl. ¶121. In response to the coupling measurements taken during the support arm's sweep, the primary coil is moved to this "target position XA" (the claimed second alignment position) where coupling between the primary and secondary devices is strongest. Odachi 11:43-12:7, 14:11-19; Allen Decl. ¶122.

If desired, the process can be repeated to align the coils along the Y-axis (the "vehicle longitudinal direction"). Odachi 14:5-32; Allen Decl. ¶123. After the coupler is moved to position XA in the X- and/or Y-axis, a "Z-axis motor" moves the primary coupler along the Z-axis to a "position where [it] is engaged with the secondary receptacle," which can use the same "automatic positioning" process described above. Odachi 11:50-12:7 (manual), 13:3-9 (automatic); Allen Decl. ¶¶124-125; *see also* Odachi cls. 2, 4 ("first," "second," and "third" separate directions). Once the coils are aligned, a charging current is supplied to the primary coil, initiating vehicle charging via inductive coupling. Odachi 12:8-26.

C. Claim 15: Moving Transmitting Antenna Laterally

Odachi discloses “the method of claim 13, wherein moving one of the receiving antenna and the transmitting antenna comprises moving the transmitting antenna laterally relative to the receiving antenna.” Allen Decl. ¶¶126-128.

As described above for element 13[b], Odachi discloses moving its primary inductive device (claimed transmitting antenna) laterally relative to the secondary inductive device (claimed receiving antenna) in the X-axis and/or Y-axis directions. *Supra* Element 13[b]; Odachi 11:6-59 (“x-axis” movement), 14:19-32 (Y-axis movement “in the vehicle longitudinal direction”); Allen Decl. ¶127. Odachi’s directional adjustments are the same as those in the ’654 specification, which does not use the term “lateral[],” but describes moving a coil with an “x-y offset” – i.e., in either the X-axis or the Y-axis direction. ’654 Patent 6:15-24; Allen Decl. ¶¶127-128.

V. Ground 1b: Claims 1, 7, and 18 Are Unpatentable Over Odachi and Wang

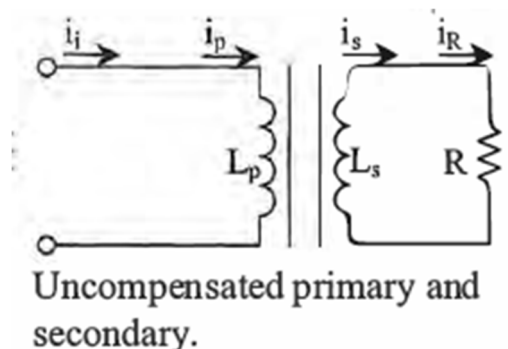
Odachi in view of Wang renders obvious claims 1, 7, and 18. While Odachi does not specify that its antennas include “capacitor[s]” or are “resonant,” this would have been an obvious modification to increase their power transmission capability and efficiency, as described in Wang.

A. Wang (Ex. 1008)

Wang, a doctoral dissertation 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 Cover; Hsieh-Yee Decl (Ex. 1010) ¶¶18-37.

Like Odachi and the '654 patent, to which it is analogous art, Wang 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” with “no physical contact between the primary and secondary,” such as in a “contact-less electric vehicle battery charger.” Wang i; Allen Decl. ¶79.

The “basic ... topologies” of such inductively coupled systems include the “[u]ncompensated” structure shown below in which a primary coil transfers energy to a secondary coil, as in Odachi.



Wang 24; Allen Decl. ¶¶80-82.

In “high power applications,” however, “[b]oth the primary and secondary

[coils] ... are often compensated by capacitors to boost the power transfer capability.” Wang i, 4-5, 20, 47-48 (the “majority” of “medium-high power range” systems are “compensated”). Compensation is accomplished by adding “a capacitor ... either in series ... or parallel” with each coil, as shown below. Wang 20-23; Allen Decl. ¶83.

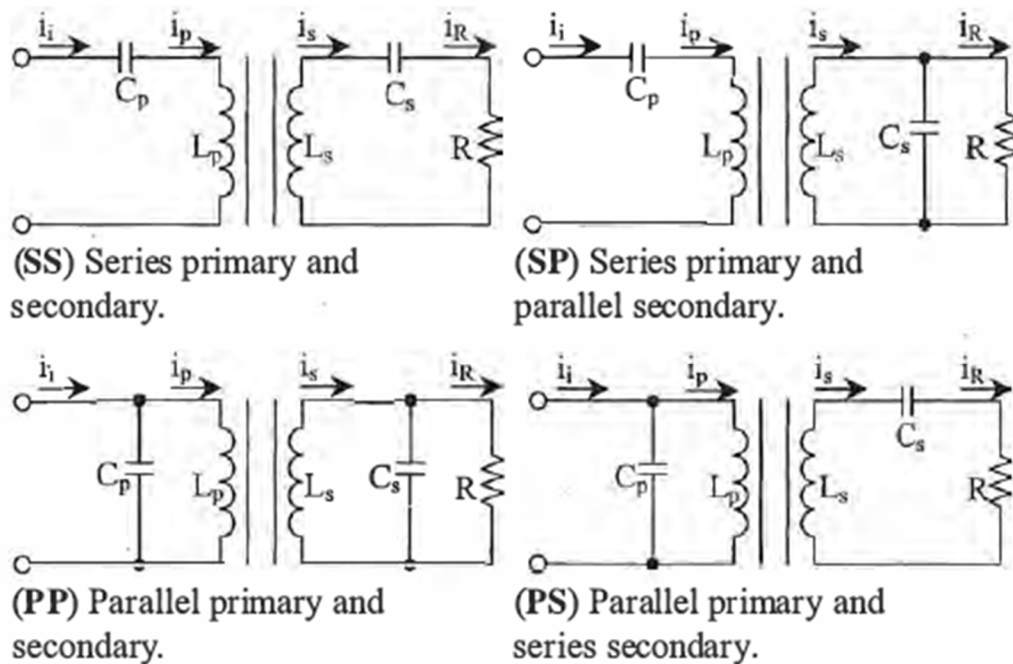


Fig. 2-12. Basic compensation topologies of ICPT systems.

Wang 24.

The compensated primary and secondary coils are “resonant circuits” which are “normally” operated at a “resonant frequency” in order to provide “maximum power transfer.” Wang 11, 20-24, 47 (“the primary resonant circuit is magnetically coupled with one or more secondary resonant circuits”); *see id.* 32 (“the secondary

resonant frequency is designed to be equal to the operating frequency in order to ensure maximum power transfer”); Allen Decl. ¶84.

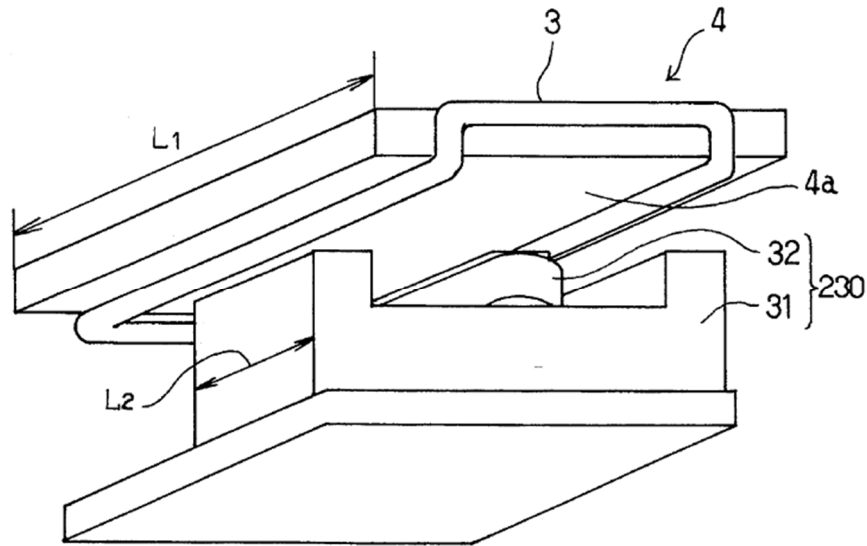
B. Claim 1

1. Claim Element 1[pre]: Preamble

To the extent the preamble is limiting, Odachi teaches or renders obvious “[a] transmitter system for wireless power.” Allen Decl. ¶¶131-140.

Odachi discloses a system for “charging a battery of an electric vehicle” using “inductive coupling” between a “primary coil connected to a power source” and a “secondary coil connected to the battery” of the vehicle. Odachi Abstract; *see also*, *e.g.*, *id.* 12:14-26 (“During the battery charging operation, the primary current flow[s] in the primary coil 32 and secondary current [is] induced in the secondary coil”); Allen Decl. ¶132. A POSA would have understood Odachi’s system to provide “wireless power” because power is transferred to the vehicle via inductive coupling, rather than through physical electrical contacts. Odachi Abstract; Allen Decl. ¶133; Wang i (“the term “inductively coupled” indicates a system with “no physical contact between the primary and secondary”).

As shown below, Odachi’s “primary coil 32” and “secondary coil 4” are not in contact with each other when charging.



Odachi Fig. 12; *see id.* 3:64-65 (“Fig. 12” shows “paired primary and secondary inductive devices”), 8:40-54 (primary coil is “within the cavity” of the secondary coil, such that “a space is formed between the primary and secondary coils on both sides thereof”); Allen Decl. ¶135. This matches the ’654 patent’s statement that “wireless power” means “any form of energy ... transmitted from a transmitter to a receiver without the use of physical electromagnetic conductors.” ’654 patent 2:5-9; Allen Decl. ¶134. Odachi has no such physical conductors. Allen Decl. ¶¶133-136.

To the extent Patent Owner contends that Odachi does not teach “wireless power,” it would have been obvious to implement Odachi wirelessly, with its primary and secondary inductive couplers spaced slightly apart. Allen Decl. ¶¶136-140. As Odachi explains, its devices need not be physically connected: “electromagnetic induction occurs between the coupler and the receptacle when the

former coupler *comes close to* the latter receptacle. As a result, an electromotive force is induced in the secondary coil.” Odachi 6:1-8; Allen Decl. ¶137; *see also* Odachi 4:41-47 (describing “magnetic circuit” that “induce[s] a secondary current in the secondary coil.”), Fig. 12 (showing gap between coils), 3:64-65 (describing Fig. 12), 8:40-54 (“a space is formed between the primary and secondary coils”).

A POSA would have understood, in view of their own knowledge and examples including Wang, that inductively coupled systems for charging vehicles could have been and frequently were implemented wirelessly. Allen Decl. ¶¶138-140; *see, e.g.*, Wang i (“[i]nductively coupled power transfer (ICPT) systems use electromagnetic fields to transfer electric power ... [with] no physical contact between the primary and secondary”); Lee (Ex. 1021) 839 (“inductive power transfer system” can “transmit power without contact”); Green (Ex. 1019) 694 (“magnetic coupling” is distinct from systems that use “physical contact”).

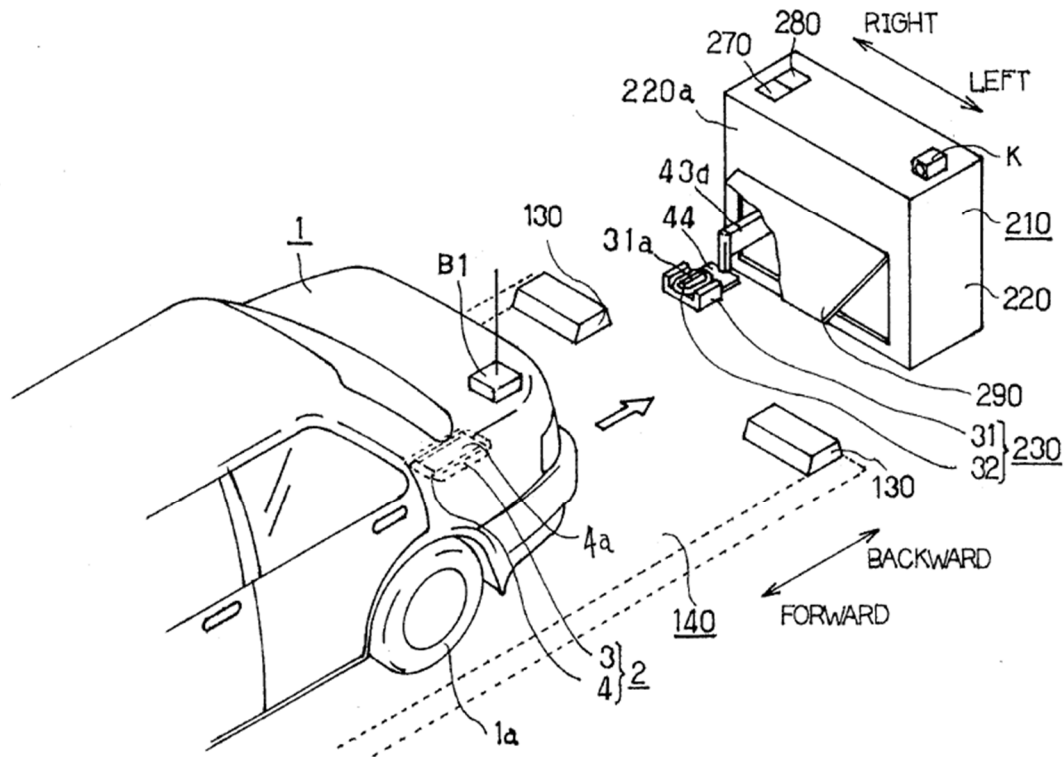
A POSA would have been motivated to implement Odachi without contact between the primary and secondary (to the extent not already taught) because doing so would increase system reliability by eliminating the problems of friction, wear-and-tear, and debris which could otherwise cause malfunctions. Allen Decl. ¶¶139-140; *see, e.g.*, Hu (Ex. 1020) 6 (“mechanical wear & tear, and electrical erosion are eliminated” in wireless system because “there is no direct friction”); Green 694 (“magnetic coupling is very advantageous – it is immune to dirt, dust and the

environment”); Lee 839 (“transmit[ting] power without contact enables high reliability and easy maintenance”). In addition, a POSA would have understood that wireless power transfer systems reduced sparks, making the system safer. Allen Decl. ¶¶139-140; Hu 6 (“there is no direct electrical contact ... so it is spark free. In addition, there are no open live wires, thus the possibility of accidental electric shock is eliminated.”); Green 694 (“magnetic coupling ... is spark free, robust and reliable”).

2. Claim Element 1[a]: Transmitting Antenna

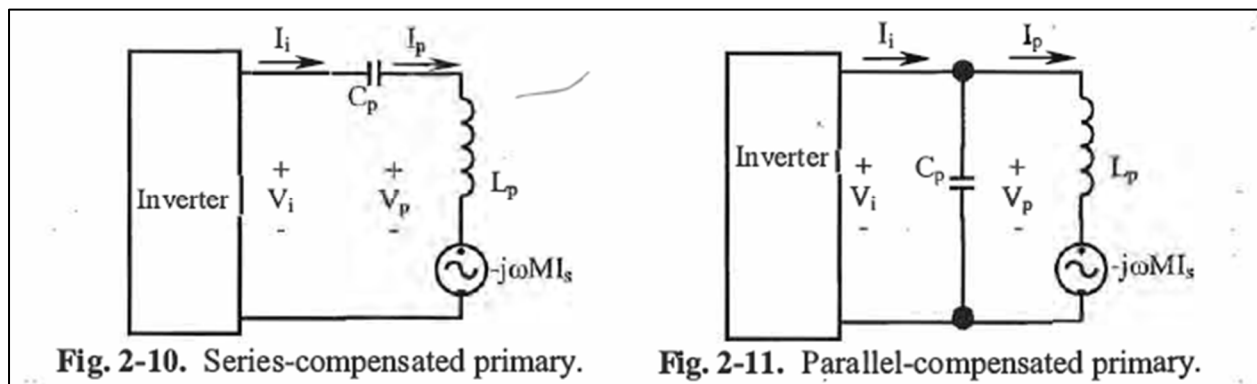
Odachi and Wang render obvious “a transmitting antenna including an inductive element and a capacitor, said transmitting antenna being resonant at a first frequency, said transmitting antenna being configured to generate a wireless field for charging a device including a receiving antenna.” Allen Decl. ¶¶141-155.

Odachi discloses a “primary inductive device or coupler 230” that corresponds to the claimed “transmitting antenna,” as shown below. Odachi Abstract, 8:16-28; Allen Decl. ¶142.



While Odachi is silent about the use of a capacitor and a resonant frequency, a POSA would have considered it obvious to include a capacitor connected to each of Odachi's primary and secondary coils, creating circuits that resonate at a particular frequency and generate (and receive) a wireless magnetic field to charge the vehicle. Allen Decl. ¶¶145-155. Inductor-capacitor resonant circuits were well known in the art, as described at least in Wang. Wang 47; Allen Decl. ¶¶146-148.

Wang, like Odachi, describes an “[i]nductively coupled” system that uses “electromagnetic fields to transfer electric power ... without contact.” Wang 1. In such a system, “a capacitor (C_p) can be connected in series ... or parallel ... with the primary winding [or coil],” as shown below.



Wang 22-23. Similarly, “[t]o compensate for the secondary inductance (L_s), a capacitor (C_s) can be connected either in series ... or parallel ... with the secondary winding [or coil].” *Id.* 20.

It would have been obvious to a POSA to implement this arrangement, known as “compensating” an inductive circuit with capacitors, in Odachi by connecting a

capacitor C_p in series with or parallel to “coil 32” of the “primary inductive device,” and another capacitor C_s in series with or parallel to “coil 4” of the “secondary inductive device or receptacle” on the vehicle. Allen Decl. ¶¶146-148; *see* Wang 4-7, 11, 20-25, 38 (describing compensation techniques); *see also* Wang-IEEE (Ex. 1025) 996 (describing parallel compensation); Elbuluk (Ex. 1014) 19 (“capacitors are usually used with induct[ors]” to “compensate[.]” and “improve the power factor”); Cook-086 (Ex. 1012) 5:6-22 (“well known” to use capacitor “to bring [a] loop antenna to resonance”). The result would be that Odachi’s compensated primary inductive device operates as a “primary resonant circuit” that is “magnetically coupled” with a “secondary resonant circuit” (Odachi’s secondary inductive device or receptacle), thereby “supply[ing] power to a load” (the receiving vehicle of Odachi). Wang 47; Allen Decl. ¶149.

A POSA would have understood that, when compensated, Odachi’s primary device was resonant at a first frequency, as Wang explains that compensated primary circuits have a “primary resonant frequency” which “is normally designed to equal the nominal frequency.” Wang 23; Allen Decl. ¶149. Similarly, Odachi’s compensated secondary device would have a “secondary resonant frequency” which is also “normally designed to equal the nominal frequency.” Wang 20; Allen Decl. ¶149.

A POSA would have been motivated to use capacitor-compensated resonant circuits in Odachi, as this design was nothing more than a combination of known elements (inductive coils and capacitors) arranged according to known methods (connected in series or parallel resonant circuits) to yield predictable results (a resonant power transfer system). Allen Decl. ¶150; *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 401, 416 (2007). As Wang explains, “the primary and secondary [coils]” of such systems “[we]re *often* compensated by capacitors,” which were “basic compensation topologies.” Wang 20. Indeed, the “*majority*” of “inductively coupled power transfer systems” that operated “in the medium-high power range” were “compensated” with capacitors in this manner. Wang 47-48; *see also id.* 4 (“primary and secondary windings ... [were] *normally* compensated by capacitors”); Allen Decl. ¶¶150-151. A POSA would have understood that providing wireless power to an electric vehicle, as in Odachi, is a “medium-high power range” application and would therefore benefit from compensating capacitors. Allen Decl. ¶151.

In addition, a POSA would have been motivated to use capacitor-compensated circuits to increase Odachi’s ability to efficiently transfer power, including at higher voltages or current. Allen Decl. ¶¶152-155. As Wang explains, the reason “primary and secondary” coils “are often compensated by capacitors” is because doing so “boost[s] the power transfer capability of the pickup, while minimizing the VA

rating of the power supply.” Wang 20; *see id.* 4 (“[T]o increase the amount of power transferred” requires “high frequency” which “is normally compensated by capacitors”); *Volvo Penta of the Americas v. Brunswick Corp.*, 81 F.4th 1202, 1209 (Fed. Cir. 2023) (claims obvious where “the prospect of increased ... efficiency has the support of an express statement” in the prior art). Thus “series and parallel secondary compensation *improve the power transfer capability of the pickup*,” as compared to uncompensated circuits. Wang 21; Allen Decl. ¶152; *see also* Wang-IEEE 995 (“resonant circuits are normally employed ... to boost the power transfer capability”). Compensated primary circuits were also known to yield “useful” “voltage gain” or “current gain.” Wang 23-24; *see id.* 38 (the “objective” of “primary compensation” is “voltage gain” or “current gain”).

A POSA would have recognized that by transferring power more efficiently, the modified Odachi could wirelessly charge more powerful vehicles, charge vehicles quicker, and compensate for obstacles that might otherwise impede transfer efficiency. Allen Decl. ¶¶152-153; Wang 4-5. Indeed, the Examiner noted this same rationale (with different prior art) multiple times in rejecting then-pending claims of the ’654 patent:

It would have been obvious to one of ordinary skill in the art at the time of the invention to ... adopt[] the inductive element with capacitor structure for primary antenna for the benefit of increasing the efficiency of the energy transfer.

'654 FH 118; *see id.* 120-121 (same finding for receiver antenna).

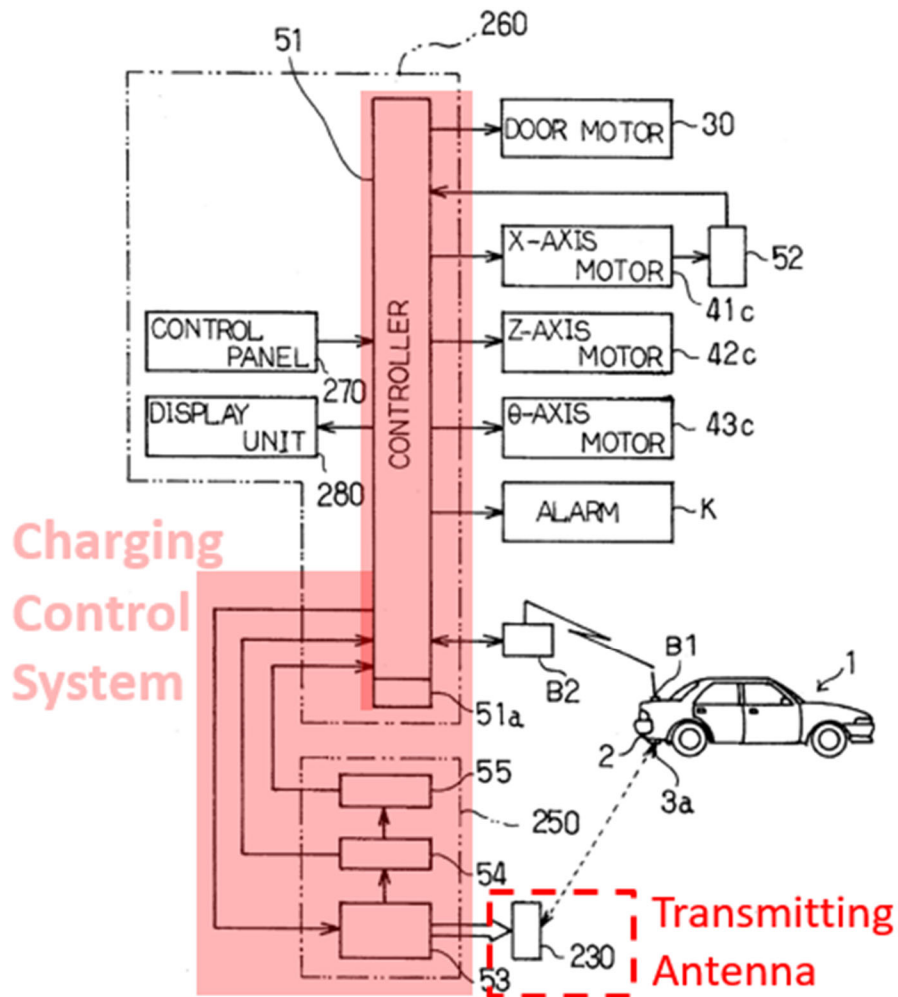
A POSA would have been readily able to implement Wang's resonant compensated circuits in Odachi's system because this arrangement was well-known. Allen Decl. ¶154. Capacitors were "often" used to "boost the power transfer capability" of inductively coupled systems. Wang 47, 20; Allen Decl. ¶154. Both uncompensated primary and secondary circuits (as originally in Odachi) and compensated circuits (as a POSA would modify Odachi) were "fundamental" or "basic compensation topologies" whose circuit diagrams and functionalities would have been well-known to a POSA. Wang 24; Allen Decl. ¶¶154-155; *see also* Stielau (Ex. 1017) 86 (describing same as "basic compensation topologies").

3. Claim Element 1[b]: Charging Control System

Odachi and Wang render obvious "a charging control system coupled to said transmitting antenna and configured to generate a signal at said first frequency and provide said signal to said transmitting antenna." Allen Decl. ¶¶156-161.

Odachi discloses a charging control system coupled to the transmitting antenna, namely "controller 51" and "power unit 250" connected to "primary inductive coupler 230" as shown below.

Fig. 13



Allen Decl. ¶157 (annotating Odachi Fig. 13). Power unit 250 includes “power circuit 53,” which is “connected to the controller 51 and also to the primary coil 32 of the inductive coupler 230.” Odachi 10:13-30; Allen Decl. ¶157.

Odachi’s charging control system is configured to generate and provide a signal to the transmitting antenna, as power circuit 53 “selectively suppl[ies] to the coil an electric current for battery charging.” Odachi 10:13-30, 12:8-13 (“power circuit 53 ... responding to the signal from the controller, starts to supply a charging

current to the primary coil 32 of the inductive coupler 230, thereby initiating the battery charging operation”); Allen Decl. ¶158.

Odachi teaches that this signal is an “AC charging current,” and that the controller “control[s] the primary current or voltage so that a secondary current of a constant value flows in the secondary coil.” Odachi 5:18-39, 7:27-38, 12:14-26; Allen Decl. ¶158. Odachi does not specify the frequency at which the current is provided, leaving that detail up to the implementing POSA. Odachi 5:18-39, 7:27-38, 12:14-26; Allen Decl. ¶159.

When Odachi is implemented using compensated circuits, the AC current signal provided from power circuit 53 to the primary device would (or would obviously) have the same frequency at which the primary device is resonant, in order to ensure maximum power transfer. Allen Decl. ¶¶159-160; *supra* Element 1[a]. As Wang explains, a compensated primary circuit is driven by an alternating current at “operational frequency ω .” Wang 16-17; *see id.* 17 (“a constant current I_p at a known frequency ω flows in the primary”). This “primary current is normally controlled at the maximum rating to ensure maximum power transfer capability.” *Id.* 19. The way to achieve this “maximum power transfer” is “normally” for the “secondary resonant frequency” and the “primary resonant frequency” to each “equal the nominal frequency (ω_0),” and then to set the “operating frequency around the resonating frequency (ω_0).” Wang 20, 23, 31-32; *see id.* 32 (“the secondary resonant

frequency is designed to be equal to the operating frequency in order to ensure maximum power transfer”); Allen Decl. ¶¶159-160. Thus, for maximum power transfer, a POSA implementing Odachi with compensated circuits would ensure that the secondary and primary have the same resonant frequency, and that the primary device is operated by an alternating current (the AC current provided from the power unit) driven at that same frequency. Allen Decl. ¶¶159-160; Wang 20, 23, 31-32, 52 (“magnetic coupling ... is dependent on the operating frequency of the primary power supply”).

It was within a POSA’s knowledge and skill to drive Odachi’s compensated primary device with a current signal whose operating frequency was equal to the resonant frequency of the primary and secondary coils using the formulas provided in Wang. Allen Decl. ¶161; *see* Wang 20-21 (formulas showing effect of “secondary compensation capacitance” on nominal frequency and “pickup power”), 22-24 (same for primary compensation).

4. Claim Element 1[c]: Alignment Controller

Odachi discloses “an alignment controller configured to test coupling of said transmitting antenna to the receiving antenna in the first alignment position and based on a degree of the coupling, the alignment controller further configured to adjust an x-y alignment of the transmitting antenna relative to the receiving antenna from the first alignment position to a second alignment position having a finer

alignment between the receiving antenna and the transmitting antenna than the first alignment position to improve said coupling.” Allen Decl. ¶¶162-170.

As described for Element 13[b], Odachi teaches a “controller” that moves the primary inductive coupler along the X-, Y-, and/or Z- axis starting at its “home position” and ending at a “target position XA where the coupler is just aligned with the secondary inductive receptacle.” *Supra* Element 13[b], Odachi 11:6-59, 10:13-30; 13:46-53; 14:12-32; Allen Decl. ¶163. Target position XA is determined by monitoring either “check current I_{RMS} ” in the primary coil or “voltage V_{RMS} ... induced across the secondary coil” at numerous positions as the primary inductive device is swept across the secondary device. *Supra* Element 13[b]; Odachi 10:13-30, 11:6-59, 13:39-64, 14:12-32. Specifically, a circuit compares I_{RMS} or V_{RMS} to a reference value, and generates a high or low signal as the inductive coupler is swept across the secondary coil. Odachi 10:13-30, 11:6-59, 13:39-64; 14:12-32. The system records the positions (X1 and X2) of the primary coupler when the signal switches from H to L, or vice-versa, and calculates the midpoint of those positions as the best-aligned position XA. Odachi 10:13-30, 11:6-59, 13:39-64; 14:12-32. The primary coupler is then moved to position XA. *Id.*; Allen Decl. ¶¶163-164.

Thus, a POSA would have understood that Odachi’s “controller” and related motors and circuitry constitute an “alignment controller,” and that they adjust the x-y alignment of the primary coupler, because they control alignment of Odachi’s two

coils by moving the primary coil from its home position to target position XA where it is better aligned with, and better coupled to, the vehicle coil. Allen Decl. ¶¶163-66.

A POSA would have further understood that Odachi's controller "test[s] coupling" of the primary device because it monitors I_{RMS} and V_{RMS} , which change proportionally to the "electromagnetic induction ... between the coupler and the receptacle." Odachi 6:1-45 (describing how I_{RMS} varies with coupling); 11:17-32 (same); 13:39-64 (same for V_{RMS}); Allen Decl. ¶¶167-169. In other words, I_{RMS} and V_{RMS} indicate the degree of "coupling" because their changes reflect changes in the amount of power being induced in the secondary coil. Allen Decl. ¶¶167-169. This is the same mechanism of testing coupling described in the '654 patent: "measurement of the amount of power that is transferred to the receiving antenna." '654 patent cls. 18-19, 6:5-14.

As Odachi performs its sweep, this testing occurs at a number of "first alignment positions" at which I_{RMS} or V_{RMS} is measured, including for example the starting position E1, and positions X1 and X2. Odachi Figs. 4-5, 11:18-42, 13:39-64; Allen Decl. ¶¶167-169. Based on the "degree of coupling" at those positions — i.e., the values of I_{RMS} or V_{RMS} — the system adjusts the x-y alignment of the primary inductive coupler by calculating "target position XA" and then moving the primary inductive coupler (in the X- and/or Y-axis directions) to that position, where it will

have better alignment and improved coupling than was obtained at first positions E1, X1 or X2. Odachi 10:13-30, 11:6-59, 13:39-64; 14:12-32; Allen Decl. ¶¶167-169.

This functionality would remain unchanged when Odachi is modified to use capacitor-compensated circuits as taught in Wang. Allen Decl. ¶170.

C. Claim 7: Transmitting Power

Odachi and Wang render obvious “[t]he transmitter system of claim 1, wherein said charging control system [is] configured to generate a signal of a type that, when output to said transmitting antenna, transmits power to a remote receiving antenna.” Allen Decl. ¶¶171-173.

As described for Element 1[b], Odachi’s controller with power unit (claimed charging control system) is configured to generate an AC current signal (claimed signal) that, when provided to the primary inductive device (claimed transmitting antenna), transmits power to the secondary inductive device mounted on the electric vehicle (claimed remote receiving antenna). *Supra* Element 1[b]; Odachi 11:60-12:26 (“the power circuit ... responding to the signal from the controller, starts to supply a charging current to the primary coil 32 of the inductive coupler 230, thereby initiating the battery charging operation.”), Fig. 13; Allen Decl. ¶¶172-173. In other words, “the primary current flowing in the primary coil” is what creates the “secondary current induced in the secondary coil,” resulting in the vehicle receiving

power to charge. Odachi 12:14-26 (“the controller 51 controls the battery charging operation by controlling the primary current or voltage”); Allen Decl. ¶¶172-173.

D. Claim 18: Measuring Power

Odachi and Wang render obvious “the apparatus of claim 1, wherein the coupling test comprises a measurement of the amount of power that is transferred to the receiving antenna.” Allen Decl. ¶¶174-176.

As described for Element 1[c], Odachi teaches a coupling test in that the primary inductive device is swept across the secondary inductive device in either the X or Y-axis direction, while measuring “check current I_{RMS} ” in the primary coil or “voltage V_{RMS} ... induced across the secondary coil.” *Supra* Element 1[c]; Odachi 10:13-30, 11:6-59, 13:39-64; 14:12-32; *see also* Element 13[b] (describing same functionality). The measured I_{RMS} or V_{RMS} values are compared to reference values to generate “high” or “low” signals, which in turn are used to determine a “target position” for maximum coupling, to which the primary inductive device is then moved. *Supra* Elements 1[c], 13[b]; Odachi 11:18-32, 13:39-64; Allen Decl. ¶175.

A POSA would have understood that measuring I_{RMS} or V_{RMS} constitutes measuring the amount of power transferred to the receiving antenna. Allen Decl. ¶176. V_{RMS} directly indicates the “voltage ... across the secondary coil,” which is one component of the transferred power. Odachi 13:39-64; Allen Decl. ¶176. Similarly, I_{RMS} is “smallest” “where the electromotive force induced in the secondary

coil ... becomes the greatest,” and thus inversely indicates the amount of power transferred to the secondary coil. Odachi 6:4-27; Allen Decl. ¶176.

VI. Ground 1c: Claims 4-6 Are Unpatentable Over Odachi, Wang and Partovi

A. Partovi (Ex. 1006)

U.S. Patent No. 7,952,322 to Partovi (“Partovi”) is § 102(e) prior art because it was filed on January 30, 2007 and its application published on August 9, 2007.

Partovi is analogous to the ’654 patent and Odachi in that it discloses an “inductive power source and charging system.” Partovi 6:33-40; Allen Decl. ¶¶85-86. Partovi’s system “comprises multiple coils or sets of wires,” as shown below. Partovi 6:33-40, Figs. 1, 3.

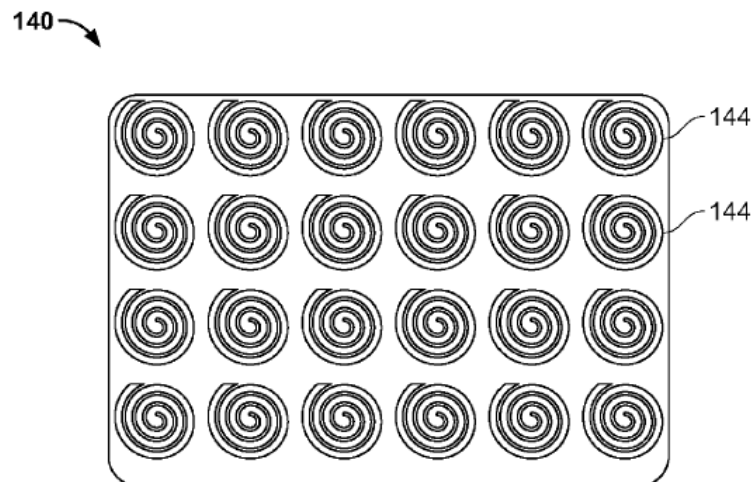


FIG. 3

Partovi Fig. 3. The “total area” of the “charger can be covered by coils ... that create[] [a] magnetic field,” allowing for charging “regardless of [the] position” of

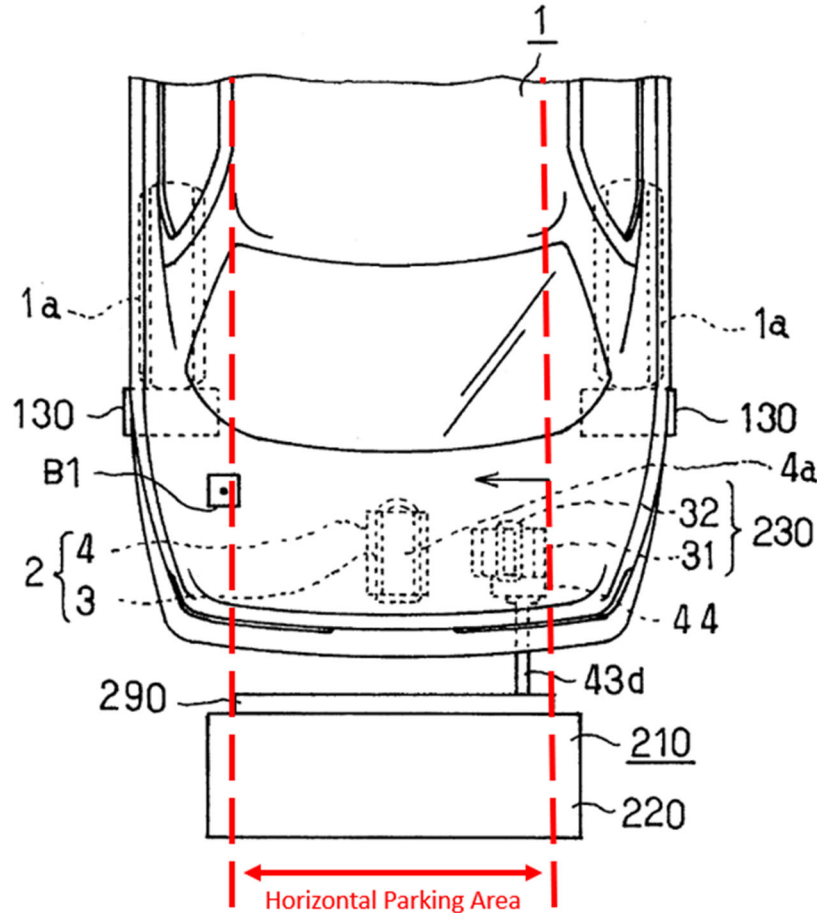
the receiving device. *Id.* 8:53-59; Allen Decl. ¶86. When a “receiver coil” of a device to be charged “is generally aligned upon one or more primary coils,” the primary coils “are capable of being selectively switched or activated by a switch in the base unit.” *Partovi* 26:23-30.

B. Claim 4: Antenna Array

Odachi, Wang, and Parvoti render obvious “[t]he transmitter system of claim 1, wherein said transmitting antenna includes an array of antennas that extend over a specified area of a parking space.” Allen Decl. ¶¶179-189.

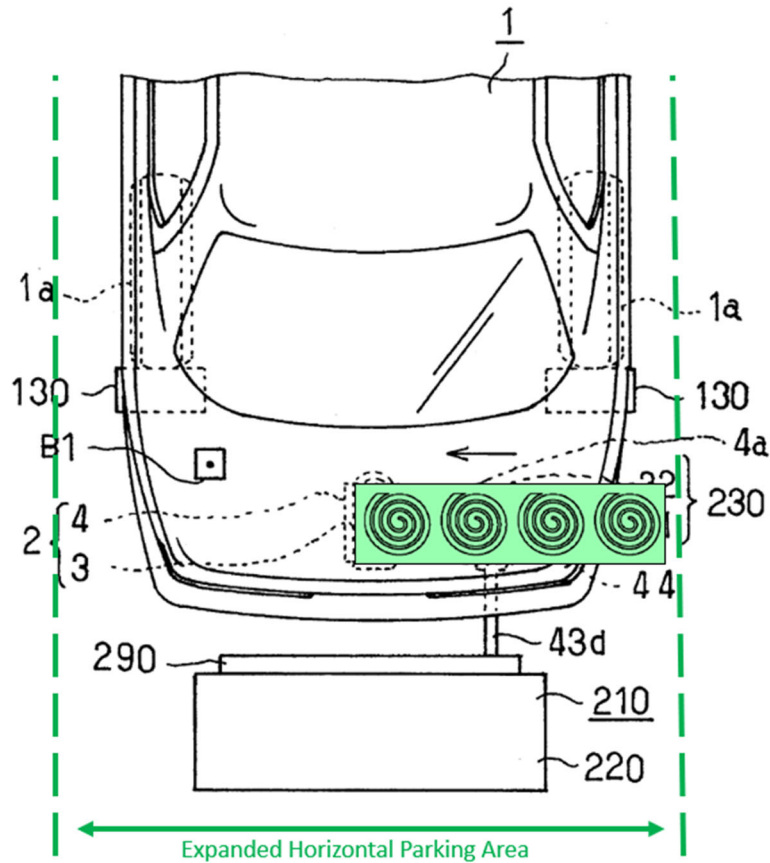
It would have been obvious to a POSA to implement Odachi’s capacitor-compensated system such that the primary inductive device comprises an array of “multiple coils” as in *Partovi*, rather than a single coil. *Partovi* 6:33-40, Fig. 3; Allen Decl. ¶¶180-189. Doing so would expand the “total area” covered by the charger, allowing for vehicle charging to occur “regardless of [the] position” of the vehicle. *Partovi* 8:53-59.

Without modification, Odachi’s charging system requires the vehicle to be parked with the vehicle-mounted coil falling within a limited horizontal parking range, shown below.



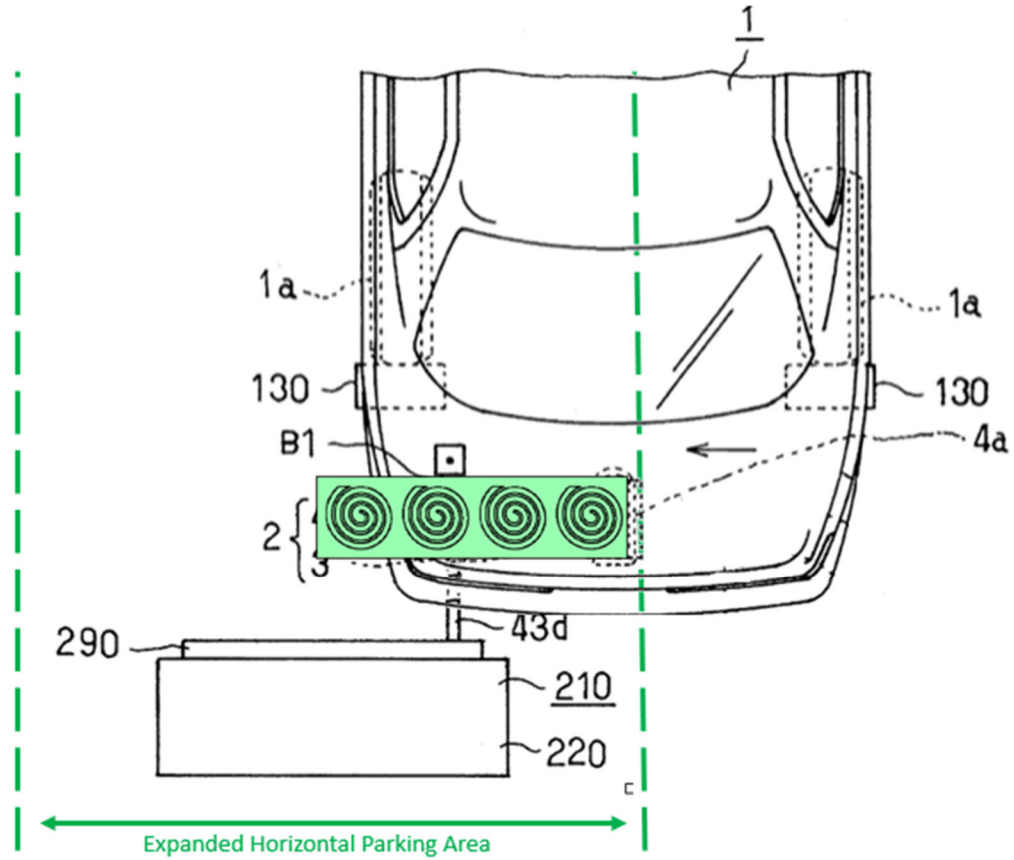
Allen Decl. ¶183 (annotating Odachi Fig. 11); Odachi 12:42-52 (describing “permissible distance ... within which the vehicle should be parked”), 3:18-22 (same). If the car is “parked” with its coil outside the range of support arm 43d, the primary coil cannot reach the secondary coil, and so may not be able to charge the vehicle, or may do so inefficiently. Odachi 8:1-15; Allen Decl. ¶¶182-183.

Mounting an array of coils (as taught by Partovi) on support arm 43d, rather than a single coil, would allow the coils to extend over a larger area of the parking space, expanding the “total area” in which a vehicle could be parked and charged by Odachi’s system, as shown below. Partovi 8:53-59, Fig. 3.



Allen Decl. ¶184 (annotating Odachi Fig. 11 with Partovi Fig. 3). This expanded range would allow the system to charge larger vehicles, or vehicles parked in a less-centered position within the parking space, furthering Odachi’s goal of “free[ing]” the driver “from laborious parking operations in positioning” the vehicle. Odachi 7:39-50, 10:43-53 (vehicle must be “parked properly”); Allen Decl. ¶¶184-185.

For example, while unmodified Odachi allows for only “slight error” in parking, using a coil array would allow vehicles to be charged with proper alignment even when parked with significantly more error, as shown below. Odachi 12:1-7; Allen Decl. ¶186.



Allen Decl. ¶186 (modifying Odachi Fig. 11 with Partovi Fig. 3). Thus, utilizing a coil array “widen[s]” “the range of permissible distance along the X-axis within which the vehicle should be parked,” as Odachi teaches is desirable. Odachi 12:43-52.

A POSA would have had a reasonable expectation of success in using Partovi’s coil array with Odachi, as additional “coils” could be added in the well-known manner already disclosed in Odachi (compensated as described by Wang). Odachi 4:16-32; Allen Decl. ¶¶187-188. Coil arrays required no specialized knowledge or technique, but only “applying an alternating current to a winding, coil,

or any type of current carrying wire.” Partovi Abstract. Moreover, coil arrays for wirelessly charging were already well-known to a POSA. Allen Decl. ¶188; *see* Mashinsky (Ex. 1013) [0053] (“horizontal or vertical array of conducting wires to create resonance in a desired predetermined frequency upon request from the ... vehicle”), Fig. 8; Boys-638 (Ex. 1009) 5:1-15 (“an array of conductors ... to allow powering of vehicles”); Ross 15:47-16:22 (“several modules ... laid end-to-end” provide vehicle charging), Figs. 4, 5; Choi (Ex. 1015) Abstract, 2:35-56, 5:49-56 (“sending coil array”).

Although the above annotations show a 1x4 array with the coil shape shown in Partovi, a POSA could and would have implemented Odachi’s array with other shapes and sizes, including for example a 4x4 array of coils, or coils sized like Odachi’s original coil, for interoperability. Allen Decl. ¶185.

Thus, modifying Odachi and Wang to include Partovi’s array of coils represents a combination of known prior art elements (multiple coils in a wireless charging system) according to known methods (placing coils in an array) to yield predictable results (a wireless power transfer system with increased “total area” of charging). Allen Decl. ¶189.

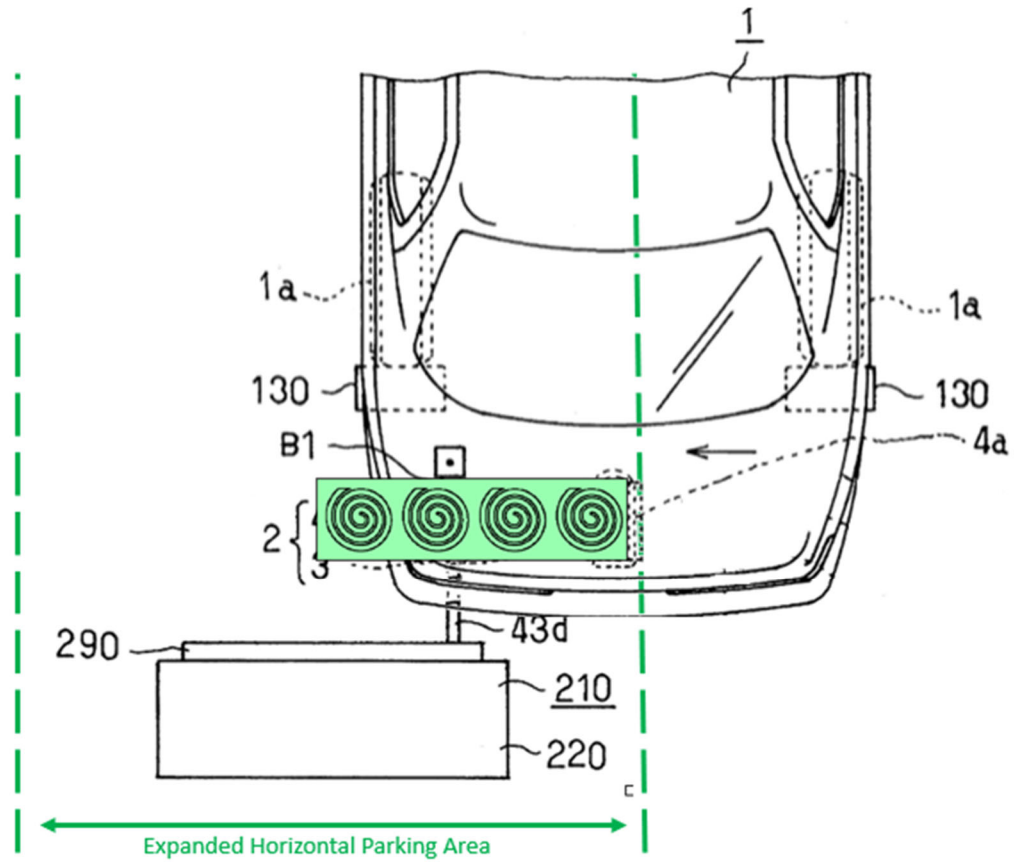
C. Claims 5-6: Antenna Selection and Switch

Odachi, Wang, and Partovi render obvious “[t]he transmitter system of claim 4, wherein said charging control system is further configured to select one of said

antennas of said array” as recited in claim 5, and “[t]he transmitter system of claim 5, further comprising a switching device connected between the charging control system and each of the antennas of the array, the switching device configured to transmit the signal to the selected antenna of the array” as recited in claim 6. Allen Decl. ¶¶190-195.

When implementing Odachi with a coil array, it would have been obvious to further include Partovi’s teaching of “a switch in the base unit” to “selectively switch[] or activate” one coil at a time in order to charge the vehicle. Partovi 26:23-30; Allen Decl. ¶192. In particular, a POSA would have modified Odachi’s “power unit” and “controller” to include a switch between “power circuit 53” and each “primary coil” in the array, such that when the power circuit “selectively suppl[ies] ... an electric current for battery charging,” it supplies that current only to the best-coupled coil in the array. Odachi 10:13-30, Fig. 13; Allen Decl. ¶192.

For example, as shown in the below figure, only the right-most coil would be activated to charge the parked vehicle, as that is the coil closest to, and therefore best coupled to, the vehicle coil.



Allen Decl. ¶193 (modifying Odachi Fig. 11 with Partovi Fig. 3). During “positioning mode,” “the magnitude of the current I_{RMS} ” would be monitored across each coil in the array, as described for Odachi’s single coil. Odachi 11:6-42; *supra* Element 1[c]. Because I_{RMS} is inversely proportional to the level of coupling, the four I_{RMS} signals would be compared against each other, with the “smallest” I_{RMS} value indicating the “greatest” “force induced in the secondary coil,” and therefore the coil that should be activated. Odachi 6:5-27; Allen Decl. ¶¶193-194. Alternatively, each coil could be activated one at a time, in order to measure V_{RMS}

as Odachi teaches, and only the coil yielding the highest V_{RMS} would be selected by the switch and receive current. Odachi 13:39-64; Allen Decl. ¶194.

A POSA would have been motivated to activate one coil at a time, and not all coils in the array simultaneously, both to minimize interference and to save power by not providing current to coils that would only yield, at best, inefficient power transfer compared to the better-coupled selected coil. Allen Decl. ¶195; *Intel Corp. v. Qualcomm Inc.*, 21 F.4th 784, 797 (Fed. Cir. 2021) (“energy efficiency” is “technology-independent, universal, and even common-sensical” motivation to combine).

VII. Ground 2: Claims 8-10, 12-14, 16, and 19 Are Unpatentable Over Ross, Alone or In View of Wang

Ross, alone or in view of Wang, renders obvious to a POSA claims 8-10, 12-14, 16, and 19. Ross discloses an inductively coupled power transfer system using “coils,” but does not specify whether its coils include “capacitor[s]” or are “resonant.” However, this would have been an obvious modification to increase Ross’s efficiency and power transmission capability, as taught in Wang.

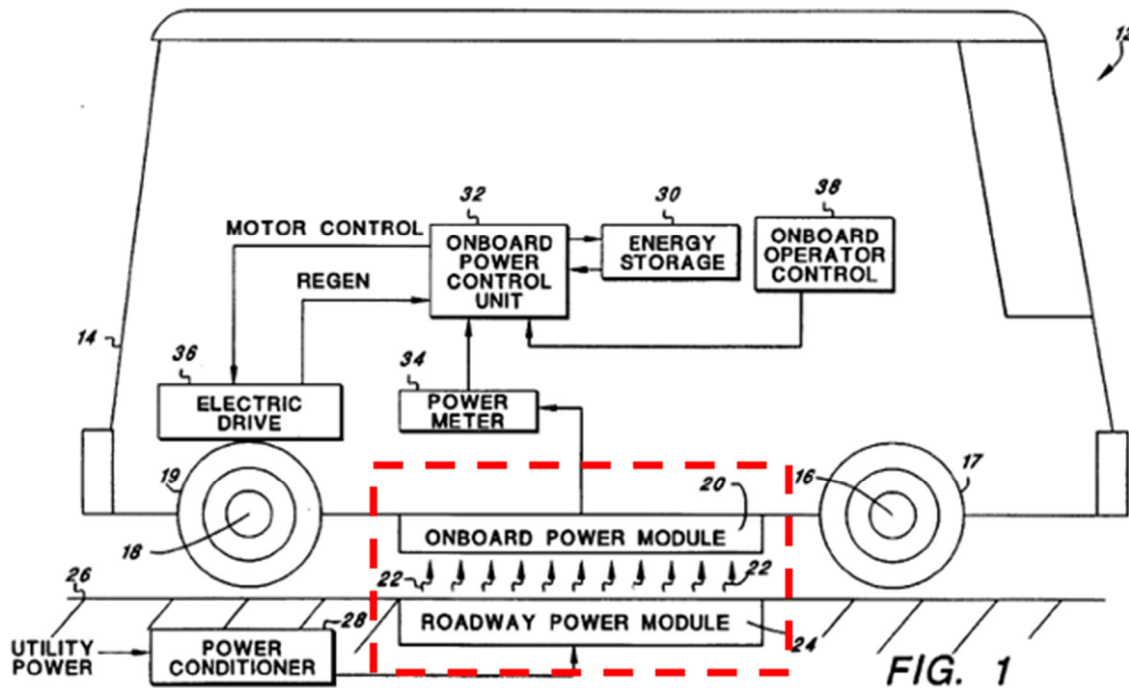
A. Ross (Ex. 1007)

U.S. Patent No. 5,669,470 to Ross (“Ross”) is prior art under pre-AIA 35 § 102(a), (b) and (e) because it issued on September 23, 1997, a decade before the ’654 patent’s claimed priority date.

Ross teaches a “roadway-powered electric vehicle” (“RPEV”) with a “power

receiving module” that “receives electrical power” from “a roadway power transmitting module” via inductive coupling, as shown below. Ross 7:57-8:13, Fig.

1.



Allen Decl. ¶88 (annotating Ross Fig. 1).

The “receiving module 20” includes a “coil 42” “carried on the underneath side of the RPEV,” while the “roadway power transmitting module 24” includes “a coil 40” “embedded in the roadway.” Ross 9:11-43, 7:57-8:12, Fig. 2. “When a suitable ac electrical current flows through the [transmitting] coil 40 at frequency f_1 , such current generates a magnetic field that varies at frequency f_1 .” Ross 7:57-8:13, 9:11-43, Figs. 1-2. “[A]n ac current is thus established in the coil 42 and power is

effectively coupled from the [transmitting] coil 40 to the [receiving] coil 42.” Ross 7:57-8:13, 9:11-43, Figs. 1-2; Allen Decl. ¶¶89-90.

When the RPEV approaches a stopping area over an embedded transmitting coil, “an auto-positioning control ... effectively ‘takes-over’ the driving of the vehicle for the final 10-15 feet.” Ross 12:33-62. In auto-positioning mode, a “microprocessor controller 56” controls the “steering of the vehicle” so that “the vehicle is laterally positioned, to within a rough tolerance, e.g. ± 5 -10 cm, of the optimum lateral position when the vehicle comes to its designed stopped location.” *Id.* 12:44-67; Allen Decl. ¶91.

The vehicle coil 42 is mounted “on a movable assembly” in order to “improve the coupling efficiency between the embedded coil 40 and the onboard coil 42.” Ross 9:44-67; Allen Decl. ¶¶92-93. Once the vehicle has been steered into place and stopped, a “horizontal coil positioning unit” uses “hydraulic[s]” to move the vehicle-mounted coil assembly, “further control[ing] the lateral position of the coil 42 so that it is more closely aligned, e.g., to within ± 1 -2 cm, of the optimum lateral position.” *Id.* 12:44-67. In order “to sense the relative lateral location of the coil[s]” during this adjustment, the vehicle coil can be “laterally moved in one direction or the other” while “monitoring the change in the amplitude of the inductively received power signal” at the vehicle coil. Ross 13:15-32; Allen Decl. ¶¶94-96. The coil is “laterally position[ed]” using the “horizontal coil positioning unit 46 and/or the

steering of the RPEV” at the “position that keeps the induced power signal at a peak or maximum level,” indicating the strongest coupling. Ross 13:15-32; Allen Decl. ¶¶94-96.

In addition to lateral positioning, a “vertical (air gap) positioning unit” can lower the “assembly” on which the coil is mounted “so as to reduce the air gap to near zero.” Ross 12:44-67. With an “air gap near zero, the onboard energy storage system 30 is charged ... through the inductive coupling link.” *Id.* 12:63-13:4. Thus “[t]he positioning units ... in combination with the steering of the RPEV ... combine to allow the onboard coil 42 to be optimally aligned with the embedded coil,” to provide “the maximum possible coupling efficiency between the two coils.” *Id.* 9:30-10:5; Allen Decl. ¶¶97-98.

B. Independent Claim 13

1. Claim Element 13[pre]: Preamble

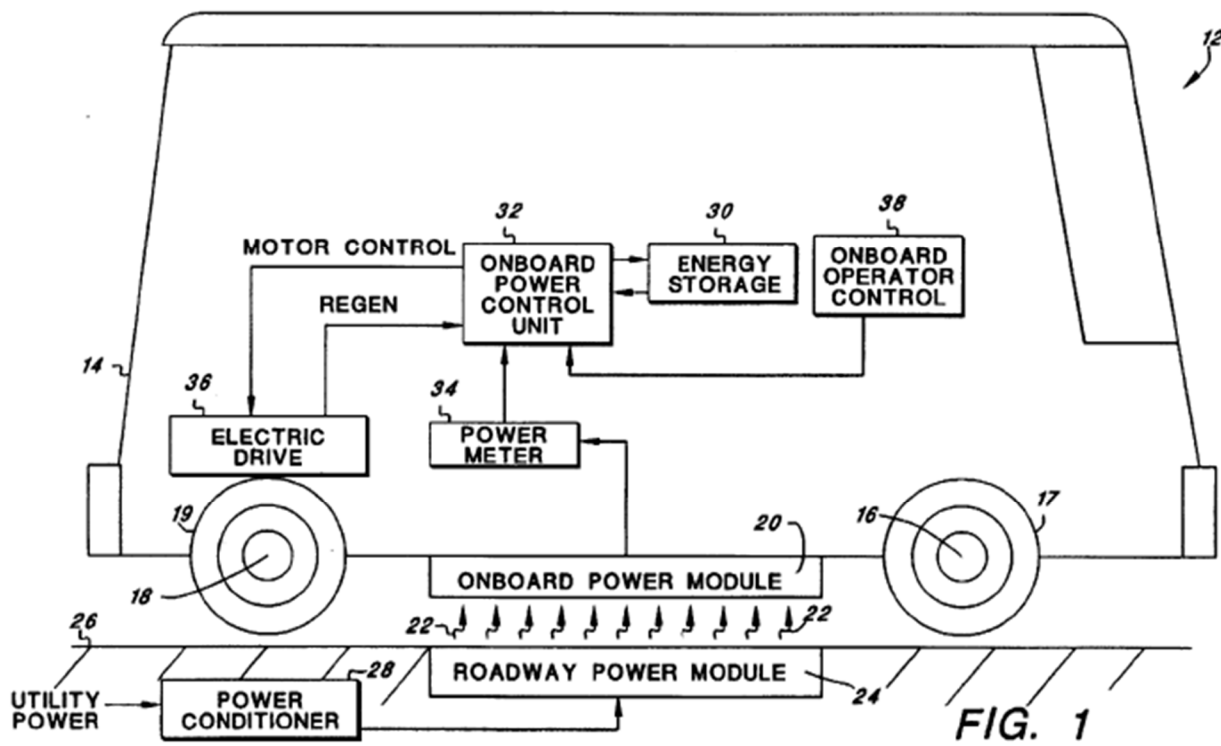
To the extent the preamble is limiting, Ross teaches “[a] method, comprising...” Allen Decl. ¶¶198-199.

Ross discloses “systems and methods” for “position[ing] the relative spacing ... and alignment between the onboard coil and the embedded coils” of an electric vehicle charging system “in order to make the energy transfer from the roadway to the vehicle more efficient.” Ross 20:29-41; *see id.* Abstract, 6:25-38; Allen Decl. ¶199.

2. Claim Element 13[a]: Guiding a Receiving Antenna into a First Alignment Position

Ross teaches “guiding a receiving antenna of a vehicle to a first alignment position relative to a transmitting antenna.” Allen Decl. ¶¶200-205.

Ross teaches a “roadway-powered electric vehicle (RPEV)” as shown below.



Ross Fig. 1, 7:57-8:13. A “power receiving module 20” (claimed receiving antenna) is “mounted on the underneath side of the RPEV,” while a “roadway power transmitting module 24” (claimed transmitting antenna) is “embedded in a roadway ... over which the RPEV travels.” Ross 7:57-8:13; Allen Decl. ¶201. Power receiving module 20 and power transmitting module 24 can each be “a coil” (elements 42 and 40, respectively) as shown below. Ross 9:11-43; Allen Decl. ¶202.

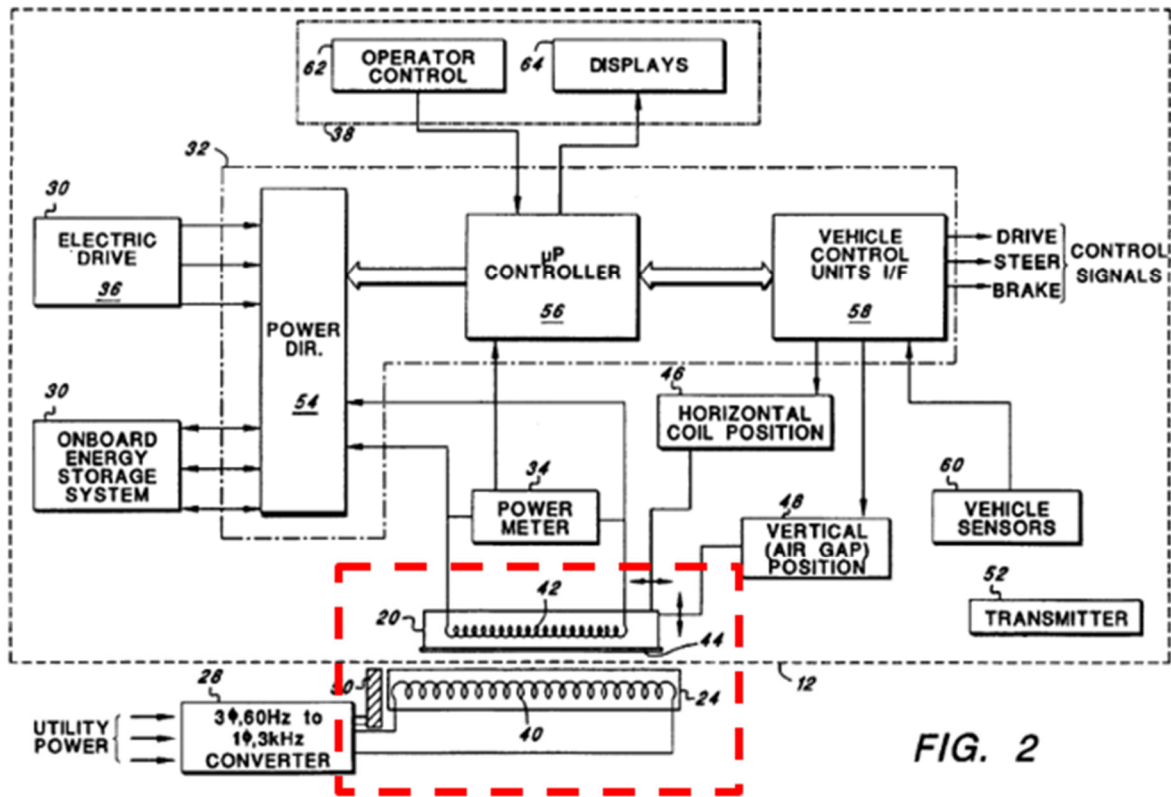


FIG. 2

Allen Decl. ¶202 (annotating Ross Fig. 2).

The power receiving module “receives electrical power” from the power transmitting module via “inductive coupling.” Ross 7:57-8:13, 9:30-43; Allen Decl. ¶202. When “a suitable AC electrical current flows through the [transmitting] coil 40,” it “generates a magnetic field” that “cuts through the [receiving] coil 42 and induces a voltage therein according to Faraday’s law of induction.” Ross 9:20-31. In this manner, “an AC current is thus established in the [receiving] coil 42 and power is effectively coupled from the [transmitting] coil 40 to the [receiving] coil 42.” *Id.* The received power is “stored in an onboard energy storage system” and used to power “the electric drive” of the vehicle. Ross 8:14-64.

Ross teaches that the RPEV (with its receiving antenna) is guided into a first alignment position by being driven or parked over a roadway-embedded transmitting coil, which couples to the vehicle-mounted coil. Ross 12:32-62; *see id.* Figs. 1-2, 4, 7, 7:11-13; Allen Decl. ¶¶203-205. When the RPEV approaches a “designated stop[],” such as “passenger loading/unloading zones, parking garages, or the like,” “an auto-positioning control ... effectively ‘takes over’ the driving of the vehicle for the final 10-15 feet.” Ross 6:12-24, 12:33-44; Allen Decl. ¶203.

In auto-positioning mode, “vehicle sensors ... sense the position of the [vehicle] relative to the roadway power transmitting module 24 embedded in the roadway.” Ross 12:44-47. “[M]icroprocessor controller 56” then controls “the steering of the vehicle ... so that the vehicle is laterally positioned, to within a rough tolerance, e.g. ± 5 -10 cm, of the optimum lateral position when the vehicle comes to its designed stopped location.” *Id.* 12:30-62. This “optimum lateral position” is the position in which the vehicle coil is “optimally aligned with the embedded coil” in the roadway “so as to provide the maximum possible coupling efficiency between the two coils.” Ross 9:44-10:5; Allen Decl. ¶204.

Alternatively, this “rough tolerance” positioning can be performed “manual[ly],” by the vehicle “operator” “driving” into the parking position. Ross 12:33-47; Allen Decl. ¶205.

3. Claim Element 13[b]: Moving Antenna to Improve Alignment

Ross discloses or renders obvious “responsive to detecting a degree of coupling in the first alignment position between the receiving antenna and the transmitting antenna that is measured at the receiving antenna, moving one of the receiving antenna and the transmitting antenna from the first alignment position to a second alignment position to improve alignment of the receiving antenna with the transmitting antenna and improve the degree of coupling.” Allen Decl. ¶¶206-212.

After Ross’s vehicle is parked within “rough tolerance” relative to the embedded coil (the claimed first alignment position), the onboard coil is moved to a position that provides better coupling and alignment with the embedded road coil (the claimed second alignment position). Ross 9:44-10:5, 12:10-62, 13:15-32; Allen Decl. ¶¶207-209.

Specifically, “[i]n order to improve the coupling efficiency between the embedded coil 40 and the onboard [vehicle] coil 42,” Ross’s invention “mounts the [vehicle] coil 42 on a movable assembly.” Ross 9:44-62. The “horizontal position of the movable assembly ... is controlled by a horizontal coil position unit 46,” which uses “conventional hydraulic and/or electronic positioning devices” to move the coil assembly. Ross 9:44-62, 12:52-62. The “vertical position of the assembly” is similarly controlled by a “vertical (air gap) coil position unit 48.” *Id.*

Once the vehicle is “stopped” as described for Element 13[a], “the horizontal coil positioning unit ... further controls the lateral position of the coil 42 so that it is more closely aligned, e.g., to within ± 1 -2 cm, of the optimum lateral position.” Ross 12:52-62; Allen Decl. ¶¶208-209. Once horizontal alignment is achieved, the vertical positioning unit “lower[s]” the coil assembly towards the road and the coil embedded therein, “so as to reduce the air gap to near zero.” Ross 12:52-62. Thus “the positioning units 46 and 48, in combination with the steering of the RPEV 12 ... combine to allow the onboard coil 42 to be optimally aligned with the embedded coil 40 so as to provide the maximum possible coupling efficiency between the two coils.” *Id.* 9:50-10:5.

A POSA would have understood that when Ross’s system moves the coil assembly from a first “rough” alignment position to a second “more closely aligned” position, it does so by detecting the degree of coupling in the initial position and then moving the coil to the better-coupled position. Allen Decl. ¶¶210-212; Ross 12:52-62. The coil is moved to “the optimum lateral alignment,” which is the position at which “the maximum possible coupling efficiency between the two coils” is achieved. Ross 9:44-66; Allen Decl. ¶¶210-212; *see* Ross 9:50-10:5 (“optimum lateral alignment of the assembly relative to the embedded coil ... allows a maximum amount of power to be coupled”), 6:25-39 (“laterally and vertically position[ing]

the relative spacing and alignment between” the two coils “maximize[s] the alignment between the coils, thereby making the power transfer ... more efficient.”).

This optimal alignment and coupling is determined, for example, by “monitoring the change in the amplitude of the inductively received power signal as the coil 42 is laterally moved in one direction or the other.” Ross 13:20-32. The “processor controller ... laterally positions the coil ... using the horizontal coil positioning unit ... to maintain the coil 42 at a lateral position that keeps the induced power signal at a peak or maximum level.” *Id.* The “induced” or “inductively received” power signal is the power received and measured at the vehicle coil. *Id.*; *see id.* 9:15-29 (system “induces a voltage” in “coil 42” of “onboard power receiving module”), 3:66-67 (“A power meter, carried onboard the vehicle, monitors how much power is coupled to or used by the vehicle”); Allen Decl. ¶211. The amplitude of the inductively received power signal indicates the degree of coupling, because it is directly proportional to the degree of coupling and is reflective of the amount of “power ... effectively coupled from the [transmitting] coil 40 to the [receiving] coil 42.” Ross 9:20-46; *see also id.* 3:66-67; Allen Decl. ¶¶211-212.

C. Claim 14: Moving Receiving Antenna Laterally

Ross discloses “the method of claim 13, wherein moving one of the receiving antenna and the transmitting antenna comprises moving the receiving antenna laterally relative to the transmitting antenna.” Allen Decl. ¶¶213-214.

As explained for Element 13[b], Ross discloses moving “the lateral position” of the vehicle-mounted coil to bring the coils into alignment. *Supra* Element 13[b]; Ross 12:44-62; *see infra* Claim 9 (further explaining that Ross’s “lateral” coil movement includes both the X-axis and Y-axis directions); Allen Decl. ¶214.

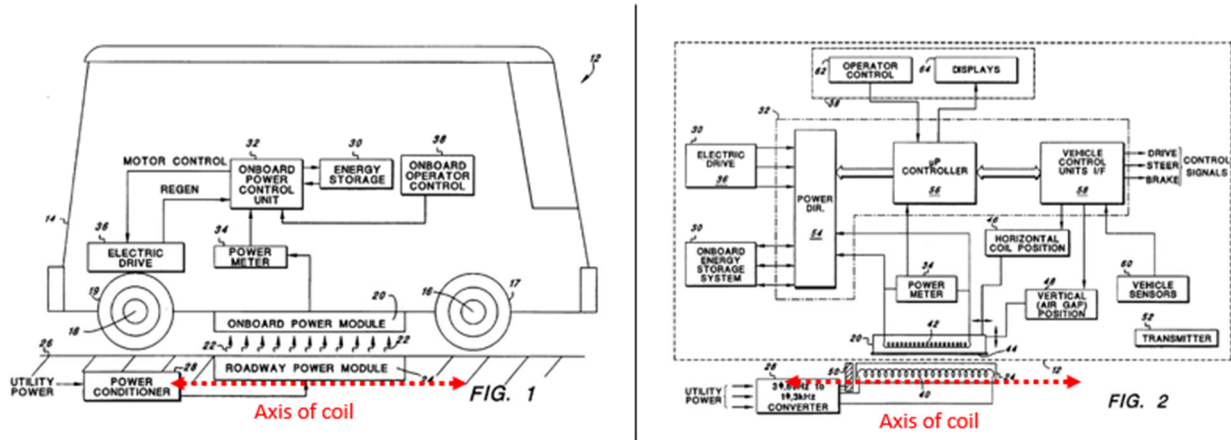
D. Claim 16: Moving Receiving Antenna Perpendicularly

Ross discloses “the method of claim 13, wherein moving one of the receiving antenna and the transmitting antenna comprises moving the receiving antenna along an axis that is perpendicular to one of a transmitting antenna coil and a receiving antenna coil.” Allen Decl. ¶¶215-219.

As explained for Element 13[b], Ross discloses moving the vehicle-mounted coil to change its “lateral position” and “vertical” position, in order to achieve “optimum” alignment. *Supra* Element 13[b]; Ross 12:44-62. A POSA would have understood this to mean the transmitting coil moves in the X-axis, Y-axis, (both lateral) and/or Z-axis (vertical) directions. Allen Decl. ¶¶216; *see also* ¶¶252-257 (explaining that a POSA would understand Ross’s “lateral” coil movement to include both the X-axis and Y-axis directions); *infra* Claim 9 (same).

Because Ross’s coil can move in any of the X-, Y-, and Z-axis directions, it discloses to a POSA that the vehicle-mounted coil can move along an axis perpendicular to one of the coils, regardless of which geospatial direction that axis

is going. Allen Decl. ¶217. As one example, the road-embedded coil 40 is shown to run from front-to-back along the vehicle (red, below).



Allen Decl. ¶218 (annotating Ross Figs. 1-2). When the vehicle is parked, “the horizontal coil positioning unit” will “control the lateral position of the coil” to create proper alignment. Ross 12:33-62. If the vehicle is not perfectly aligned left-to-right over the embedded coil (i.e., not centered within a traffic lane or parking space), this “lateral position[ing]” will move the vehicle coil leftward or rightward across the traffic lane or parking space (i.e., “into the page” in the figures shown above) and therefore along an axis perpendicular to the front-to-back transmitting coil as shown above. Ross 12:33-62, Figs. 1-2; Allen Decl. ¶218.

As a second example, when the “vertical (air gap) positioning unit” “lowers” the vehicle coil towards the roadway, this vertical movement is on an axis perpendicular to at least the transmitting coil, as shown above. Ross 12:57-62, 9:44-55; Allen Decl. ¶219.

E. Independent Claim 8

1. Claim Element 8[pre]: Preamble

To the extent the preamble is limiting, Ross discloses “[a] receiver system for wireless power.” Allen Decl. ¶¶220-221.

Specifically, Ross discloses a “roadway-powered electric vehicle” that has a “power receiving module” that “receives electrical power” from “a roadway power transmitting module” via “inductive coupling.” Ross 7:57-8:13, 9:11-10:5; *see id.* 16:38-50 (“non-contact[]”), Figs. 1, 7; Allen Decl. ¶221.

2. Claim Element 8[a]: Receiving Antenna

Ross and Wang render obvious “a receiving antenna coupled to a device, the receiving antenna including a coil and capacitor that are resonant at a first frequency.” Allen Decl. ¶¶222-236.

Ross discloses an “onboard power receiving module 20” (the claimed receiving antenna) that is “mounted on the underneath side of the RPEV” (the claimed device). Ross 7:57-8:13, Figs. 1-2; *see also id.* 9:30-43, 20:29-40 (describing same); Allen Decl. ¶223. Ross also discloses a “roadway power transmitting module 24” which can be “embedded in the roadway.” Ross 9:11-43, Figs. 1-2, 7. Each module can be “a coil.” *Id.* 9:11-43; Allen Decl. ¶¶223-225.

While Ross is silent about a capacitor or resonant frequency, a POSA would have considered it obvious to include a capacitor connected to each of Ross’s transmitting coil and receiving coil, creating circuits that resonate at a particular

frequency in order to more efficiently transfer energy. Allen Decl. ¶¶226-236. As described above when discussing Odachi and Wang, inductor-capacitor resonant circuits were well known in the art, as described in Wang. Wang 1, 20-23, 47; Allen Decl. ¶227; *supra* Ground 1b Element 1[a].

It would have been obvious to a POSA to implement this arrangement, known as “compensating” an inductive circuit with capacitors, in Ross by connecting a capacitor C_p in series or parallel with “embedded coil 40” of the “roadway power transmitting module,” and another capacitor C_s in series or parallel with “onboard coil 42” of the “onboard power receiving module” on the vehicle. Ross 9:11-29; Allen Decl. ¶228; *see* Wang 4-7, 11, 20-25, 38 (describing compensation techniques). Ross’s onboard power receiving module would then operate as a “secondary resonant circuit[]” that is “magnetically coupled with” a “primary resonant circuit” (compensated power transmitting module 20) thereby “supply[ing] power to a load” (the RPEV). Wang 47; Allen Decl. ¶229.

A POSA would have understood that Ross’s compensated onboard power receiving module was resonant at a first frequency, as Wang explains that compensated secondary circuits have a “resonant frequency (when C_s is in resonance with L_s)” which is “normally designed to equal the nominal frequency.” Wang 20; Allen Decl. ¶230.

For the same reasons explained for Odachi and Wang, a POSA would have

been motivated to use capacitor-compensated resonant circuits in Ross, as this design was nothing more than a combination of known prior art elements (inductive coils and capacitors) arranged according to known methods (connected in a series or parallel resonant circuits) to yield predictable results (an inductive wireless power transfer system). Allen Decl. ¶¶231-232; Wang 20 (inductive coils “[we]re often compensated by capacitors”), 48 (“majority” of inductive systems were compensated), 4 (coils were “normally” compensated by capacitors).

In addition, a POSA would have been motivated to use capacitor-compensated circuits to increase the efficiency and power transfer capability of Ross’s system. Allen Decl. ¶¶233-234. “[P]rimary and secondary” coils “[we]re often compensated by capacitors” because doing so was known to “boost the power transfer capability of the pickup, while minimizing the VA rating of the power supply.” Wang 20; *see id.* 4 (“[T]o increase the amount of power transferred” requires “high frequency” which “is normally compensated by capacitors”). Thus “series and parallel secondary compensation *improve the power transfer capability,*” as compared to uncompensated circuits. Wang 21; Allen Decl. ¶¶233-234; *see also* Wang-IEEE 995 (“resonant circuits are normally employed ... to boost the power transfer capability”); Wang 23-24, 38 (compensation yields “voltage gain” or “current gain”).

A POSA would have recognized that by transferring power more efficiently, the modified Ross could wirelessly charge more powerful vehicles, charge vehicles

quicker, and compensate for obstacles that might otherwise impede transfer charging. Allen Decl. ¶¶233-234; Wang 4-5 (“high power applications” of “[inductive] power transfer”). Indeed, the Examiner found the same during prosecution of the ’654 patent. ’654 FH 118 (“obvious to ... [add] capacitor structure ... for the benefit of increasing the efficiency of the energy transfer”); *see id.* 120-121 (same).

A POSA would have been readily able to implement Wang’s resonant compensated circuits in Ross’s system because this arrangement was well-known. Allen Decl. ¶235. Capacitors were “often” used to “boost the power transfer capability” of inductively powered vehicle chargers. Wang 47, 20; Allen Decl. ¶235. Both uncompensated circuits (as originally in Ross) and compensated circuits (as a POSA would modify Ross) were “fundamental” or “basic compensation topologies” whose circuit diagrams and functionalities would have been well-known to a POSA. Wang 24; Allen Decl. ¶235; *see also* Stielau 86 (“basic compensation topologies”).

3. Claim Element 8[b]: Guidance Control System

Ross teaches “a guidance controller configured to guide the receiving antenna of the device to a first alignment position relative to a transmitting antenna that is not physically connected to said device coupled to the receiving antenna.” Allen Decl. ¶¶237-239.

As explained for Element 8[a], Ross discloses a “roadway power transmitting module” (claimed transmitting antenna) that transfers power to an “onboard power

receiving module” (claimed receiving antenna) mounted to an RPEV (claimed device). Ross 9:11-43; *see* Element 8[a]; Allen Decl. ¶238. The power transmitting module is not physically connected to the RPEV. Ross 9:37-43, Figs. 1-2, 7; Allen Decl. ¶238; *supra* Element 8[pre] (“wireless power”).

As explained for Element 13[b], Ross discloses “steering” the RPEV into position “rough[ly]” over an embedded roadway coil, thereby guiding the RPEV with its receiving module into a first alignment position relative to the transmitting module. *Supra* Element 13[b]; Allen Decl. ¶239. This process can be “automated, or controlled by the controller 56,” which constitutes the claimed “guidance controller.” Ross 12:33-62 (“[t]he steering of the vehicle is then controlled by the microprocessor controller 56 so that the vehicle is laterally positioned, to within a rough tolerance ... of the optimum lateral position”); *supra* Element 13[b]; Allen Decl. ¶239.

4. Claim Element 8[c]: Lifting Device

Ross teaches “a lifting device for said receiving antenna configured to lift and lower said receiving antenna.” Allen Decl. ¶¶240-241.

Ross discloses a “vertical (air gap) positioning unit 48,” which corresponds to the claimed lifting device. Ross 12:57-62; *supra* Element 13[b]; Allen Decl. ¶241. The vertical positioning unit “lowers” the “assembly 44 on which the coil 42 is mounted,” in order “to reduce the air gap to near zero” during charging. Ross 12:33-

13:4. When charging is complete, “the vertical positioning unit 48 raises the assembly 44 back to its normal position on the underneath side of the RPEV frame.”

Ross 12:63-13:4; Allen Decl. ¶241.

5. Claim Element 8[d]: Alignment Controller

Ross discloses “an alignment controller configured to sense a degree of coupling of said receiving antenna and the transmitting antenna based on a detection of the coupling that is measured at the receiving antenna, the alignment controller being further configured to move said receiving antenna from the first alignment position to a second alignment position to better align the receiving antenna with the transmitting antenna.” Allen Decl. ¶¶242-249.

This element is taught by the same functionality described for Element 13[b]. *Supra* Element 13[b]; Allen Decl. ¶243. Namely, Ross discloses a “horizontal coil position unit 46” (the claimed alignment controller, alone or with controller 56 and related sensors and circuitry) that, after the vehicle has been “steer[ed]” into place, “further controls the lateral position of the coil 42 so that it is more closely aligned” with the roadway-embedded coil. Ross 12:33-62; Allen Decl. ¶244. The horizontal coil position unit moves the vehicle coil from a position “within a rough tolerance, e.g. ± 5 -10 cm, of the optimum lateral position” (the claimed first alignment position) to a better-aligned position “within ± 1 -2 cm, of the optimum lateral position” (the claimed second alignment position). Ross 12:33-63; Allen Decl. ¶244.

A POSA would have understood that this horizontal movement better aligns the two coils, as the purpose of the positioning unit is to “allow the onboard coil 42 to be optimally aligned with the embedded coil 40 so as to provide the maximum possible coupling efficiency between the two coils.” Ross 9:44-54; Allen Decl. ¶245; *see* Ross 9:62-10:5 (“optimum lateral alignment of the assembly 44 relative to the embedded coil ... allows a maximum amount of power to be coupled”), 6:25-39 (“laterally and vertically position[ing] the relative spacing and alignment between” the two coils “maximize[s] the alignment between the coils, thereby making the power transfer ... more efficient.”).

A POSA would have further understood that the horizontal coil position unit and controller are “configured to sense a degree of coupling,” as claimed, and move the coil in response to the sensed degree of coupling. Allen Decl. ¶246. That is how the system determines how far, and in what direction, to move the coil in order to be “optimally aligned” and achieve “the maximum possible coupling.” Ross 9:44-10:5, 12:44-62; *see also id.* 3:66-67 (“A power meter, carried onboard the vehicle monitors how much power is coupled to or used by the vehicle”); Allen Decl. ¶246.

For example, the horizontal positioning device may “sense the relative lateral location” of the two coils “by monitoring the change in the amplitude of the inductively received power signal as the [receiving] coil 42 is laterally moved.” Ross 13:15-32. The “processor controller 56 then laterally positions the coil 42,

using the horizontal coil positioning unit 46 and/or the steering of the RPEV, to maintain the coil 42 at a lateral position that keeps the induced power signal at a peak or maximum level.” Ross 13:15-32; Allen Decl. ¶247.

As explained for Element 13[b], a POSA would have understood that measuring the “amplitude of the inductively received power signal,” and using that information to move the coil and “keep[] the induced power signal at a peak or maximum level,” thereby obtaining “optimum lateral position,” constitutes sensing the degree of coupling and moving the coil in response. *See supra* Element 13[b]; Ross 13:15-32; Allen Decl. ¶248-249. This is the same manner of sensing coupling disclosed in the ’654 patent: “a measurement of the amount of power that is transferred to the receiving antenna.” ’654 patent cls. 18-19; Allen Decl. ¶249.

F. Claim 9: X-Y Axis Alignment Control

Ross discloses or renders obvious “[t]he receiver system of claim 8, further comprising an x-y alignment control configured to automatically align said receiving antenna to better align the receiving antenna with the transmitting antenna by moving said receiving antenna in x and y directions based on a degree of coupling between the receiving antenna and the transmitting antenna.” Allen Decl. ¶¶250-257.

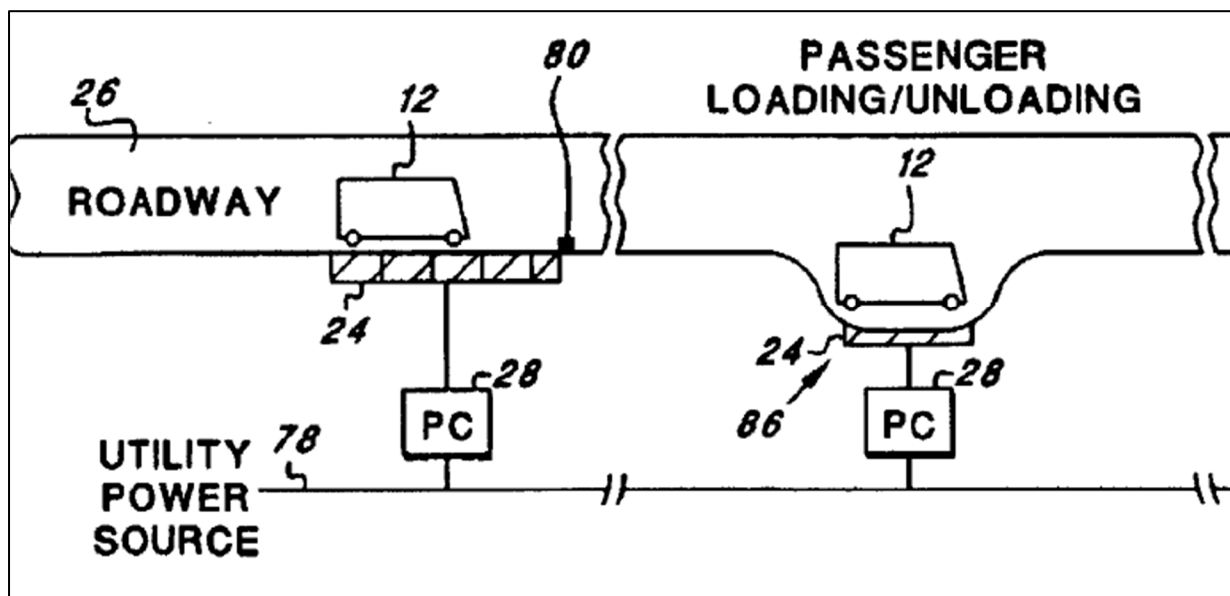
As explained for Element 8[d], Ross discloses a “horizontal coil positioning unit” that, together with a controller, moves “the lateral position” of the vehicle-

mounted coil to “the optimum lateral position” based on a detected degree of coupling. Ross 12:33-62, 13:15-32; *supra* Element 8[d]; Allen Decl. ¶251. A POSA would have understood that these components constitute an x-y alignment control that automatically aligns the vehicle coil with the embedded roadway coil by moving the vehicle coil in the X- and Y-directions to the optimum lateral position based on that detected coupling. Allen Decl. ¶¶252-257; *supra* Elements 13[b] (detecting coupling), 8[d] (sensing degree of coupling).

A POSA would have understood Ross’s “lateral” positioning to indicate movement in both the X-axis and Y-axis directions, as these directions are both on the “lateral” (horizontal) plane, as contrasted with the “vertical” alignment separately discussed in Ross. *See, e.g.* Ross 12:33-62 (“lateral, as well as vertical (air gap) positioning”), 9:52-10:5 (also contrasting “lateral” with “vertical”), 11:59-67 (same), 12:32-62 (same), 20:35-41 (same); Allen Decl. ¶¶253-254. Ross’s term “horizontal coil positioning” further indicates movement in both the X- and Y-axis directions. Ross 12:52-62, Allen Decl. ¶254; *see* Collins Dictionary (Ex. 1026) 1-3 (defining “horizontal” as “at right angles to the vertical, parallel to level ground”); Cambridge Dictionary (Ex. 1027) 2 (“level to the ground, rather than up or down”), Britannica Dictionary (Ex. 1028) 1 (“positioned from side-to-side rather than up and down”).

This understanding is confirmed by Ross's statement that "laterally and vertically position[ing]" the coil alignment "maximize[s] the alignment between the coils," which would not be true unless such "lateral" positioning included both the X- and Y-axis directions. Ross 6:25-39, 9:43-10:4, 12:33-13:4; Allen Decl. ¶255. If Ross's "lateral" positioning were only able to move the coil along either the X- or Y-axis, but not both, the alignment would be impeded by misalignment along the other axis, and not "maximize[d]" as Ross teaches. Allen Decl. ¶255; *see* Ross 6:25-39, 9:55-10:5.

This understanding is further bolstered by Ross's Figure 4, excerpted below, which shows that when Ross's vehicle "is laterally positioned" at a loading/unloading area, the vehicle moves both along the direction of road travel, and side-to-side across traffic (i.e., in both the X- and Y- directions). Ross 12:33-62, Fig. 4, Allen Decl. ¶256.

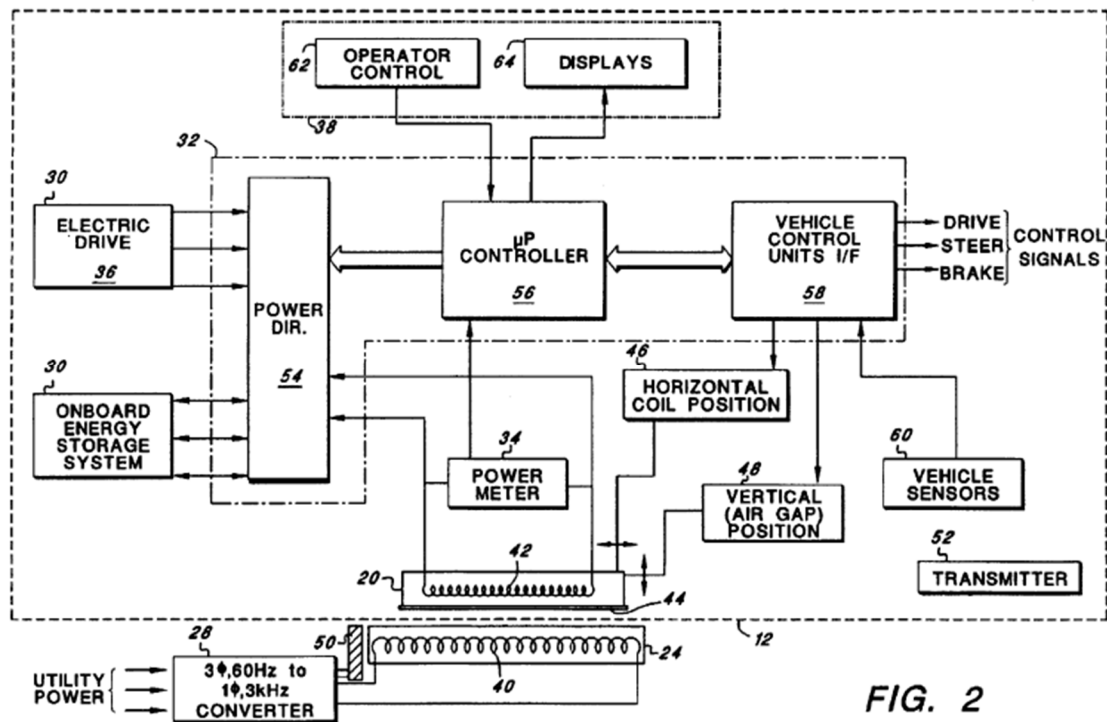


To the extent not disclosed in Ross, it also would have been obvious to a POSA to implement Ross such that the vehicle coil is moved in both the X- and Y-axis directions to achieve the disclosed “optimum lateral position.” Ross 12:33-62; Allen Decl. ¶257. Ross already discloses the importance of, and mechanisms for, properly aligning the vehicle coil with the embedded roadway coil in a “vertical” direction (i.e., Z-axis) and “lateral” direction(s), to achieve optimum coupling. Ross 6:30-39, 9:55-10:5, 12:33-62, 13:5-32. It would have been obvious to a POSA to implement this lateral alignment in both the X- and Y-axis directions, as these are the only two “lateral” axes. Allen Decl. ¶¶253-254, 257. In addition, automatically aligning the coils in both the X- and Y-axis directions would maximize coupling, as Ross explains that “coupling efficiency is a function of ... the relative alignment between the coils.” Ross 9:20-43. A POSA would have understood that automatically aligning a coil in both the X- and Y-axis directions would achieve better relative alignment, and thus greater “coupling efficiency,” than a system that aligned its coils only in either the X- or Y-axis direction. Allen Decl. ¶¶255-257; Ross 9:44-66 (optimum lateral alignment yields better coupling).

G. Claim 10: Magnetically Induced Signal Circuitry

Ross discloses “[t]he receiver system of claim 8, further comprising circuitry that receives a magnetically induced signal from said receiving antenna and produces power therefrom.” Allen Decl. ¶¶258-262.

Ross discloses that its “electric vehicle system [] uses inductive coupling to couple electrical energy between embedded coils in the roadway and coils carried onboard the EV” and that this power is created by a “varying magnetic field [that] cuts through the [receiving] coil 42.” Ross 20:29-40, 9:11-20. The power received by vehicle coil 42 through magnetic induction from roadway coil 24 is then “coupled through a power director 54 to the onboard energy storage system 30,” as shown below. *Id.* 11:37-49.



Ross Fig. 2; Allen Decl. ¶¶259-261. The received power is further “directed, as required, from the energy storage system 30 to the electric drive train 36,” which drives the vehicle by “provid[ing] the motive force for propelling the front and/or rear suspension systems.” Ross 11:37-49, 8:54-9:3, Fig. 2; Allen Decl. ¶¶261-262.

Thus, Ross discloses circuitry (e.g. vehicle coil 42, power director 54, drive train 36, onboard energy storage system 30) that receives a magnetically induced signal from the receiving antenna (i.e. the voltage and current induced in the power receiving module by the roadway transmitting module), and uses that magnetically induced voltage and current to produce power to drive the motors of the electric vehicle. Allen Decl. ¶¶259-262.

H. Claim 12: Battery Operated Vehicle

Ross discloses “[t]he receiver system of claim 8, wherein said receiving antenna and said lifting device are part of a battery operated vehicle.” Allen Decl. ¶¶263-264.

Ross discloses that the “power receiving module 20” (claimed receiving antenna) and “vertical (air gap) coil position unit” (claimed lifting device) are both part of a “roadway-powered electric vehicle,” which is operated by an “electromechanical battery.” Ross 7:57-8:1 (power receiving module), 9:44-54 (vertical positioning unit), 20:8-16 (battery); *see also* Ross 6:58-61 (RPEV “is preferably realized using a plurality of electromechanical battery (EMB) modules”), 6:4-7 (further describing battery), 8:47-64 (battery), Figs. 1-2, 7; Allen Decl. ¶264; *supra* Elements 8[a] (receiving antenna), 8[c] (lifting device).

I. Claim 19: Measurement of Power

Ross discloses “the apparatus of claim 8, wherein the sensed degree of coupling comprises a measurement of the amount of power that is transferred to the receiving antenna.” Allen Decl. ¶¶265-267.

As described for Elements 13[b] and 8[d], Ross discloses moving the vehicle coil to the optimum coupling position by, for example, “monitoring the change in the amplitude of the inductively received power signal” as the coil is moved, and placing the coil “at a lateral position that keeps the induced power signal at a peak or maximum level.” Ross 13:15-32; Allen Decl. ¶266; *supra* Element 8[d], 13[b]. A POSA would have understood that the “amplitude of the inductively received power signal” or “peak or maximum level[s]” of the “induced power signal” are measurements of the amount of power received at, and therefore transferred to, the receiving antenna. Allen Decl. ¶¶266-267; *see* Ross 13:15-32 (amplitude of power signal).

VIII. The Board Should Reach the Merits of This Petition

Neither Section 325(d) nor *Fintiv* warrant denial of this petition, as detailed below. If Patent Owner argues for denial, InductEV will seek permission to reply to address the facts and law as they stand at that time.

A. Section 325(d) does not warrant denial

Section 325(d) does not apply because the Patent Office has never been presented with arguments regarding Odachi or Wang. Thus, every ground contains

at least one reference not previously considered, and the 35 U.S.C. § 325(d) analysis fails to meet Step 1 of the *Advanced Bionics* test. *Advanced Bionics, LLC v. Med-El Elektromedizinische Geräte GMBH*, IPR2019-01469, Paper 6 at 8 (Feb. 13, 2020) (precedential).

Step 2 of the *Advanced Bionics* test also is not satisfied for any ground. None of the art used in Grounds 1a or 1b was presented to the Office. With respect to Ground 1c, the Examiner did not consider Partovi, but considered its publication, U.S. 2011/01221385 (“Partovi Application,” Ex. 1016). However, the Examiner did not consider Partovi Application in combination with Odachi and Wang, as this petition presents Partovi. *See* ’654 FH 118-127, 144, 162-163, 175-180. Moreover, neither the Examiner nor Patent Owner disputed that Partovi teaches an “array” of coils, which it plainly does and which is the teaching for which Petitioner uses it here. Partovi Figs. 1-4; Partovi Application [0060]-[0061] (“coil array”); *supra* Ground 1c.

With respect to Ground 2, the Examiner did not consider Ross, but considered another patent by the same inventor (“Ross-090”). However, the Examiner did not consider Ross-090 in combination with Wang, or with the support of Dr. Allen’s testimony regarding how a POSA would interpret the reference, as this petition presents Ross. *Supra* Ground 2.

Moreover, the Examiner's findings regarding Ross-090 were material error, or are inapplicable to this petition. For example, the Examiner found that Ross-090 "does not disclose an alignment controller configured ... to adjust the position of the ... transmitting antenna." '654 FH 155. But this petition does not assert that Ross moves the transmitting antenna, only that it moves the receiving antenna. *See* Ground 2.

To the extent the Examiner's statements could be read to state that Ross-090 does not teach "an alignment controller configured to detect coupling" at all, this was error, as Ross-090 discloses a "lateral (horizontal) positioning device 46" which "laterally position[s]" the receiving coil "so that the coil 42 can maintain ... an optimum lateral position relative to the coil 40 that is embedded in the roadway." Ross-090 14:49-54. This is accomplished by "monitoring *the change in the amplitude of the inductively received power signal* as the coil 42 is laterally moved," such that "the horizontal coil positioning unit 46 ... maintain[s] the coil 42 at a lateral position that *keeps the induced power signal at a peak or maximum level.*" Ross-090 14:49-65. As explained for Ground 2, a POSA would have understood that monitoring the "amplitude of the inductively received power signal" is a method of "detect[ing] coupling." Allen Decl. ¶¶211-212, 248-249, 266-267. Indeed, this is the method of detecting coupling recited in the '654 patent: "a measurement of the amount of power that is transferred to the receiving antenna." '654 patent cls. 18-

19. Thus, the Examiner erred by “misapprehending or overlooking specific teachings” of Ross-090, leading to erroneous statements about Ross-090, as well as erroneous issuance of the ’654 patent. *Advanced Bionics*, Paper 6 at 8 n.9.

Neither the Examiner nor Patent Owner acknowledged the above-cited disclosures of Ross-090. *See* ’654 FH 155 (citing only “Col. 10 line 50 to Col. 11, line 10”). That too, was error. *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, especially where “neither the Examiner nor the Applicant addressed this [disclosure] during prosecution”).

The Examiner’s error is further demonstrated by Ground 2 above, which explains how these same disclosures (and further supporting disclosures) in Ross render obvious the challenged claims in combination with Wang. *Supra* Ground 2, Element 8[d].

Thus, *Becton Dickinson* factors (d)-(f) support institution. First, the “extent of the overlap” is minimal, as Grounds 1a and 1b contain no prior art that was previously presented, and Grounds 1c and 2 each contain at least one reference not previously presented. *Becton, Dickinson & Co. v. B. Braun Meluncheon AG*, IPR2017-01586, Paper 8 at 17 (Dec. 15, 2017); *see Oticon Med. AB v. Cochlead Ltd.*, IPR2019-00975, Paper 15 at 20 (Oct. 16, 2019) (precedential) (instituting trial where one “new, noncumulative prior art” reference was asserted, even where other

art was previously presented). In addition, Petitioner uses Partovi only for a point that was not disputed during prosecution.

Second, the Examiner materially erred in its assessment of the prior art, which as explained above and in Ground 2 discloses an “alignment controller” that detects coupling. Moreover, the Examiner’s erroneous findings regarding Ross-090 would apply (at most) only to the “alignment controller” of claim 8, and not to also-challenged claims 13, 14, or 16 in Ground 2, which do not recite an alignment controller.

Lastly this petition presents evidence, including additional supporting passages of Ross, the combination with Wang, and the testimony of Dr. Allen, that were not before the Board. *Supra* Ground 2.

B. *Fintiv* does not warrant denial

Under the current facts, *Fintiv* is inapplicable. The corresponding district court litigation has seen no movement beyond the filing of a motion to dismiss, no scheduling order has been entered, and no trial date has been scheduled.

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 ’654 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), 8,912,687 (IPR2023-01208), and 10,027,184 (IPR2024-00105), each of which are asserted in that district court case.

C. Grounds for Standing

Petitioner certifies that the '654 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).

Petitioner also designates the following backup counsel:

- Jonathan M. Strang (Reg. No. 61,724), jonathan.strang@lw.com, Latham & Watkins LLP; 555 Eleventh Street, NW, Ste. 1000, Washington, D.C. 20004-1304; 202.637.2362 (Tel.); 202.637.2201 (Fax).
- Charles H. Sanders (Reg. No. 47,053), charles.sanders@lw.com, Latham & Watkins LLP; 200 Clarendon Street,

Boston, MA 02116; 617.948.6022 (Tel.); 617.948.6001 (Fax).

- Blake R. Davis (*pro hac vice* motion to be filed),
blake.davis@lw.com, Latham & Watkins LLP;
505 Montgomery Street, Ste. 2000, San Francisco, CA 94111-6538;
415.395.8033 (Tel.); 415.395.8095 (Fax).
- Jeffrey G. Homrig (*pro hac vice* motion to be filed),
jeff.homrig@lw.com, Latham & Watkins LLP; 300 Colorado St.,
Suite 2400, Austin, TX 78701; 737.910.7344 (Tel.); 737.910.7301
(Fax).
- Razi Safi (Reg. No. 75,594), razi.safi@lw.com, Latham & Watkins
LLP; 555 Eleventh Street, NW, Ste. 1000; Washington, D.C. 20004-
1304; 202.637.2120 (Tel.); 202.637.2201 (Fax).

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 '654 patent.

Respectfully submitted,

Dated: November 6, 2023

By: / David A. Zucker /

David A. Zucker (Reg. No. 74,095)
david.zucker@lw.com
Latham & Watkins LLP
555 Eleventh Street, NW, Ste. 1000
Washington, DC 20004-1304
Telephone: 202.637.2200
Fax: 202.637.2201

*Counsel for Petitioner
InductEV, Inc.*

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 13,999 words, which is the sum of 13,973 words calculated by Microsoft Word's word-count feature and 26 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).

By: / David A. Zucker /

David A. Zucker (Reg. No. 74,095)
david.zucker@lw.com
Latham & Watkins LLP
555 Eleventh Street, NW, Ste. 1000
Washington, DC 20004-1304
Telephone: 202.637.2200
Fax: 202.637.2201

*Counsel for Petitioner
InductEV, Inc.*

CERTIFICATE OF SERVICE

The undersigned certifies that a complete copy of this Petition for *Inter Partes* Review of U.S. Patent No. 8,466,654 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:

Joseph Re
John Sganga
Craig Summers
Edward Schlatter
Daniel Altman
160649 - Knobbe, Martens, Olson & Bear, LLP (WTCY)
WiTricity's
2040 Main Street
Fourteenth Floor
Irvine, CA 92614

via FEDERAL EXPRESS next business day delivery, on November 6, 2023.

By: / David A. Zucker /

David A. Zucker (Reg. No. 74,095)
david.zucker@lw.com
Latham & Watkins LLP
555 Eleventh Street, NW, Ste. 1000
Washington, DC 20004-1304
Telephone: 202.637.2200
Fax: 202.637.2201

*Counsel for Petitioner
InductEV, Inc.*