UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.
Petitioner

v.

NUCURRENT, INC.
Patent Owner

Patent No. 9,941,729

PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 9,941,729

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Ex. 1002	Declaration of R. Jacob Baker, Ph.D., P.E.
Ex. 1003	Curriculum Vitae of R. Jacob Baker, Ph.D., P.E.
Ex. 1004	Prosecution History of U.S. Patent No. 9,941,729
Ex. 1005	U.S. Patent Application Publication No. 2014/0035383 to Riehl
Ex. 1006	Riehl et al., "Wireless Power Systems for Mobile Devices Supporting Inductive and Resonant Operating Modes," IEEE Transactions on Microwave Theory and Techniques, vol. 63, no. 3, pp. 780-790, Mar. 2015 ("Riehl IEEE")
Ex. 1007	U.S. Patent Application Publication No. 2011/0241437 to Kanno
Ex. 1008	U.S. Patent Application Publication No. 2012/0274148 to Sung
Ex. 1009	Certified English Translation of Japanese Patent Application Publication No. JP 2013-93429 to Kazuya, Japanese Language Version of JP2013-93429, and Translation Certificate
Ex. 1010	U.S. Patent Application Publication No. 2015/0091502 to Mukherjee
Ex. 1011	Certified English Translation of Korean Patent Application Publication No. 10-2013-0045307 to Yu, Korean Language Version of 10-2013-0045307, and Translation Certificate
Ex. 1012	Riehl et al., "Wireless Power Systems for Mobile Devices Supporting Inductive and Resonant Operating Modes," IEEE Transactions on Microwave Theory and Techniques, vol. 63, no. 3, pp. 780-790, Mar. 2015 (copy from Library of Congress)

Ex. 1013	Asa et al., "A Novel Mult-Level Phase-Controlled Resonant Inverter with Common Mode Capacitor for Wireless EV Chargers," 2015 IEEE Transportation Electrification Conference and Expo (ITEC), June 2015 ("Asa")
Ex. 1014	IEEE Xplore Webpage
Ex. 1015	U.S. Patent Application Publication No. 2007/0126544 A1 ("Wotherspoon")

I. INTRODUCTION

Samsung Electronics Co., Ltd. ("Petitioner") requests *inter partes* review ("IPR") of claims 1-9, 11-19, 21, and 23-26 of U.S. Patent No. 9,941,729 (Ex. 1001), which, on its face, is assigned to NuCurrent, Inc. ("Patent Owner"). For the reasons set forth below, the challenged claims should be found unpatentable and canceled.

II. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8

Real Parties-in-Interest: Petitioner identifies the following as the real parties-in-interest: Samsung Electronics Co., Ltd., Samsung Electronics America, Inc.

Related Matters: Patent Owner has asserted the '729 patent against Petitioner and the other real party-in-interest in *NuCurrent, Inc. v. Samsung Elecs. Co., Ltd. et al.*, No. 1:19-cv-00798-DLC (S.D.N.Y.). Patent Owner has also asserted U.S. Patent Nos. 8,680,960 ("the '960 patent"), 9,300,046 ("the '046 patent"), 8,698,591 ("the '591 patent"), and 8,710,948 ("the '948 patent") in this action. On March 22, 2019, Petitioner filed petitions challenging certain claims of the '960, '046, '591, and '948 patents. The specification of the '729 patent is identical to the specification of U.S. Patent No. 10,063,100 ("the '100 patent"), also assigned to Patent Owner, even though the two patents are not in the same family. On May 28, 2019, Petitioner filed PGR2019-00049, -00050 challenging certain claims of the '100 patent.

Counsel and Service Information: Lead counsel is Naveen Modi (Reg. No.

46,224), and Backup counsel are (1) Joseph E. Palys (Reg. No. 46,508), (2) Paul Anderson (Reg. No. 39,896) and (3) Chetan R. Bansal (Limited Recognition No. L0667). Service information is Paul Hastings LLP, 875 15th St. N.W., Washington, D.C., 20005, Tel.: 202.551.1700, Fax: 202.551.1705, email: PH-Samsung-NuCurrent-IPR@paulhastings.com. Petitioner consents to electronic service.

III. PAYMENT OF FEES UNDER 37 C.F.R. § 42.15(a)

The PTO is authorized to charge all fees due at any time during this proceeding, including filing fees, to Deposit Account No. 50-2613.

IV. GROUNDS FOR STANDING

Petitioner certifies that the '729 patent is available for IPR and Petitioner is not barred or estopped from requesting IPR on the grounds identified herein.

V. PRECISE RELIEF REQUESTED AND GROUNDS RAISED

A. Claims for Which Review Is Requested

Petitioner respectfully requests review of claims 1-9, 11-19, 21, and 23-26 ("challenged claims") of the '729 patent, and cancellation of these claims as unpatentable.

B. Statutory Grounds of Challenge

The challenged claims should be canceled as unpatentable on the following grounds:

Ground 1: Claims 1, 5-8, 12-14, 16-18, 21, and 23 are unpatentable under AIA 35 U.S.C. § 103(a) as being obvious over U.S. Patent Application Publication

No. 2014/0035383 ("Riehl") (Ex. 1005);

Ground 2: Claims 3, 4, 9, 14, and 26 are unpatentable under AIA 35 U.S.C. § 103(a) as being obvious over Riehl and Riehl et al., "Wireless Power Systems for Mobile Devices Supporting Inductive and Resonant Operating Modes" ("Riehl IEEE") (Ex. 1006);

Ground 3: Claim 11 is unpatentable under AIA 35 U.S.C. § 103(a) as being obvious over Riehl and U.S. Patent Application Publication No. 2011/0241437 ("Kanno") (Ex. 1007);

Ground 4: Claim 15 is unpatentable under AIA 35 U.S.C. § 103(a) as being obvious over Riehl and U.S. Patent Application Publication No. 2012/0274148 ("Sung") (Ex. 1008);

Ground 5: Claim 24 is unpatentable under AIA 35 U.S.C. § 103(a) as being obvious over Riehl and Japanese Patent Application Publication No. JP 2013-93429 ("Kazuya") (Ex. 1009);

Ground 6: Claims 1, 2, 5-8, 12-14, 16-19, 21, 23, and 25 are unpatentable under AIA 35 U.S.C. § 103(a) as being obvious over Riehl and Korean Patent Application Publication No. 10-2013-0045307 ("Yu") (Ex. 1011);

Ground 7: Claims 3, 4, 9, 14, and 26 are unpatentable under AIA 35 U.S.C. § 103(a) as being obvious over Riehl, Yu, and Riehl IEEE;

Ground 8: Claim 11 is unpatentable under AIA 35 U.S.C. § 103(a) as being obvious over Riehl, Yu, and Kanno;

Ground 9: Claim 15 is unpatentable under AIA 35 U.S.C. § 103(a) as being obvious over Riehl, Yu, and Sung;

Ground 10: Claim 24 is unpatentable under AIA 35 U.S.C. § 103(a) as being obvious over Riehl, Yu, and Kazuya.

The ’729 patent issued from U.S. Application No. 14/821,065 (“the ’065 application”) filed August 7, 2015. (Ex. 1001, Cover). The ’729 patent does not claim priority from any other application.

Riehl, Riehl IEEE, Kanno, Sung, Kazuya, Yu published more than one year prior to the filing date of the ’065 application and qualify as prior art under one or both AIA 35 U.S.C. §§ 102(a)(1) and 102(a)(2). Mukherjee was filed on October 1, 2013 and qualifies as prior art under § 102(a)(2).

Riehl IEEE is an IEEE publication that was publicly available to persons interested and skilled in the art before August 2015. The Board has routinely held and even taken official notice that IEEE publications like Riehl IEEE are printed publications. *Power Integrations, Inc., v. Semiconductor Components Industries, LLC*, IPR2018-00377, Paper No. 10 at 10 (July 17, 2018) (quoting *Ericsson, Inc. v. Intellectual Ventures I LLC*, IPR2014-00527, Paper 41 at 11 (May 18, 2015)). Indeed, in *Ericsson*, the Board “accept[ed] the publication information on the IEEE copyright line on page 1 of [the IEEE reference] as evidence of its date of publication and public accessibility." *Ericsson*, IPR2014-00527, Paper 41, 10-11; *see also Coriant (USA) Inc. v. Oyster Optics, LLC*, IPR2018-00258, Paper 13 at 11 (June 6, 2018); *Microsoft Corp. v. Bradium Techs. LLC*, IPR2016-00449, Paper 9 at 13 (PTAB July 27, 2016) (noting generally that "IEEE publications, such as the one in which Reddy appeared, are distributed widely and intended to be accessible to the public").

Here, Riehl IEEE bears the markings "MARCH 2015" (Ex. 1006, 1) and "IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. 63, NO. 3, MARCH 2015" (*id.* at 780, 782, 784, 786, 790), and states that "IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES . . . is published monthly by the Institute of Electrical and Electronics Engineers, Inc." (*id.* at 3). A copy of Riehl IEEE from the Library of Congress (Ex. 1012, showing "LIBRARY OF CONGRESS") additionally bears the marking "2015 Mar." (*Id.*) Moreover, an article by E. Asa *et al.*, which is itself an IEEE publication published before August 2015, cites Riehl. (Ex. 1013, 1 ("©2015 IEEE"), 6 (citation information regarding Riehl); Ex. 1014, 1 (indicating that Asa was "[p]ublished in: 2015 IEEE Transportation Electrification Conference and Expo (ITEC)," "Date of Conference: 14-17 June 2015," "Date Added to IEEE Xplore: 27 July 2015"), 2 ("Publisher: IEEE").)

Out of the references relied upon in this petition, only Kanno was considered by the Patent Office during prosecution of the '729 patent. (*See generally* Ex. 1004; Ex. 1001, References Cited.)

VI. LEVEL OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art ("POSITA") at the time of the alleged invention of the '729 patent, which for purposes of this proceeding is the early-to-mid 2010s (including August 7, 2015) would have had a bachelor's degree in electrical engineering or a similar field, and at least two to three years of experience in integrated circuit design including power electronics. (Ex. 1002, ¶¶20-21.) More education can supplement practical experience and vice versa. (*Id.*)[1]

VII. OVERVIEW OF THE '729 PATENT AND PRIOR ART

A. The '729 Patent

The '729 patent generally relates to "an antenna having a single coil structure in which a multitude inductor coils are electrically connected in series" "having a compact design that enables adjustment or tuning of the inductance within the antenna which results in the ability to tune multiple antenna frequencies." (Ex. 1001, 10:1-7; Ex. 1002, ¶¶26-32; *see also id.*, ¶¶22-25.)

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[1] Petitioner submits the declaration of R. Jacob Baker, Ph.D., P.E. (Ex. 1002), an expert in the field of the '729 patent. (Ex. 1002, ¶¶5-14; Ex. 1003.)

The '729 patent acknowledges that antennas were known to be "a key building block in the construction of wireless power and/or data transmission systems." (Ex. 1001, 2:64-65.) At the time of the alleged invention of the '729 patent, devices (such as cellphones) included multi-mode antennas that could support more than one wireless charging standard (e.g., the Qi and the PMA standards). (*Id.*, 2:29-55, 3:1-6.) Purportedly, these "multi mode" antennas had "a relatively large footprint" and were "ideally not suited for incorporation within small electronic devices . . . ." (*Id.*, 3:22-38.) Such a multi-mode antenna having two coils is disclosed with reference to figure 1. (*Id.*)

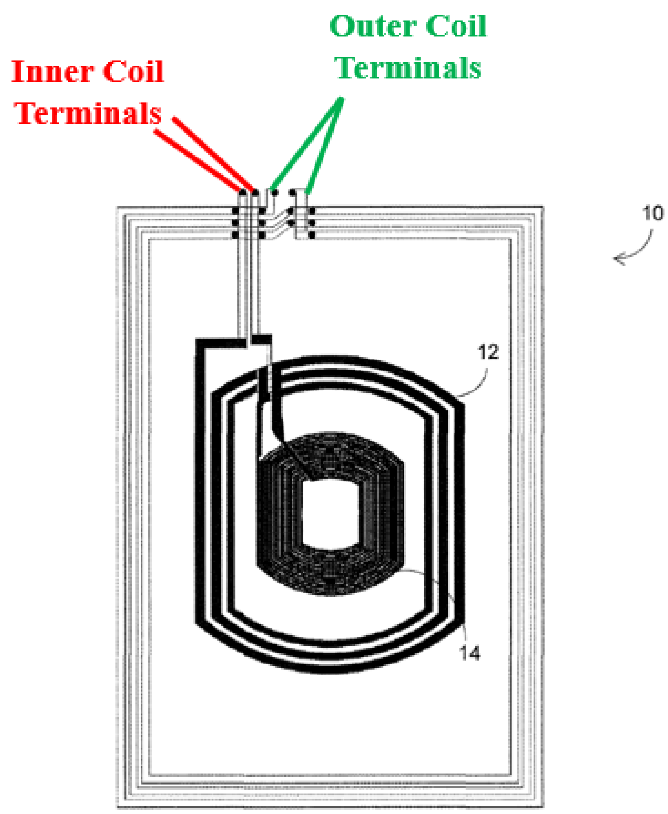

FIG. 1
PRIOR ART

(*Id.*, FIG. 1 (annotated); Ex. 1002, ¶27.)

The ’729 patent purportedly improves upon the prior art dual mode antenna by disclosing a single structure multi-mode antenna in which an outer coil is connected to an inner coil and one of the three terminals is shared by both coils. (Ex. 1001, 3:22-28, 12:46-51, FIG. 3.) Figure 3 of the ’729 patent shows an example of such an antenna that “comprises a first outer coil 42 that is electrically connected in series to a second interior coil 44.” (*Id.*, 12:46-51, FIG. 3.)

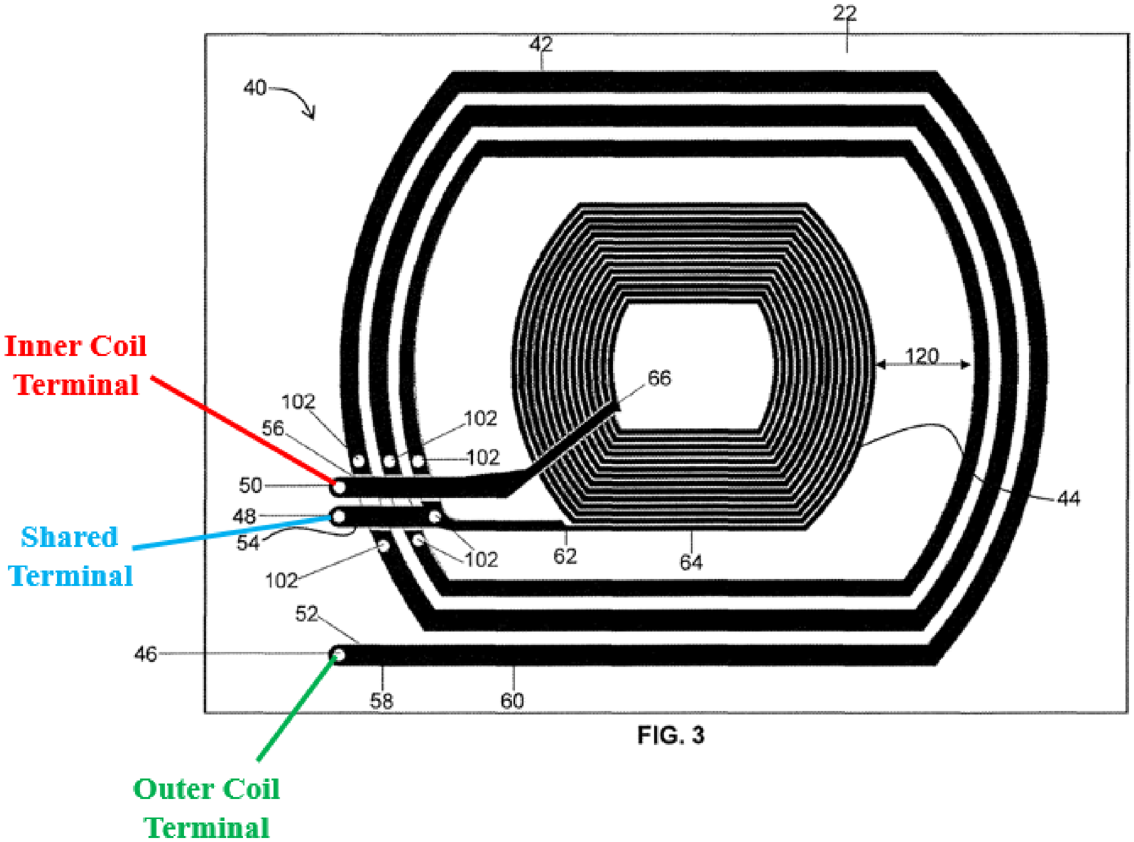

FIG. 3

(Ex. 1001, FIG. 3 (annotated); Ex. 1002, ¶28.) But, as explained below and in the declaration of Dr. Baker (Ex. 1002, ¶¶34-214), all of the claimed features of the ’729 are disclosed or suggested by the prior art.

VIII. CLAIM CONSTRUCTION

For IPR proceedings, the Board applies the claim construction standard set forth in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). *See* 83 Fed. Reg. 51,340-51,359 (Oct. 11, 2018). Under *Phillips*, claim terms are typically given their ordinary and customary meanings, as would have been understood by a POSITA, at the time of the invention, having taken into consideration the language of the claims, the specification, and the prosecution history of record. *Phillips*, 415

F.3d at 1313; *see also id.,* 1312-16. The Board, however, only construes the claims when necessary to resolve the underlying controversy. *Toyota Motor Corp. v. Cellport Systems, Inc.*, IPR2015-00633, Paper No. 11 at 16 (Aug. 14, 2015) (citing *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)). Petitioner believes that no express constructions of the claims are necessary to assess whether the prior art reads on the challenged claims.[2]

IX. DETAILED EXPLANATION OF GROUNDS

A. Ground 1: Riehl Renders Claims 1, 5-8, 12-14, 16-18, 21 and 23 Obvious

1. Claim 1

a) **"An antenna, comprising:"**

To the extent the preamble is limiting, Riehl discloses this feature. (Ex. 1005, ¶¶7-9, 16, FIGS. 3-6; Ex. 1002, ¶¶40-43.) Figure 3 of Riehl shows a dual-mode wireless power receiver.

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[2] Petitioner reserves all rights to raise claim construction and other arguments in district court as relevant and necessary to those proceedings. For example, a comparison of the claims to any accused products may raise controversies that need to be resolved through claim construction that is not necessary here given the similarities between the references and the patent.

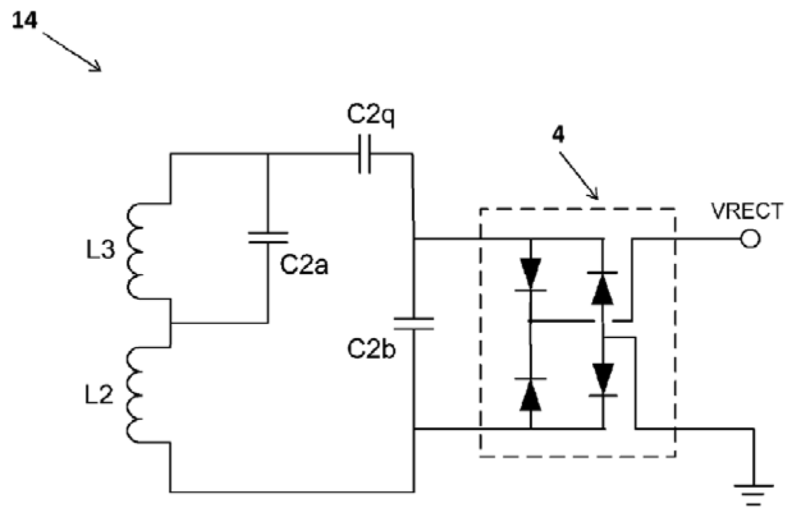


FIG. 3

(Ex. 1005, FIG. 3.)

The "dual-mode wireless power receiver" includes two inductor coils L2 and L3. (Ex. 1005, ¶¶7-9, 16, 22, 28, FIGS. 3-6.) The two inductor coils form a "receiver coil" that can "receive power either from an inductive charger at low frequency . . . or at high frequency . . . ." (*Id.*, ¶¶7-9, 26.) Moreover, the two inductor coils L2 and L3 are connected in series. (*Id.*, FIG. 3.) A POSITA would have understood that such a "receiver coil" including one or more inductive elements is an "antenna." (Ex. 1002, ¶43; Ex. 1005, ¶7.) Such an understanding is consistent with the '729 patent, which describes a combination of two inductor coils connected in series as an "antenna." (Ex. 1001, 2:3-6, 3:67-4:3; *see also infra* Sections IX.A.1(b)-(h).)

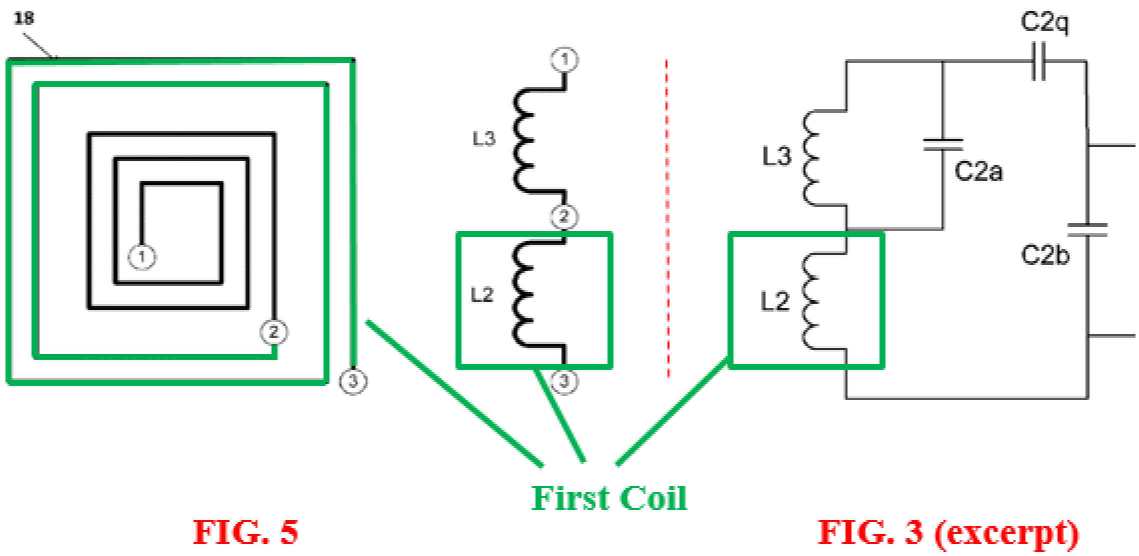
b) **"a) a first conductive wire forming . . . within the first coil;"[3]**

Riehl discloses these features. (Ex. 1002, ¶¶44-61.)

<u>"a first conductive wire forming a first coil contactable to a substrate surface"</u>

Figure 3 of Riehl discloses the circuit topology of Riehl's "dual-mode receiver." (Ex. 1005, FIG. 3, ¶22.) The "dual-mode receiver" of figure 3 includes two inductors L2 and L3. (*Id.*, FIG. 3, ¶¶22-25.) The physical arrangement of these two inductors L2 and L3 is set forth in figure 5, which discloses "a coil arrangement used in accordance with the invention" where the two inductors L2 and L3 are formed "in the same plane of a printed circuit board . . . ." (*Id.*, ¶¶12, 14, 28, FIGs. 3, 5).

[3] The claim language is reproduced below.



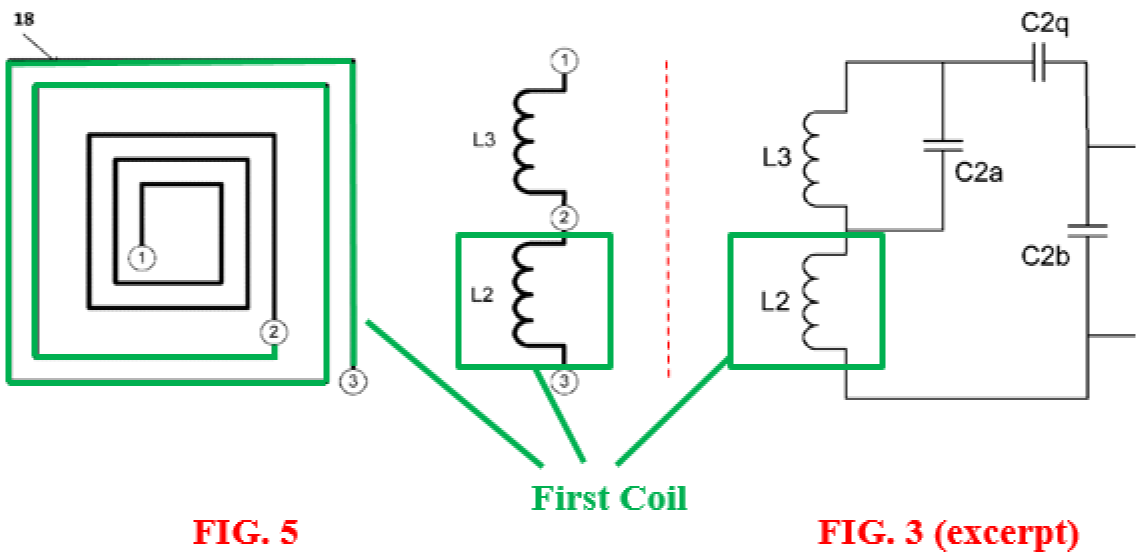
(*Id.*, FIGs. 5 (left) (annotated), 3 (right) (excerpt, annotated); Ex. 1002, ¶45.)

The annotated figures above show a first inductor (L2) ("a first conductive wire forming a first coil") (highlighted in green) and a second inductor (L3) formed on a printed circuit board ("contactable to a substrate surface"). (Ex. 1002, ¶46; Ex. 1005, FIG. 5, ¶28; *see also id.*, ¶14).

Each of the inductors L2 and L3 is a "coil." (Ex. 1005, FIG. 5, ¶28.) Moreover, the inductors L2 and L3 constitute a "conductive wire" because each of the inductors L2 and L3 have to conduct current in order for the circuit of figure 3 to function as a wireless power receiver. (Ex. 1002, ¶¶47-48.)

<u>"a first coil . . . configured to generate a first inductance and a first resonant frequency"</u>

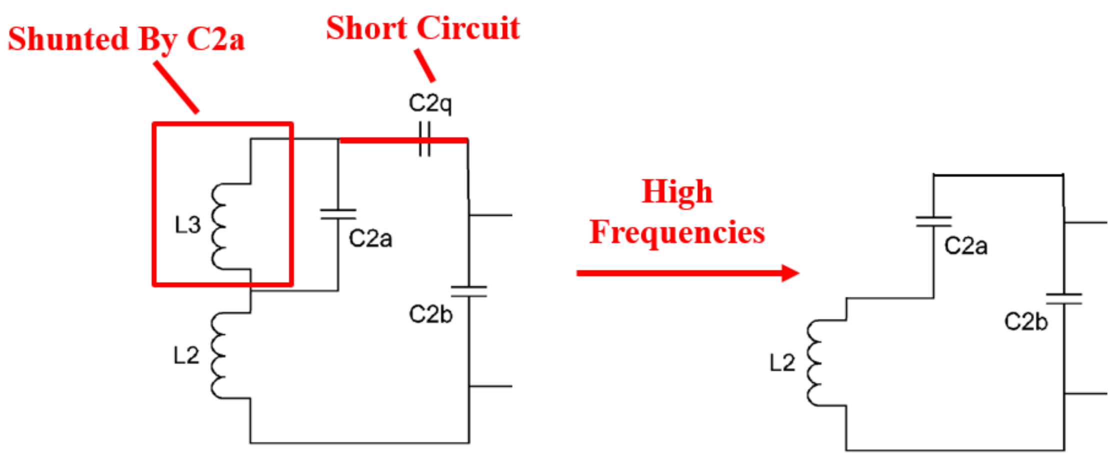
Riehl discloses that inductor coil L2 is configured to generate a first inductance and a first resonant frequency. (Ex. 1002, ¶¶49-59; Ex. 1005, ¶¶12, 17-18, 20, 23 ("inductance of L2"), FIGs. 3, 5.)



(*Id.*, FIGs. 5 (left) (annotated), 3 (right) (excerpt, annotated); Ex. 1002, ¶49.)

For example, Riehl discloses that the capacitance of capacitors C2*a* and C2*b* and the inductance of inductor L2 ("first inductance") are selected to form an electromagnetic resonator with a resonant frequency of 6.78 MHz ("configured to generate a . . . first resonant frequency"). (Ex. 1002, ¶50; Ex. 1005, ¶¶17-18, 20, 25.) Specifically, when operating in high-frequency mode, the C2*q* capacitor is effectively a short circuit and "the capacitor *C2a* has an impedance much lower than the inductor L3 at high frequencies, [and] thus it shunts L3." (Ex. 1005, ¶¶22, 25.)

Therefore, at high frequencies, the circuit shown in figure 3 "can be reduced to a series-parallel resonant circuit where L2, C2*a* and C2*b* are the active elements, similar to FIG. 2" where "[t]his circuit can be tuned to resonance at 6.78 MHz" and the inductance is approximately equal to L2. (*Id.*, ¶25.)



(Ex. 1005, FIG. 3 (excerpt, annotated); Ex. 1002, ¶51.)

Therefore, inductor L2 has an inductance and in the high-frequency mode, L2 has a resonant frequency of 6.78 MHz. (Ex. 1002, ¶52.) The understanding that inductor L2 of Riehl constitutes a first coil configured to generate a first inductance and a first resonant frequency is supported by Riehl IEEE (Ex. 1006) and consistent with the way this element is disclosed by the '729 patent.[4] (Ex. 1002, ¶¶53-59; Ex. 1001, 10:66-11:3, 18:58-19:1.)

"the first coil comprising a continuous electrically conductive path that extends along the first conductive wire from a first coil first end that resides at an end of an outermost turn of the first coil to a first coil second end that resides at an end of an inner most turn of the first coil,"

Riehl discloses this feature. (Ex. 1005, FIG. 5, ¶28.) As discussed above, inductor L2 is a first coil formed of a conductive wire and therefore, forms an "electrically conductive path." As further demonstrated by figure 5, inductor L2 forms a continuous spiral-shape ("comprising a continuous electrically conductive path") extending from an outer end ("extends along the first conductive wire from a first coil first end that resides at an end of an outermost turn of the first coil") at connection point 3 to an inner end ("to a first coil second end that resides at an end of an inner most turn of the first coil") at connection point 2.

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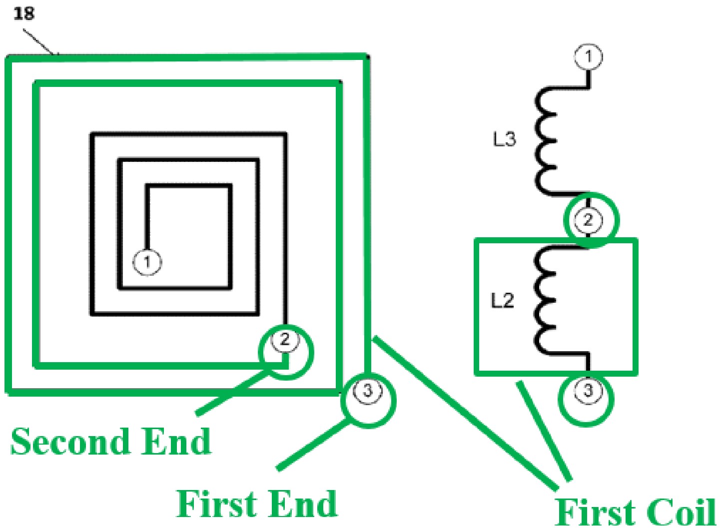
[4] Riehl IEEE is cited as evidence supporting the knowledge of a POSITA at the relevant time and how such a POSITA would have understood the disclosure of Riehl.



(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶60.)

<u>"the first coil comprising Nl number of turns, wherein a first gap extends between adjacent turns within the first coil;"</u>

As shown in figure 5, inductor L2 includes two adjacent turns ("first coil comprising N1 number of turns") separated by a gap or space.

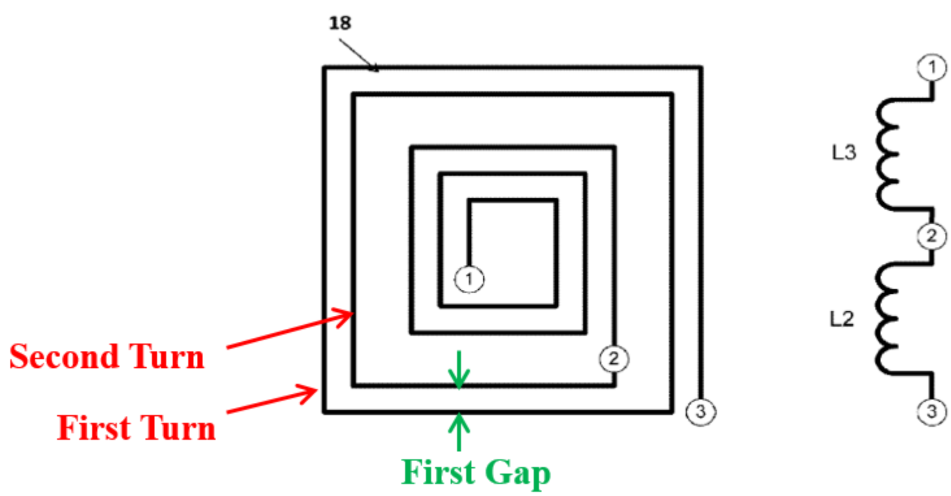


FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶61.)

c) **"b) a second conductive wire forming . . . junction therebetween;"[5]**

Riehl discloses these features. (Ex. 1002, ¶¶62-72.)

<u>"a second conductive wire forming a second coil . . . the second coil comprising a continuous electrically conductive path that extends along the second conductive wire from a second coil, first end that resides at an end of an outermost turn of the second coil to a second coil second end that resides at an end of an inner most turn of the second coil,"</u>

As discussed above in Section IX.A.1(b), inductor L2 is a coil of conductive material. Therefore, Riehl discloses that L3 is "a second conductive wire forming a second coil." (Ex. 1002, ¶36; *see also* Ex. 1005, FIGs. 3, 5, ¶28.) Furthermore, as seen from figure 5, L3 forms a continuous spiral-shape ("comprising a continuous electrically conductive path that extends along the second conductive wire") extending from an outer end at connection point 2 ("extends along the second conductive wire from a second coil, first end that resides at an end of an outermost turn of the second coil") to an inner end at connection point 1 ("to a second coil second end that resides at an end of an inner most turn of the second coil"). (Ex. 1005, FIGs. 3, 5, ¶28.)

[5] The full claim language is reproduced below.

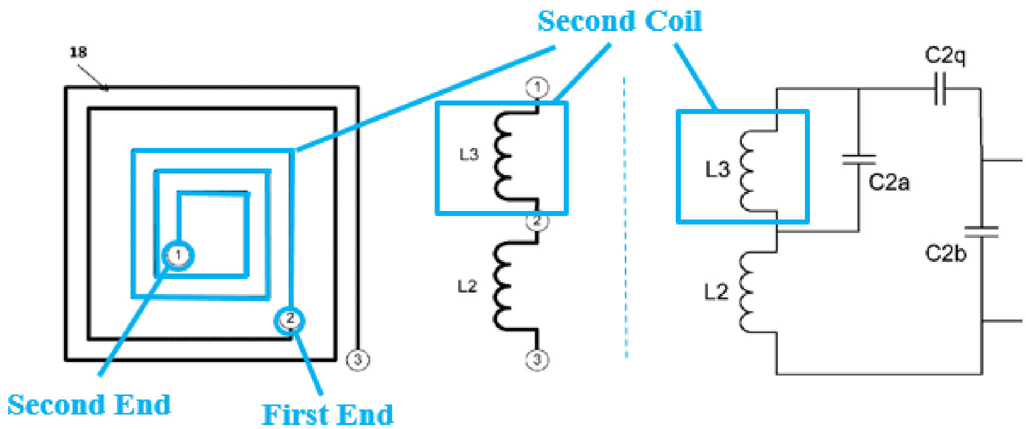
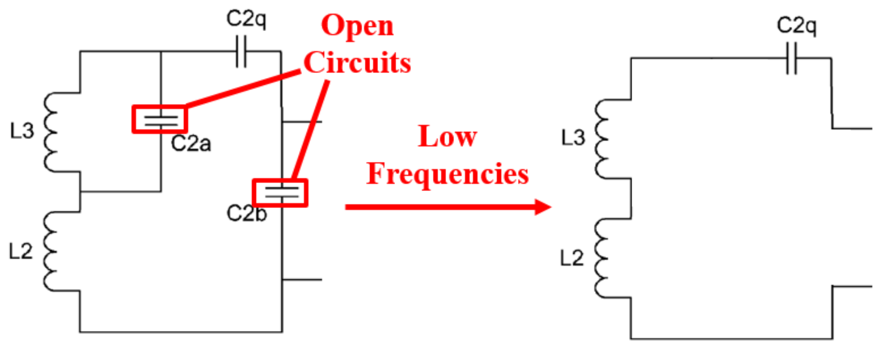


FIG. 5 **FIG. 3 (excerpt)**

(Ex. 1005, FIGs. 5 (annotated), 3 (excerpt, annotated); Ex. 1002, ¶63.)

<u>"a second coil . . . configured to generate a second inductance and a second resonant frequency,"</u>

Riehl discloses the second coil L3 is configured to generate a second inductance and a second resonant frequency. (Ex. 1005, ¶¶12, 17-18, 20, 23-24, FIGs. 3, 5; Ex. 1002, ¶¶64-68.) Riehl discloses that "[a]t low frequencies, the C2*a* and C2*b* capacitors can be approximated as open circuits." (Ex. 1005, ¶24.) Therefore, as illustrated in the demonstrative below, at low frequencies, the dual mode receiver "can be reduced to a pure series LC circuit in which L2, L3 and C2*q* are the series elements." (*Id.*)



(Ex. 1005, FIG. 3 (excerpt, annotated); Ex. 1002, ¶64.)

In an exemplary configuration L3's inductance is 10 times the inductance of L2. (Ex. 1005, ¶23.) As disclosed by Riehl, "[o]ne can choose C2*q* to combine with this inductance to create a series resonance at 100 kHz." (*Id.*, ¶24.) Therefore, the capacitance of capacitor C2*q* and the inductance of inductor L3 ("second inductance") can be selected to form an electromagnetic resonator with a resonant frequency of "100kHz, as required by the Qi specification." (*Id.*, ¶¶17-18, 20, 24.) As such, the inductor L3 is "configured to generate a second inductance and second resonant frequency." (Ex. 1002, ¶65.)

The understanding that the inductor L3 in Riehl constitutes a second coil configured to generate a second inductance and a second resonant frequency is supported by Riehl IEEE and consistent with the '729 patent. (Ex. 1002, ¶¶66-68; Ex. 1001, 10:66-11:3, 18:58-19:1.)

<u>"wherein the first resonant frequency is different than the second resonant frequency,"</u>

The "first resonant frequency" is 6.78 MHz (*supra* Section IX.A.1(b)) whereas the "second resonant frequency" is 100 kHz. (Ex. 1002, ¶69.)

<u>"wherein the second coil is disposed on the substrate surface positioned one of within an inner perimeter formed by the innermost turn of the first coil and adjacent the first coil,"</u>

Riehl discloses forming L2 and L3 on a printed circuit board ("the second coil is disposed on the substrate surface") in a planar concentric fashion with L3 disposed inside the inner turn of L2 ("positioned one of within an inner perimeter formed by the innermost turn of the first coil and adjacent the first coil"). (Ex. 1005, ¶28, FIG. 5.)

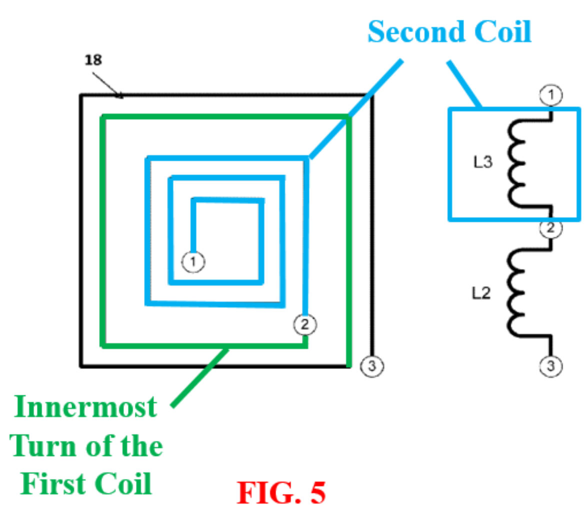


FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶70.)

<u>"the second coil comprising N2 number of turns, wherein a second gap extends between adjacent turns within the second coil,"</u>

Riehl discloses this feature. (Ex. 1005, FIG. 5, ¶28; Ex. 1002, ¶71.) For example, inductor coil L3 three adjacent turns ("second coil comprising N2 number of turns") separated by a gap or space. (Ex. 1005, FIG. 5.)

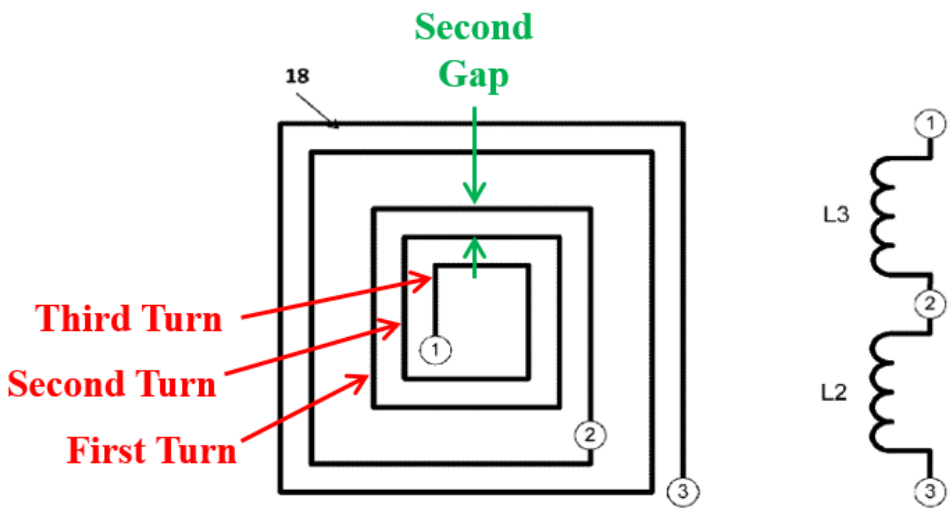


FIG. 5

(*Id.*, FIG. 5 (annotated); Ex. 1002, ¶71.)

<u>"and wherein the first end of the second coil meets and joins the second end of the first coil forming a continuous junction therebetween;"</u>

Riehl discloses this feature. (Ex. 1005, FIGS. 3, 5, ¶28; Ex. 1002, ¶72.) For example, Riehl discloses the outer end of inductor coil L3 ("first end of the second coil") "meets and joins" the inner end of inductor coil L2 ("the second end of the first coil"), at connection point 2 "forming a continuous junction therebetween."

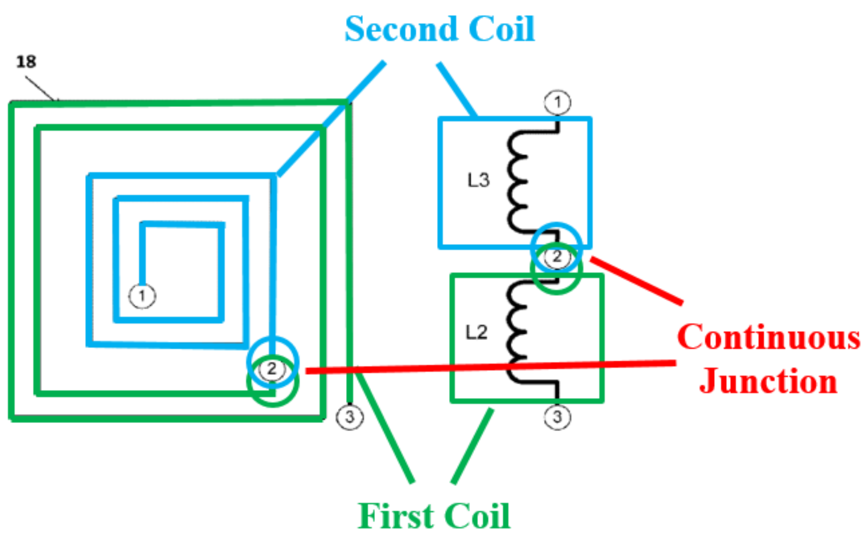


FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶72.)

d) **"c) a third gap separating the outermost turn of the second coil from the innermost turn of the first coil, wherein the third gap is greater than the first and second gaps;"**

Riehl discloses or suggests this feature. (Ex. 1002, ¶¶73-79.) For example, Riehl discloses a third gap separating the outermost turn of the second inductor coil, L3, from the innermost turn of the first inductor coil, L2. (Ex. 1005, FIG. 5.)

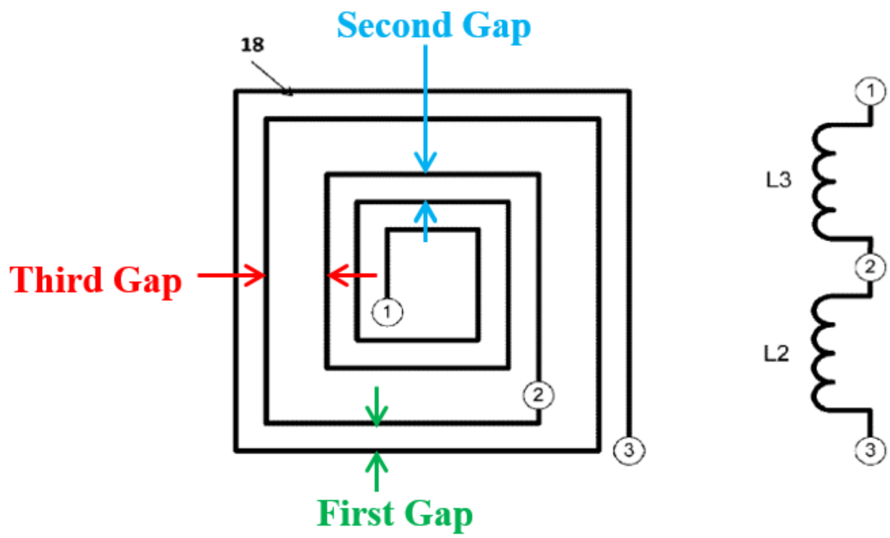


FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶73.)

While figure 5 of Riehl is not drawn to scale, it suggests to a POSITA that the third gap is larger than the first and second gaps. (Ex. 1002, ¶¶73-79.) In fact, as discussed below, a POSITA would expect that the third gap is larger than the first and second gaps given the teachings of various contemporaneous references (e.g., Riehl IEEE and Mukherjee) and would have found it obvious to ensure such a feature in Riehl. (*Id.*)

In particular, increasing the gap between the first and second coils would reduce mutual inductance between the coils. (Ex. 1002, ¶74.) Such an understanding is supported by Riehl IEEE. (*Id.*; Ex. 1006, 786.) Therefore, a POSITA would have been motivated to increase the gap between the coils to minimize the mutual inductance between them. (Ex. 1002, ¶75.) Small mutual inductance between L2 and L3 ensures that they do not behave like the primary and secondary coils of a transformer. (*Id.*) A POSITA would have understood that increasing the gap between L2 and L3 ensures that L2 and L3 behave as individual inductors. (*Id.*)

Furthermore, as demonstrated by both Riehl IEEE and Mukherjee[6], it was well-known that the gap between the coils should be larger than the gap between the turns within each of the coils. (Ex. 1005, FIG. 5; Ex. 1006, FIG. 11; Ex. 1002, ¶¶76-77.) Therefore, based on the disclosure of Riehl as well as the knowledge of a POSITA as evidenced by Riehl IEEE and Mukherjee, Riehl discloses or suggests "wherein the third gap is greater than the first and second gaps." Moreover, a POSITA would have understood that the gaps between turns of the coils (i.e., the "first" and "second" gaps) should be made smaller to decrease the size of the coils but the distance between the coils (i.e., the "third gap" in Riehl) should be made larger to decrease the mutual inductance between the coils. (*Id.*, ¶78.) Indeed, increasing the third gap (i.e., the gap between the first and second coils) would have been a cheap and efficient way of minimizing the mutual inductance between the inner and outer coils in Riehl. (*Id.*)

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[6] Riehl IEEE and Mukherjee are cited as evidence supporting the knowledge of a POSITA at the relevant time.

Furthermore, choosing a third gap that is greater than the "first and second gaps" would have been obvious because it would have been one of a "finite number of identified, predictable solutions." (Ex. 1002, ¶79.) *Perfect Web Techs., Inc. v. InfoUSA, Inc.*, 587 F.3d 1324, 1331 (Fed. Cir. 2009) (finding that a claimed step was obvious when it was one of three available choices).

e) **"d) a first terminal electrically connected to the first end of the first coil, a second terminal electrically connected to the second end of the second coil and a third terminal electrically connected to either of the first or second coils;"**

Riehl discloses this claim feature. (Ex. 1002, ¶¶80-84.) Riehl discloses forming coil L2 with connection point 3 on its outer end ("first terminal electrically connected to the first end of the first coil"), forming coil L3 with connection point 1 on its inner end ("second terminal electrically connected to the second end of the second coil"), and forming coils L2 and L3 such that both the first end of coil L3 and the second end of coil L2 are connected at connection point 2 ("a third terminal electrically connected to either of the first or second coils.") (Ex. 1005, FIGs. 3, 5, ¶28.) Notably, a POSITA would have understood that the terminals labeled below in figure 5 would include not just the connection point on the coil, but additional conductive material that connects external circuitry to the connection point on the coil. (Ex. 1002, ¶81.) For example, the "terminals" recited in claim 1 would include a terminal lead that extends from the connection point on the coil to, for example, the ends of the capacitors and the inputs to the rectifier circuit shown in figure 3 of

Riehl. (*Id.*) Such an understanding is consistent with claim 9 of the ’729 patent. (*Id.*; Ex. 1001, 33:39-46.)

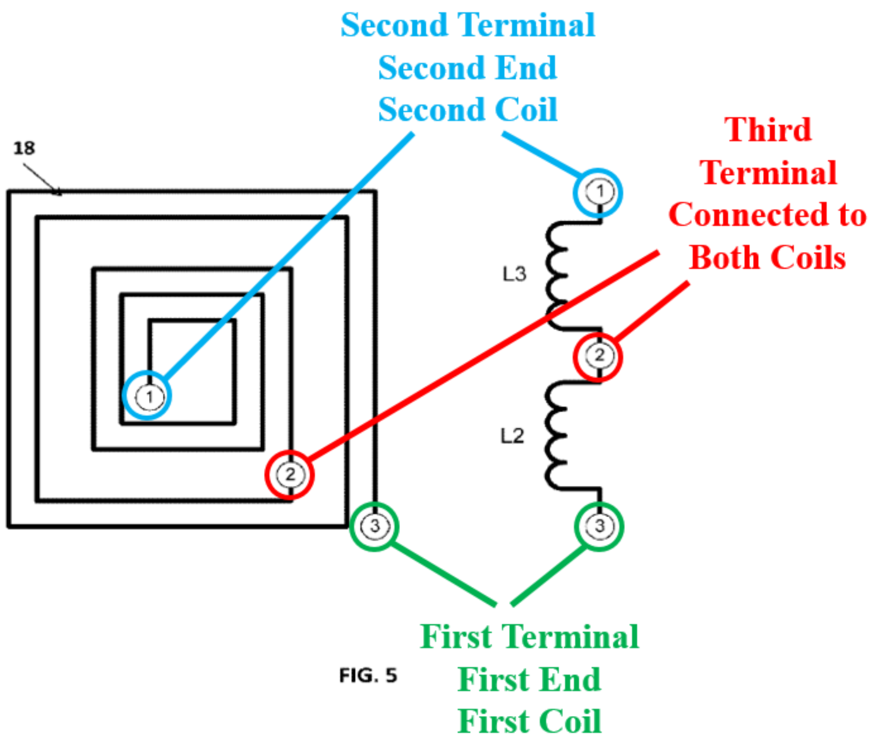


FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶80.)

As shown in annotated figure 3 of Riehl below, each of the connection points 1, 2, and 3 are part of a “terminal” because they allow for connections between the coils and, for example, the capacitors C2*a*, C2*b*, and C2*q*. (Ex. 1005, FIG. 3.) For example, as shown below, the first terminal is coupled to C2*b* and the rectifier circuit, the second terminal is connected to capacitors C2*a* and C2*q*, and the third terminal is coupled to capacitor C2*a*. (*Id.*; Ex. 1002, ¶82.)

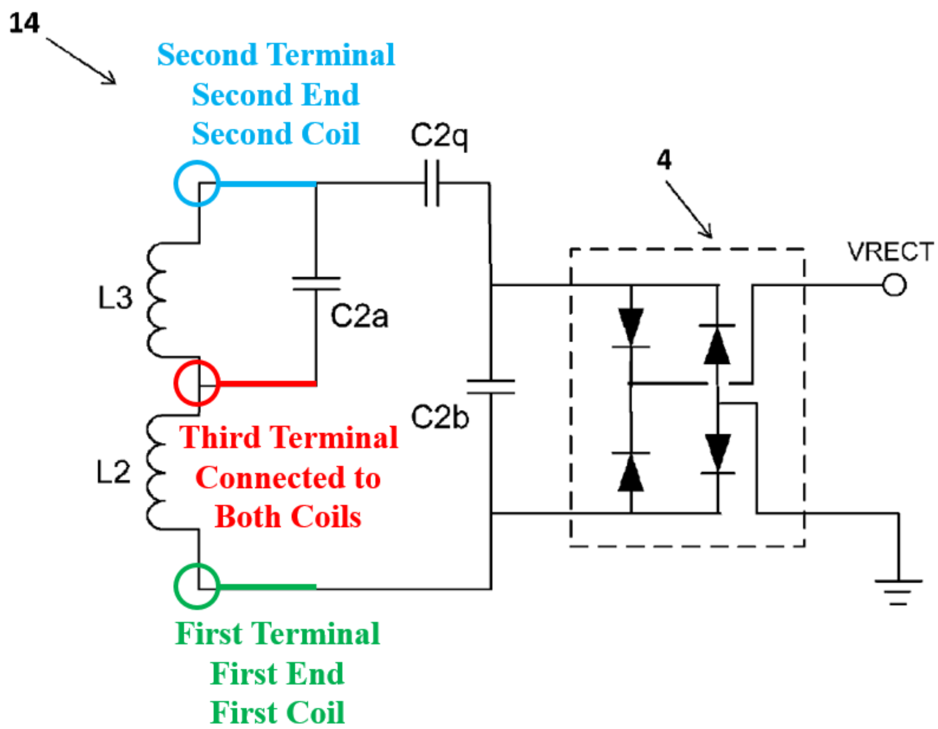


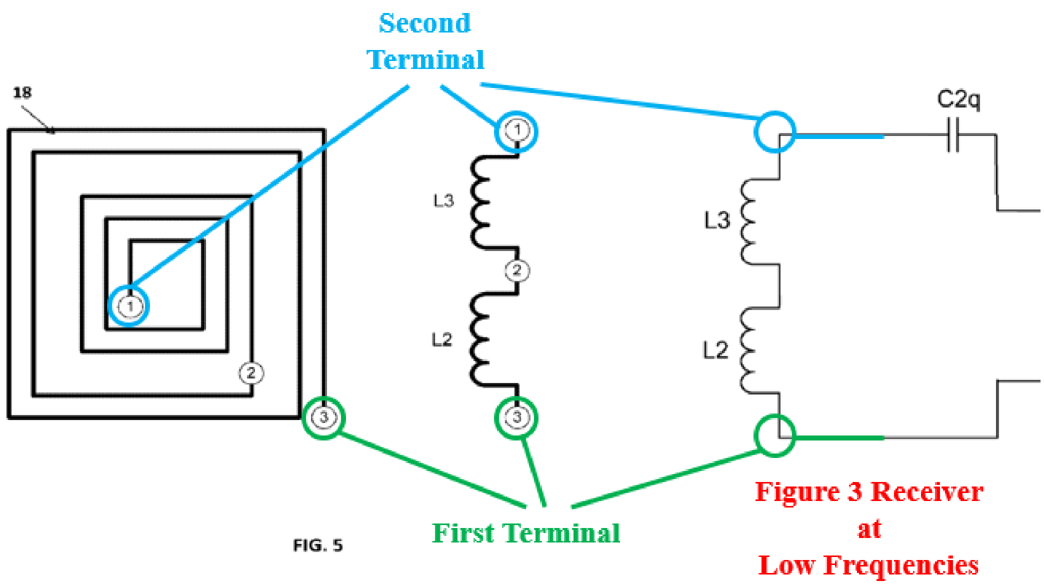
FIG. 3

(Ex. 1005, FIG. 3 (annotated); Ex. 1002, ¶82.)

Riehl's disclosure of this claim feature is consistent with the disclosure of the '729 patent. (Ex. 1002, ¶¶83-84.)

f) **"and e) wherein a tunable inductance is generatable by electrically connecting two of the first, second and third terminals;**

Riehl discloses this feature. (Ex. 1002, ¶¶85-92.) As shown in the demonstrative below, at low frequencies, capacitor C2*a* acts as an open circuit, and current flows between terminal 1 ("the second terminal") and terminal 3 ("the first terminal") so that the total inductance for the receiver circuit is the sum of the inductances of L2 and L3. (Ex. 1005, ¶¶22-24.) Therefore, terminals 1 and 3 are "electrically connected" to the receiver circuitry, which includes the capacitor network and the rectifier circuitry that are shown in figure 3 of Riehl. Accordingly, the inductance seen by the rectifier circuit is the series inductance of L2 plus L3 and corresponds to the connections to the first and second terminals. (*Id.*, ¶24; Ex. 1002, ¶85.)



(Ex. 1005, FIGs. 3, 5 (excerpt, annotated); Ex. 1002, ¶85.)

But at high frequencies, C2*a*'s impedance is much lower than inductor L3's, thereby shunting L3 so that current does not flow through inductor L3. (Ex. 1005, ¶¶22-25.) As a result, at high frequencies current flows between terminal 2 ("the third terminal") and terminal 3 ("the first terminal"), and terminals 2 and 3 are "electrically connected" by the receiver circuitry, which includes the capacitor network and the rectifier circuitry. In such a scenario, the inductance seen by the rectifier circuit is equal to the inductance of L2 and corresponds to connections to first and third terminals. (*Id.*; Ex. 1002, ¶¶86-87.)

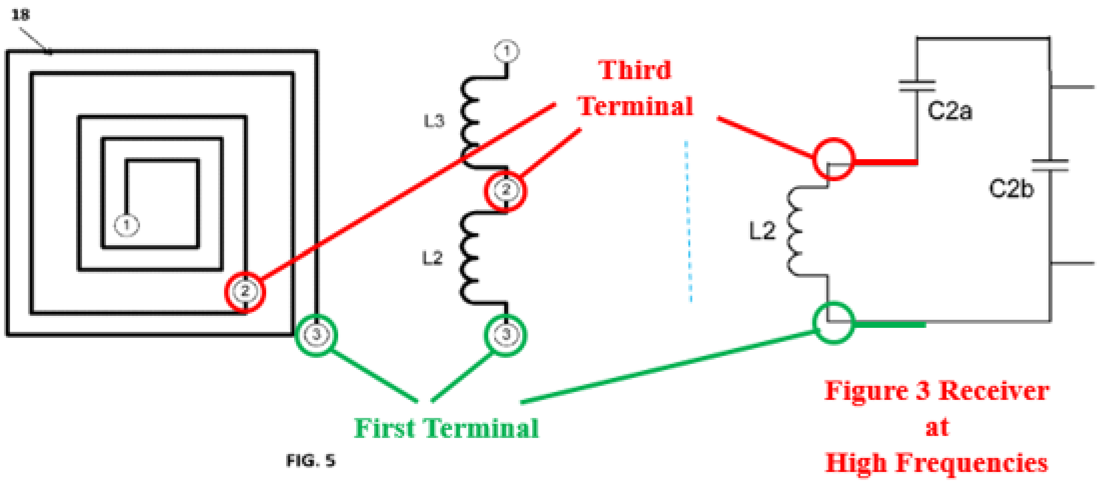


FIG. 5

(Ex. 1005, FIGs. 5 (left) (annotated), 3 (right) (excerpt, annotated); Ex. 1002, ¶87.)

Therefore, Riehl discloses either connecting the first and second terminals to generate a high inductance or connecting the first and third terminals to generate a low inductance ("a tunable inductance is generatable by electrically connecting two of the first, second and third terminals"). (Ex. 1002, ¶88.)

To the extent that Patent Owner argues that the claim requires connecting two of the three terminals to each other in a more direct fashion as opposed to through the rectifier circuit, Riehl still discloses this claim feature.[7] (Ex. 1002, ¶¶89-92.) For example, the capacitor C2a is an open circuit at low frequencies, and therefore does not provide an electrical connection between the second and third terminals. However, at high frequencies, capacitor C2a provides a low impedance path around inductor L3 such the second and third terminals are electrically connected. (Ex. 1005, ¶¶22-25.) Electrically connecting the second and third terminals changes ("tunes") the inductance of the coil structure to correspond to the lower inductance of L2 alone as opposed to the series inductance of L2 and much larger L3. (*Id.*) As shown below, in this high-frequency configuration, connection point 1 ("second terminal") is electrically connected with connection point 2 ("third terminal"). (Ex. 1002, ¶90.)

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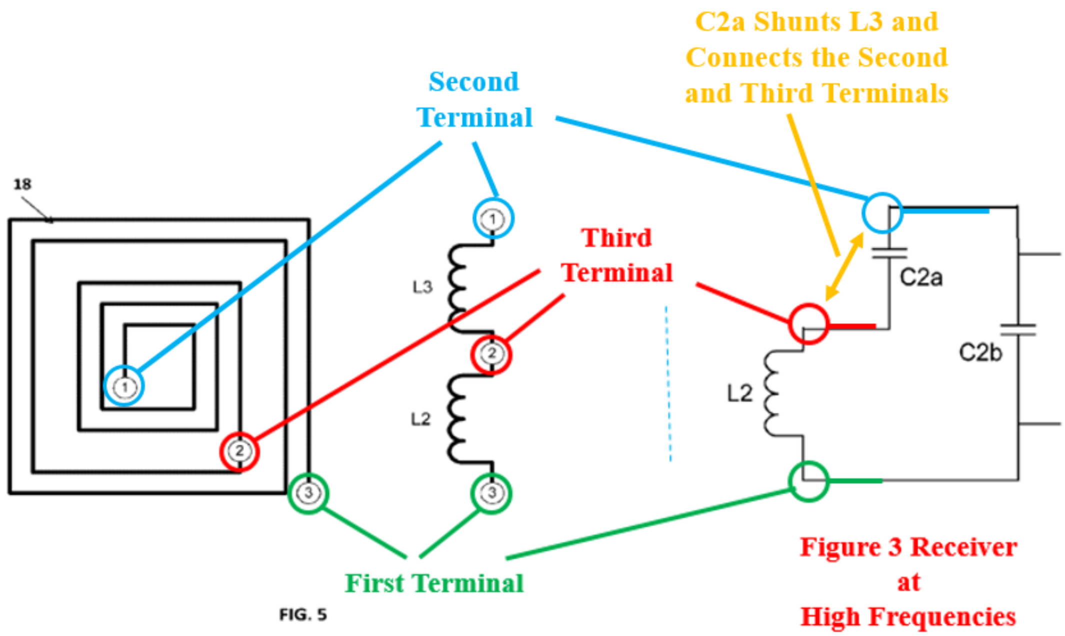
[7] Notably, the Examiner recognized a lack of clarity with respect to this limitation. (Ex. 1004, 415.)



(Ex. 1005, FIGs. 5 (left) (annotated), 3 (right) (excerpt, annotated); Ex. 1002, ¶90.)

Riehl's above operations in which capacitors act as high impedance paths that avoid electrical connectivity or act as low impedance paths that electrically connect two terminals is consistent with the '729 patent's disclosure. (Ex. 1001, 30:61-64, 6:6-9, 18:27-43; Ex. 1002, ¶¶91-92.)

g) **"f) wherein the first resonant frequency of the first coil differs from the second resonant frequency of the second coil by at least 100 kHz;"**

Riehl discloses this feature. (Ex. 1002, ¶¶93-96.) As explained above, in high-frequency mode, inductor coil L2 ("the first coil") is configured with a resonant frequency of 6.78 MHz ("the first resonant frequency"), whereas, in low-frequency mode, inductor coil L3 ("the second coil") is configured to generate a resonant frequency of 100 kHz ("the second resonant frequency") ("differs . . . by at least 100 kHz"). (Ex. 1005, ¶¶17-18, 20, 24-25.)

To the extent that Patent Owner argues that L2 also resonates at 100 kHz when the dual mode receiver of Riehl is in the low-frequency mode, Riehl still discloses the claim feature. (Ex. 1002, ¶94.) Claim 1 only requires that the **first resonant frequency** of the first coil differs from the **second resonant frequency** of the second coil by at least 100 kHz, not that all resonant frequencies of the coils differ. Moreover, Riehl's disclosure is consistent with the disclosure of the '729 patent because the resonating frequency of the inner coil is determined when both the inner and outer coils are connected in series between terminals 46 and 48 in the same manner as inductors L2 and L3 are connected in series in figure 3 of Riehl when the resonant frequency of L3 is determined. (*Supra* section IX.A.1(c); Ex. 1001, 18:58-19:1; Ex. 1002, ¶¶95-96.)

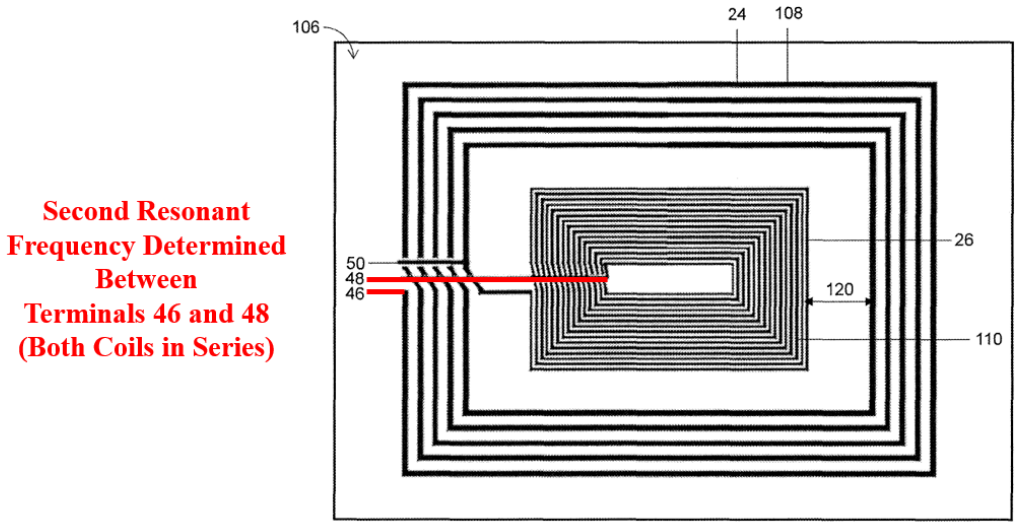


FIG. 3E

(Ex. 1001, FIG. 3E (annotated); Ex. 1002, ¶95.)

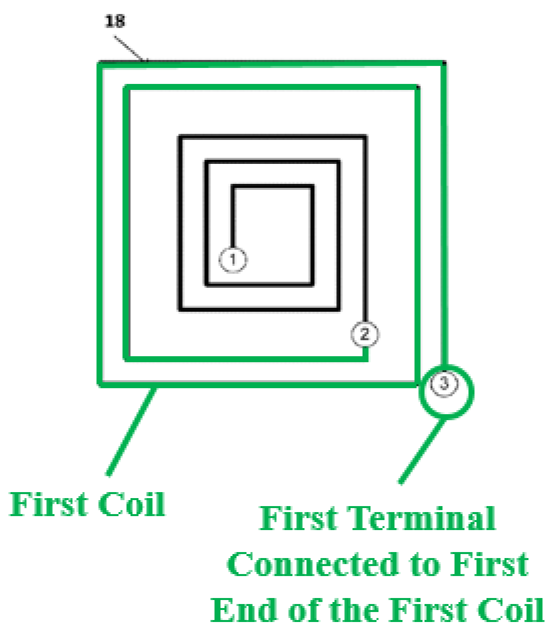
h) **"and g) wherein at least one of the first coil and the second coil operates at about 100 kHz to about 500 kHz."**

Riehl discloses this feature. (Ex. 1002, ¶95.) For example, Riehl discloses that in the low frequency mode, inductor L3 ("second coil") operates at 100 kHz. (*Supra* Section IX.A.1(c); Ex. 1005, ¶24.) Indeed, the coil arrangement of figure 5 "can receive power . . . from an inductive charger at low frequency (e.g., 100 kHz-200 kHz) . . . ." consistent with the Qi standard. (Ex. 1005, ¶¶24, 26.)

2. Claim 5

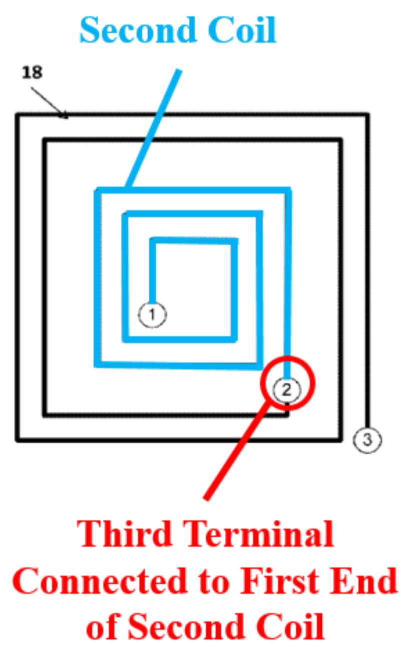
a) **"The antenna of claim 1, wherein the first terminal is electrically connected to the first end of the first coil, the first end of the first coil disposed at an end of the first wire of the first coil located at an outermost first coil perimeter, the third terminal is electrically connected to the first end of the second coil positioned at a second coil outer perimeter, and the second terminal is electrically connected to the second end of the second coil located along an interior perimeter of the second coil pattern."**

Riehl discloses claim 5. (Ex. 1002, ¶¶98-101.) As shown in annotated figure 5 below, Riehl discloses that connection point 3 ("first terminal") is at the first end of inductor L2 ("electrically connected to the first end of the first coil"). Riehl further discloses that the first end of coil L2 is positioned on L2's outermost end ("the first end of the first coil disposed at an end of the first wire of the first coil located at an outermost first coil perimeter"). (Ex. 1005, FIG. 5, ¶28.)



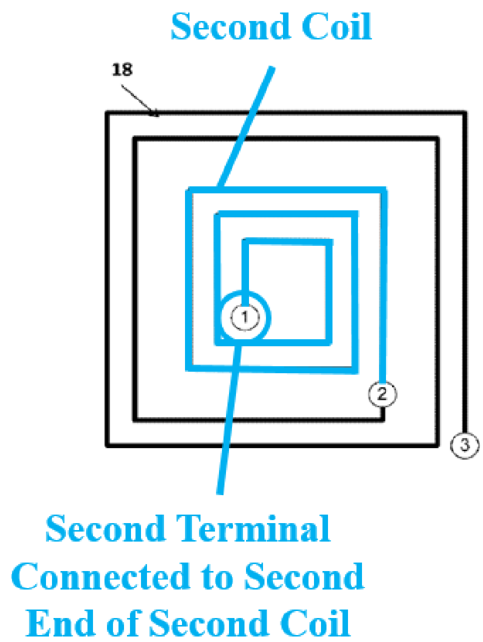
(Ex. 1005, FIG. 5 (excerpt, annotated); Ex. 1002, ¶99.)

As shown in annotated figure 5 below, Riehl discloses that connection point 2 ("third terminal") is at the first end of inductor L3 ("electrically connected to the first end of the second coil"), which is L3's outermost end ("the first end of the second coil positioned at a second coil outer perimeter"). (Ex. 1005, FIG. 5, ¶28; Ex. 1002, ¶100.)



(Ex. 1005, FIG. 5 (excerpt, annotated); Ex. 1002, ¶100.)

As shown in annotated figure 5 below, Riehl discloses that connection point 1 ("second terminal") is at L3's innermost end ("electrically connected to the second end of the second coil located along an interior perimeter of the second coil pattern"). (Ex. 1005, FIG. 5, ¶28; Ex. 1002, ¶101.)

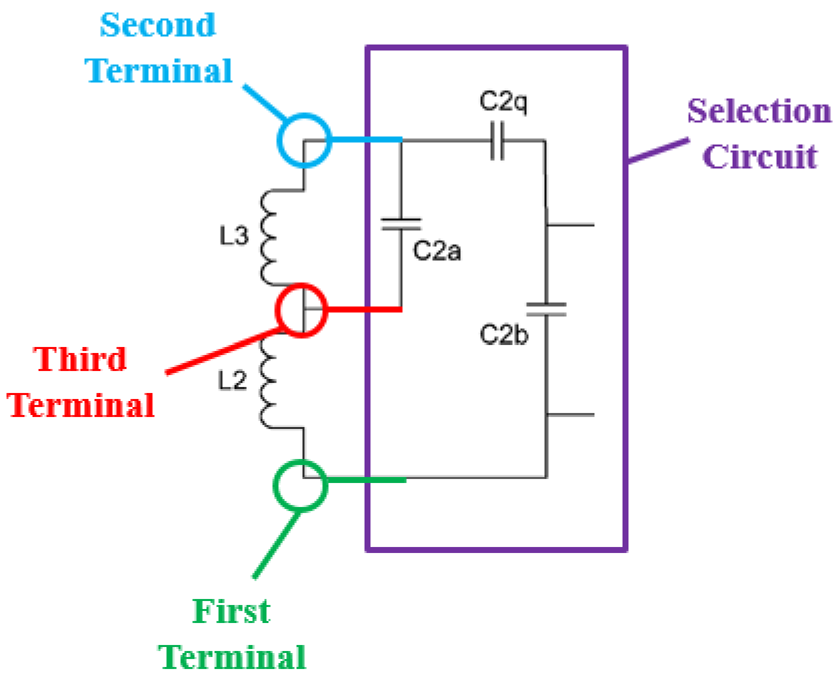


(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶101.)

3. Claim 6

a) **"The antenna of claim 1, wherein a selection circuit is electrically connected to at least one of the first, second, and third terminals."**

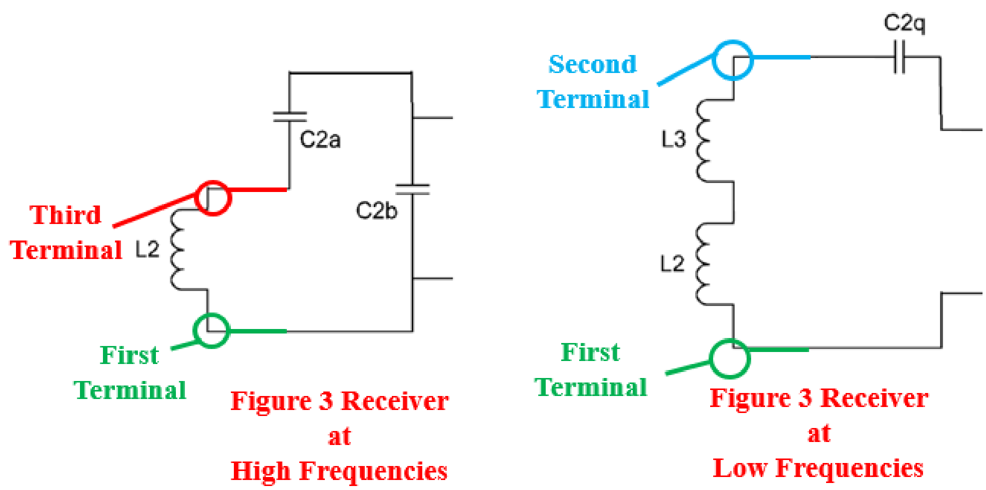
Riehl discloses this feature. (Ex. 1002, ¶¶102-04.) Riehl discloses that capacitors C2*a*, C2*b*, and C2*q* (collectively, "selection circuit") are electrically connected to the claimed first, second, and third terminals. (Ex. 1005, FIG. 3, ¶¶22, 24-25; *see supra* section IX.A.1(e).)



(Ex. 1005, FIG. 3 (excerpt, annotated); Ex. 1002, ¶102.)

Capacitors C2*a*, C2*b*, and C2*q* select different interconnections between the terminals corresponding to the ends of the inductors based on the frequency of operation. For example, at high frequencies, C2*a* provides a low-impedance connection between the second and third terminals shown in the annotated excerpt of figure 3 below, diverting current around inductor L3. (Ex. 1005, ¶¶22, 25.) Therefore, at high frequencies, the connections to the rectifier of the dual mode power receiver correspond to the ends of inductor L2 such that the first and third terminals are selected. At low frequencies, however, C2*a* and C2*b* act as open circuits, forming a series circuit that includes C2*q*, L3, and L2. (*Id.*, ¶¶22, 24.)

Therefore, at low frequencies, the claimed first and second terminals are selected for connection to the rectifier.



(Ex. 1005, FIG. 3 (excerpt, annotated) (left: high-frequency mode; right: low-frequency mode); Ex. 1002, ¶103.)

4. Claim 7

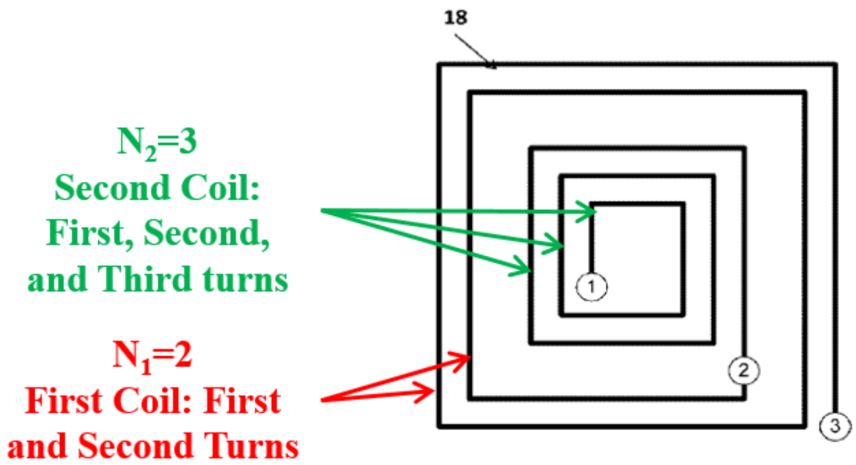
a) **"The antenna of claim 6, wherein the selection circuit comprises at least one component selected from the group consisting of a capacitor, a resistor, and an inductor."**

Riehl discloses this feature. (Ex. 1002, ¶105.) As discussed above for claim 6, the selection circuit includes capacitors C2*a*, C2*b*, and C2*q*. (*See supra* Section IX.A.3; Ex. 1005, FIG. 3, ¶¶22-25.)

5. Claim 8

a) **"The antenna of claim 1, wherein N_2 is greater than N_1."**

Riehl discloses this feature. (Ex. 1002, ¶¶106-107.) As shown in figure 5 of Riehl, the inner coil L3 has three turns and outer coil L2 has two turns.



(Ex. 1005, FIG. 5 (excerpt, annotated); Ex. 1002, ¶106.)

To the extent that Patent Owner argues or the Board finds that Riehl does not disclose that the number of turns in the second coil is greater than the number of turns in the outer coil, it would have been obvious to make the second coil have more turns. (Ex. 1002, ¶107.) As disclosed by Riehl, coil L3 ("second coil"), the inner coil shown in figure 5 of Riehl, has a higher inductance value than coil L2. (Ex. 1005, ¶23.) A POSITA would have known that increasing the number of turns of a coil can increase the inductance of the coil, and would have found it obvious to implement coil L3 to have more turns than coil L2 in order to provide a higher inductance value for coil L3. (Ex. 1002, ¶107.)

6. Claim 12

a) **"The antenna of claim 1, the antenna having a quality factor greater than 10 at an operating frequency of at least 10 kHz."**

Riehl discloses this feature. (Ex. 1002, ¶¶108-111.) Riehl discloses the circuit topology for a resonant power receiver circuit in figure 2. (Ex. 1005, FIG. 2, ¶18.)

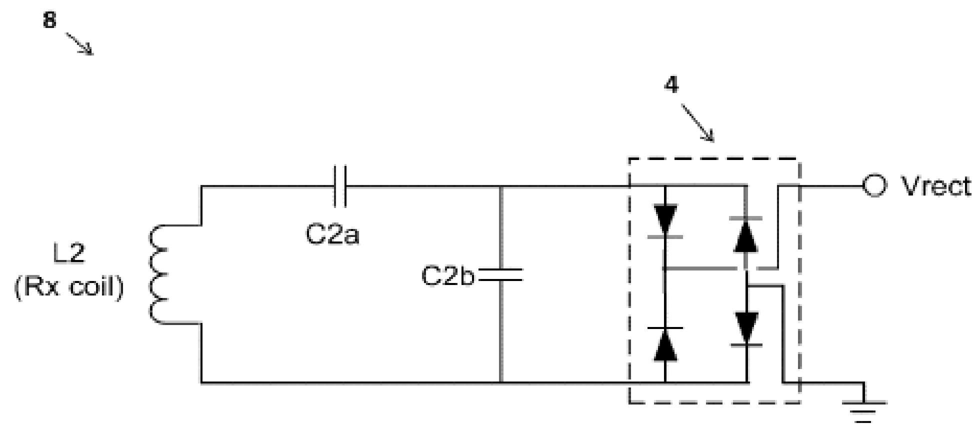


FIG. 2

(Ex. 1005, FIG. 2.)

Riehl discloses that in the circuit of figure 2, the "inductor L2 and the capacitors C2a and C2b form an electromagnetic resonator" where "the quality factor of this electromagnetic resonator can be relatively high, perhaps greater than 100." (Ex. 1005, ¶18.) Further, Riehl explains operating the circuit at "a relatively high frequency," will maximize the quality factor and in some embodiments an operating frequency of 6.78 MHz is used. (*Id.*, ¶19.) Riehl does not explicitly disclose what frequency range comprises "relatively high." (*Id.*) However, because

Riehl describes 110-205 kHz as a "low-frequency operating range," a POSITA would have understood that "a relatively high frequency" must be greater than 205 kHz. (Ex. 1002, ¶109; Ex. 1005, ¶¶18-20.)

As discussed above in section IX.A.1(b), Riehl further discloses that at high frequencies (e.g. 6.78 MHz), the dual mode power receiver illustrated in figure 3 operates in a similar manner to the resonant power receiver shown in figure 2 where L2, C2*a* and C2*b* are the active elements. (Ex. 1005, ¶25; *see supra* section IX.A.1(b).)

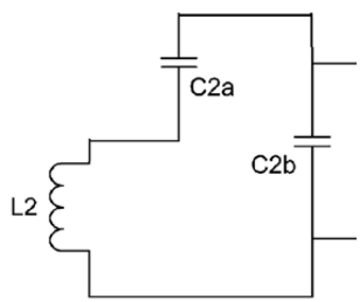


Figure 3 Receiver at High Frequencies

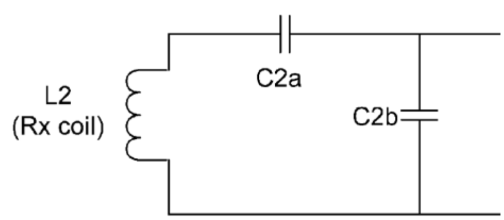


Figure 2 Receiver

(Ex. 1005, FIGs. 2, 3 (excerpts, annotated); Ex. 1002, ¶110.)

Therefore, Riehl's teachings with respect to the operation of the circuit of figure 2 apply to the circuit of figure 3 when operated at high frequencies. (Ex. 1002, ¶111.) As such, Riehl discloses that operating the dual mode power receiver of figure 3 at "a relatively high frequency" will maximize the quality factor such that it is "perhaps greater than 100". (Ex. 1005, ¶19.) As discussed immediately above, a POSITA would have understood that "a relatively high frequency" must be greater than 205 kHz, and Riehl discloses an example operating frequency of 6.78 MHz for the receiver of figure 3. (Ex. 1002, ¶111; Ex. 1005, ¶¶18-20.) Therefore, a POSITA would have understood that Riehl discloses or suggests that the dual mode power receiver of figure 3 has a "quality factor greater than 10 at an operating frequency of at least 10 kHz." (Ex. 1002, ¶111.)

7. Claim 13

a) **"The antenna of claim 1, wherein an electrical signal selected from the group consisting of a data signal, an electrical voltage, an electrical current, and combinations thereof is receivable by at least the first and second coils."**

Riehl discloses or suggests this feature. (Ex. 1002, ¶¶112-113.) For example, figure 3 of Riehl illustrates a dual-mode wireless power receiver that "can receive power from either an inductive charger operating in the range of hundreds of kHz or a resonant charger operating at a frequency in the MHz range." (Ex. 1005, ¶¶16, 22.) Wireless power transfer systems, like the one Riehl discloses, utilize mutual inductance between magnetic coils to wirelessly transfer power by magnetic induction. (*Id.*, ¶3.) When receiving power in the low-frequency range, the invention disclosed in Riehl operates in low-frequency mode in which both of the inductors L2 and L3 contribute to the overall inductance of the receiver, and therefore, contribute to receiving the transmitted power from an inductive transmitter. (*Id.*, ¶24; *see supra* section IX.A.1(c).)

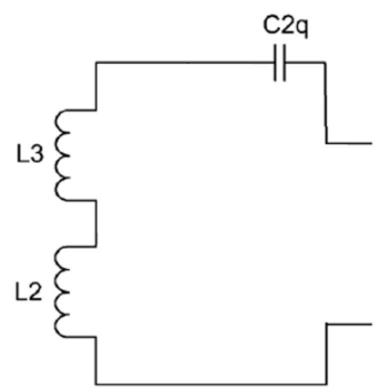


Figure 3 Receiver at Low Frequencies

(Ex. 1002, ¶112; Ex. 1005, FIG. 3 (excerpt, annotated).)

Power (W) equals voltage (V) multiplied by current (I), therefore power is a "combination" of current and voltage (W=I*R). (Ex. 1002, ¶113.) Therefore, Riehl discloses or suggests that "an electrical signal selected from the group consisting of a data signal, **an electrical voltage, an electrical current, and combinations thereof** is receivable by at least the first and second coils."

8. Claim 14

a) **"The antenna of claim 1, wherein an electrical signal selected from the group consisting of a data signal, an electrical voltage, an electrical current, and combinations thereof is transmittable by at least the first and second coils."**

Riehl discloses this feature. (Ex. 1002, ¶¶114-115.) For example, "the wireless power receiver" of figure 3 receives power and the inductor coils L2 and L3 output an AC voltage, which is rectified by the bridge rectifier 4 into a DC voltage Vrect. (*Id.*; Ex. 1005, ¶26.)

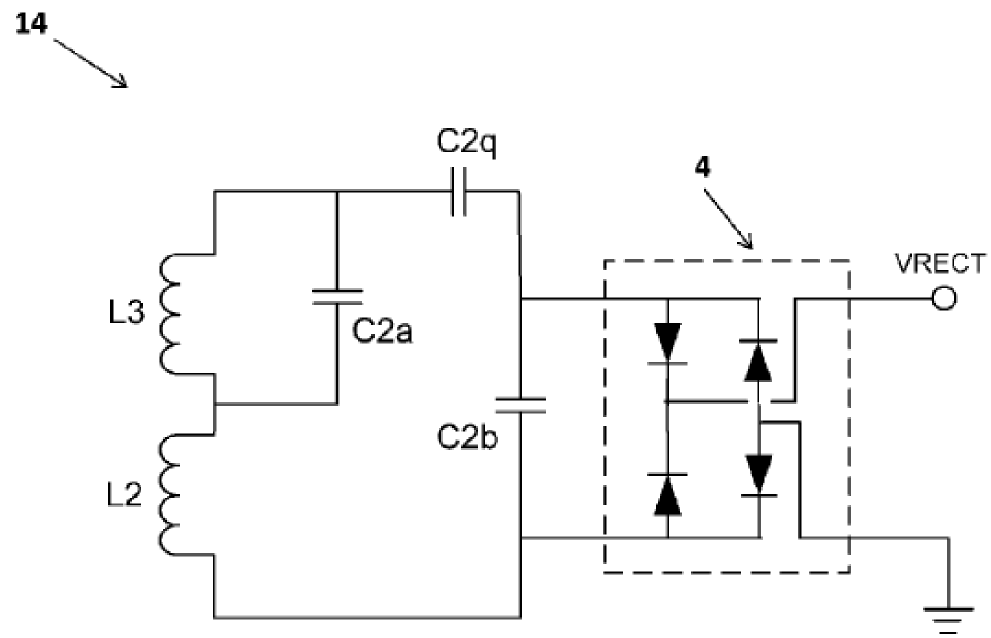


FIG. 3

(*Id.*, FIG. 3.)

Riehl explains that the function of rectifier 4 is to "generate a dc voltage Vrect" from the "AC power induced" in the coils. (*Id.*, ¶17.) A POSITA would have understood that this rectification refers to conversion of an AC voltage, which is induced in the coils and transmitted by the coils to the rectifier, to a DC voltage. (Ex. 1002, ¶115.) Accordingly, Riehl discloses "wherein an electrical signal selected from the group consisting of a data signal, an electrical voltage, an electrical current, and combinations thereof is transmittable by at least the first and second coils." (*Id.*)

9. Claim 16

a) **"The antenna of claim 1, wherein the antenna is capable of receiving or transmitting within a frequency band selected from the group consisting of about 10 kHz to about 250 kHz, about 250 kHz to about 500 kHz, 6.78 MHz, 13.56 MHz, and combinations thereof."**

Riehl discloses this feature. (Ex. 1002, ¶116.) For example, the dual-mode power receiver shown in figure 3 includes two inductor coils L2 and L3 connected in series that receive power in the range of 110-205 kHz and at 6.78 MHz. (Ex. 1005, ¶¶20, 22-26, FIG. 3.)

10. Claim 17

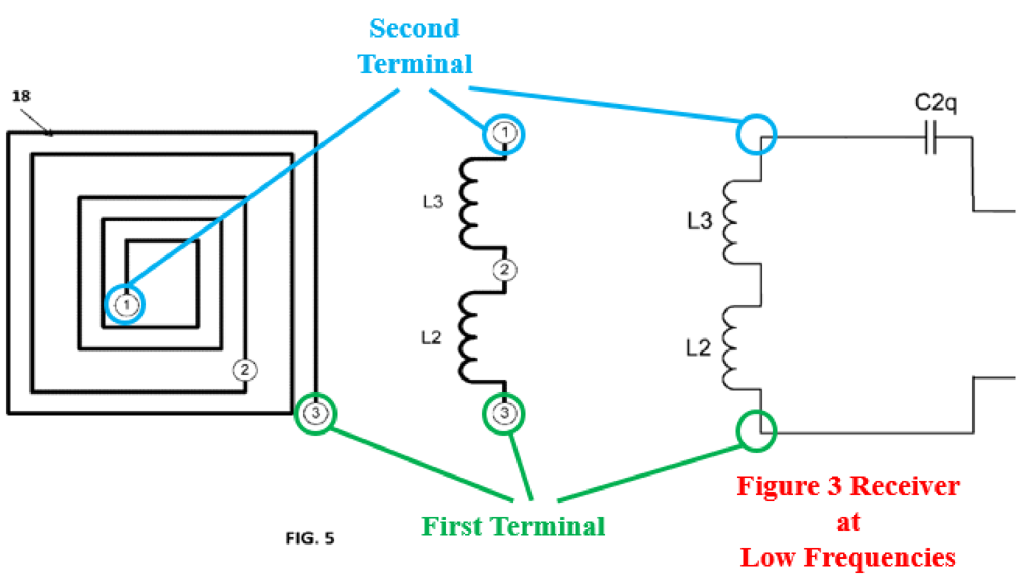
a) **"The antenna of claim 1, wherein the antenna is capable of receiving or transmitting at operating frequencies of at least 10 kHz."**

Riehl discloses this feature. (Ex. 1002, ¶117.) The dual-mode power receiver of figure 3 can have a "high operation frequency of 6.78 MHz," and therefore discloses an antenna that is capable of receiving at 6.78 MHz ("capable of receiving or transmitting frequencies of at least 10 kHz"). (Ex. 1005, ¶¶16, 20, 26, 30.)

11. Claim 18

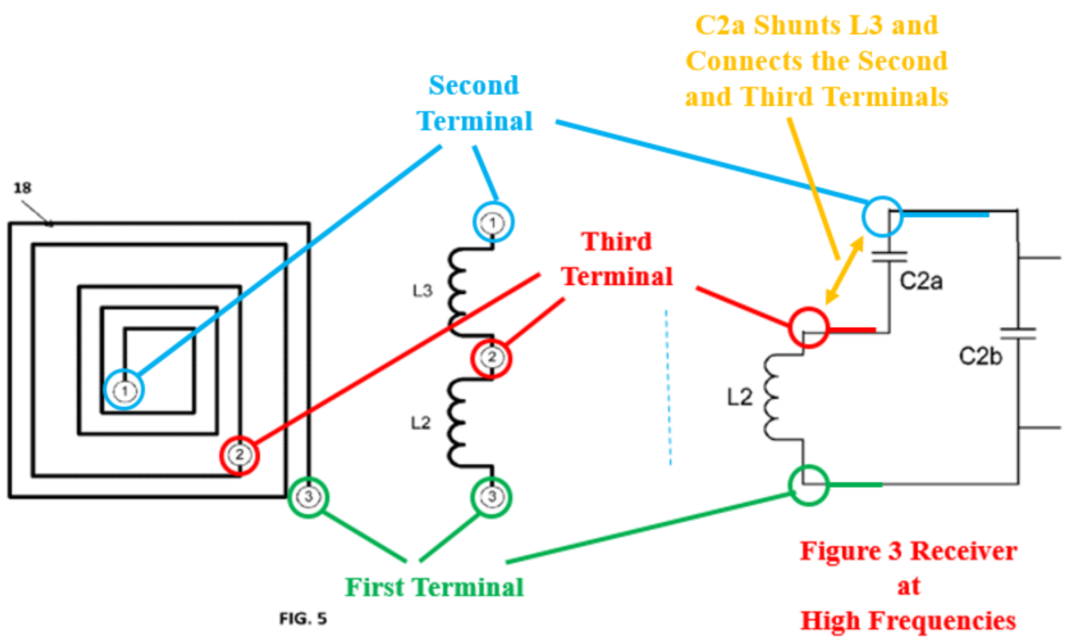
a) **"The antenna of claim 1, wherein selecting a connection between two of the first, second, and third terminals modifies an operating frequency of the antenna."**

Riehl discloses this feature. (Ex. 1002, ¶¶118-125.) For example, Riehl discloses a receiver circuit that has at least two operational frequencies: a high frequency (e.g., 6.78 MHz), and a low frequency (e.g., 100 or 110-205 kHz). (Ex. 1005, ¶¶ 16, 20, 26, 30.) As shown in the demonstrative below, when capacitors C2*a* and C2*b* act as open circuits, an electrical connection exists between connection point 1 ("the second terminal") and connection point 3 ("the first terminal") through inductors L2 and L3. (Ex. 1005, ¶¶22, 24.) As a result, the circuit operates at a low frequency. (*Id.*)



(*Id.*, FIGs. 5 (left) (annotated), 3 (right) (excerpt, annotated); Ex. 1002, ¶120.)

But when this electrical connection between the "first" and "second" terminals is modified because C2*a* shunts L3 so that the connection between these two terminals is through C2*a* and L2, as shown below, the effective inductance is reduced and the receiver circuit is able to resonate at a high frequency of 6.78 MHz. (Ex. 1005, ¶¶22, 25.)



(*Id.*, FIGs. 5 (left) (annotated), 3 (right) (excerpt, annotated); Ex. 1002, ¶121.)

Therefore, as discussed above, selecting a connection between the "first" and "second" terminals in Riehl modifies an operating frequency of Riehl's antenna. (Ex. 1002, ¶122.) Riehl's above described operation is consistent with the '729 patent. (*See* Ex. 1001, 14:30-39.)

Riehl discloses the above feature in an additional way. When capacitors C2*a* and C2*b* act as open circuits, an electrical connection exists between connection point 1 ("the second terminal") and connection point 2 ("the third terminal") through inductor L3. (Ex. 1005, ¶¶22, 24.) Therefore, the two coils operate in series and the antenna resonates at 100 kHz. (Ex. 1002, ¶123.) But when this electrical connection between the "second" and "third" terminals is modified such that current does not flow through inductor L3 and instead flows through C2*a*, the antenna resonates at 6.78 MHz. (*Id.*, ¶124; Ex. 1005, ¶¶22, 25.) That is, selecting a connection between the "second" and "third" terminals via C2*a* instead of via L3 allows modifying the operating frequency from low frequency to high frequency. (Ex. 1002, ¶125.)

12. Claim 21

a) **"The antenna of claim 1, wherein at least one of the first and second coils is configured to receive a wirelessly transmitted electrical power."**

Riehl discloses this feature. (Ex. 1002, ¶126.) As discussed above with respect to claim 13, Riehl discloses a dual-mode wireless power receiver that "can receive power from either an inductive charger operating in the range of hundreds of kHz or a resonant charger operating at a frequency in the MHz range." (Ex. 1005, ¶¶16, 26; *see supra* section IX.A.7.) When receiving power in the low-frequency range, power is received by both inductor coil L2 ("the first coil") and inductor coil L3 ("the second coil") because the inductance of both coils is utilized to create a series resonance. (*Id.*, ¶24.)

13. Claim 23

a) **"The antenna of claim 1, wherein the first resonant frequency of the first coil is on the order of a MHz and the second resonant frequency of the second coil is on the order of a kHz."**

Riehl discloses this feature. (Ex. 1002, ¶127.) As discussed above, the resonant frequency of L2 ("the first coil") is 6.78 MHz ("the first resonant frequency of the first coil is on the order of a MHz") and the resonant frequency of L3 ("the second coil") is 100 kHz ("the second resonant frequency of the second coil is on the order of a kHz"). (*See supra* sections IX.A.1(b)-(c).)

B. Ground 2: Riehl and Riehl IEEE Render Claims 3, 4, 9, 14, and 26 Obvious

1. Claim 3

a) **"The antenna of claim 1, wherein the first conductive wire comprises two or more filars electrically connected in parallel."**

Riehl in combination with Riehl IEEE discloses or suggests this feature. (Ex. 1002, ¶¶128-138.) As discussed above, Riehl discloses a first conductive wire forming a first coil. (*See supra* Section IX.A.1(b).)

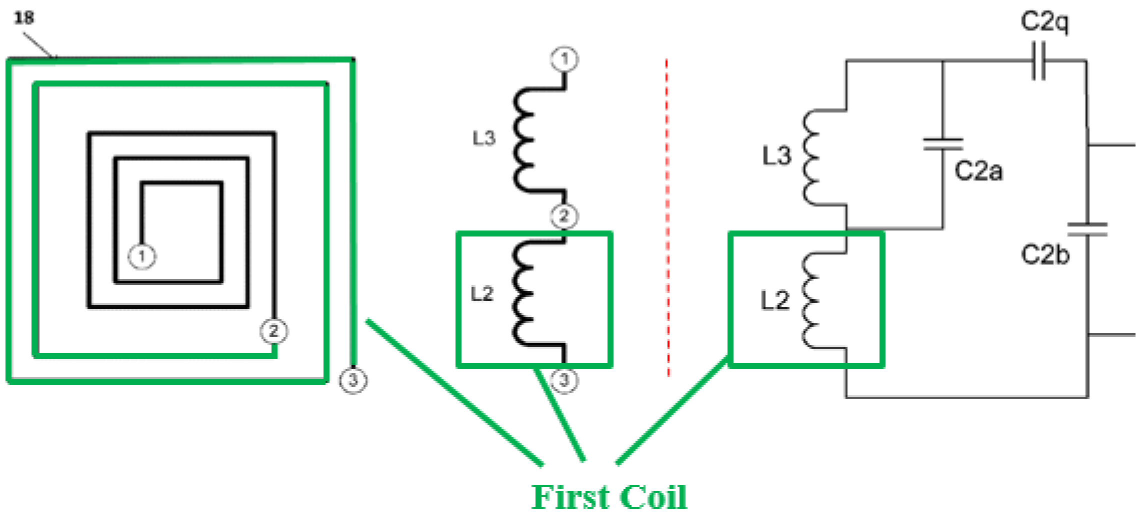


FIG. 5 **FIG. 3 (excerpt)**

(*Id.*, FIGs. 5 (left) (annotated), 3 (right) (excerpt, annotated); Ex. 1002, ¶128.)

Riehl, however, does not disclose specifics for inductor L2. However, Riehl IEEE discloses using a multi-conducting-layer coil ("the first conductive wire comprises two or more filars electrically connected in parallel") as the outer coil in a concentric arrangement of two coils, and a POSITA would have found it obvious in view of Riehl IEEE to utilize a multi-conducting-layer coil as the coil L2 shown in figures 3 and 5 of Riehl. (*Id.*, ¶129.)

Riehl IEEE, like Riehl, describes a wireless power transfer system including a dual-mode wireless power receiver that includes two coils arranged concentrically and designed to support power transfer at different frequencies. (Ex. 1006, 780, 785.) Indeed, the inventor listed on the face of Riehl is also the first-named author of Riehl IEEE, and a comparison of Riehl and Riehl IEEE makes it apparent that they both relate to the same or very similar subject matter. For example, Riehl IEEE, like Riehl, describes a multi-mode power receiver that includes "[a] coil arrangement and matching network . . . that is resonant in both 6.78-MHz and 100-kHz bands" thereby allowing the receiver to be used at both high and low frequencies. (Ex. 1006, Abstract.) Therefore, a POSITA implementing the dual-mode power receiver of Riehl would have had reason to look to Riehl IEEE. (Ex. 1002 ¶130.)

As shown in figure 11 below, Riehl IEEE discloses a two-coil arrangement in a power receiver unit (PRU) similar to that shown in figure 5 of Riehl. (Ex. 1002, ¶¶131-133.)

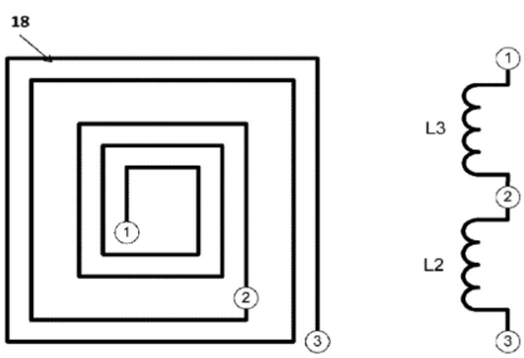


FIG. 5

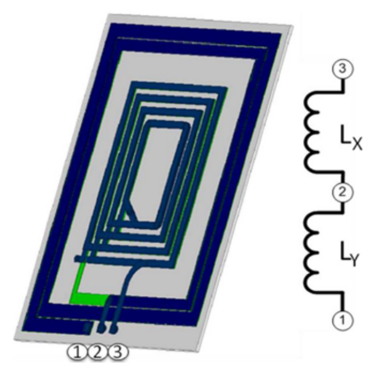


Fig. 11. Multi-mode PRU coil design.

(Ex. 1005, FIG. 5; Ex. 1006, FIG. 11.)

Riehl IEEE further discloses the outer coil in the dual-coil assembly is made up of multiple conducting layers that are connected in parallel. (Ex. 1006, 786.) As shown in annotated figure 11 below, the outer coil *Ly* has one conducting layer colored blue that overlies and mostly obscures another conducting layer colored green, where the blue and green conducting traces are connected in parallel. (*Id.*, 786, FIG. 11.)

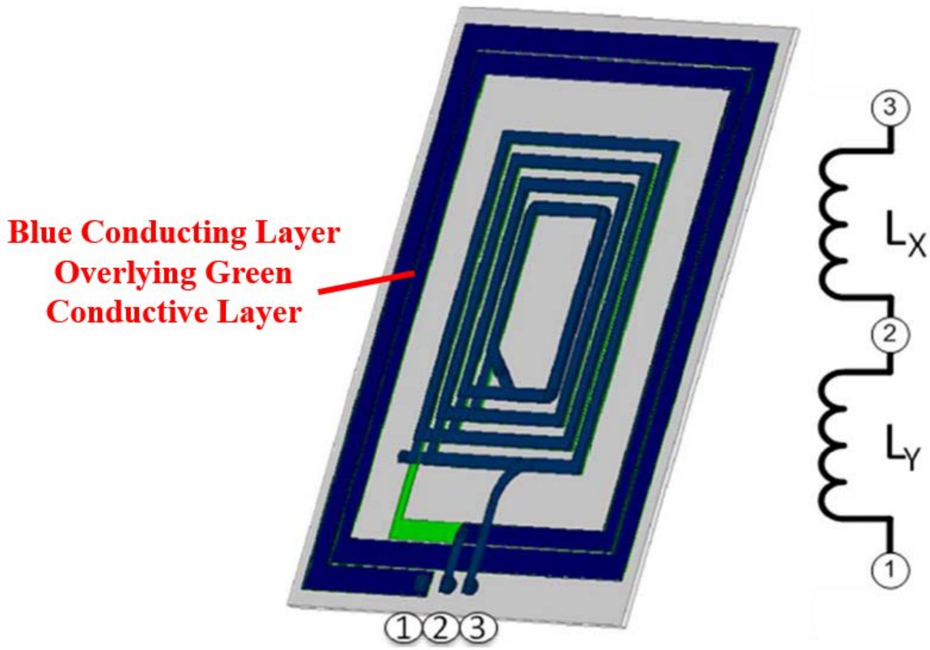


Fig. 11. Multi-mode PRU coil design.

(Ex. 1006, FIG. 11 (annotated); Ex. 1002, ¶134.)

A POSITA would have found it obvious to combine the teachings of Riehl and Riehl IEEE such that the outer coil L2 shown in figures 3 and 5 of Riehl is implemented as a multi-conducting-layer coil where the layers are connected in parallel because, *inter alia*, such a coil would have a high quality factor (Q), which is desirable in order to provide efficient power transfer in the wireless power transfer system. (Ex. 1002, ¶¶135-137; Ex. 1006, 786, 781.) *Unwired Planet, LLC v. Google Inc.*, 841 F.3d 995, 1003 (Fed. Cir. 2016). Forming the outer inductor coil disclosed by the Riehl-Riehl IEEE combination with two or more parallel traces ("two or more filars electrically connected in parallel") would have merely been the application of a known technique (using parallel wiring structures in inductors for wireless power transfer) to a similar device (the wireless power receiver in figure 3 of Riehl) ready for improvement to achieve the expected and desired result of an increased Q factor. (Ex. 1002, ¶138.) *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416-17 (2007) ("*KSR*").

2. Claim 4

a) **"The antenna of claim 1, wherein the second conductive wire comprises two or more filars electrically connected in parallel."**

Riehl in combination Riehl IEEE discloses or suggests this feature. (Ex. 1002, ¶¶139-140.) As discussed above, Riehl discloses a second conductive wire, corresponding to inductor L3, forming a second coil. (*See supra* section IX.A.1(c).)

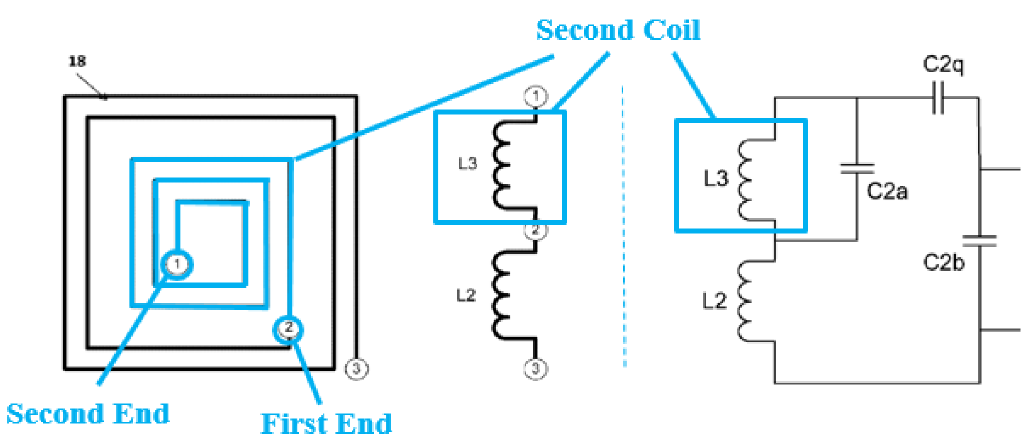


FIG. 5

FIG. 3 (excerpt)

(Ex. 1005, FIGs. 5 (annotated), 3 (excerpt, annotated); Ex. 1002, ¶139.)

Riehl does not disclose that the second coil "comprises two or more filars electrically connected in parallel." But, as discussed above with respect to claim 3, Riehl IEEE discloses the same or very similar coil arrangement as figure 3 of Riehl, and discloses that a coil in such an arrangement can be made using multiple conductive layers connected in parallel. (*Supra* Section IX.B.1.) While Riehl IEEE discloses such a configuration in the context of an outer coil (e.g., inductor L2), a POSITA would have understood that the same teachings would also be applicable to the inner coil (e.g., inductor L3). (Ex. 1002, ¶140.)

Therefore, a POSITA would have combined the teachings of Riehl and Riehl IEEE so that multiple conducting layers connected in parallel are used for the inductor L3. (Ex. 1002, ¶140.) A POSITA would have recognized that doing so would decrease the resistance of the coil, thereby increasing the quality factor, while maintaining the same amount of inductance. (*Id.*; *see* Ex. 1015, ¶[0030].) *See KSR*, 550 U.S. at 416-21.

3. Claim 9

a) **"The antenna of claim 1, wherein each terminal has a terminal lead portion that extends between a coil connection point and a terminal end the coil connection point electrically connected to either of the first and second conductive wires of the first and second coils respectively and wherein the terminal lead portion extends over at least a portion of either of the first and second conductive wires of the first and second coils respectively."**

Riehl in combination with Riehl IEEE discloses or suggests this feature. (Ex. 1002, ¶¶141-153.) As shown in annotated figure 3 of Riehl below, terminals corresponding to each of the connection points allow for connections between the coils and, for example, the capacitors C2*a*, C2*b*, and C2*q*. Therefore, each of the terminals shown in annotated figure 3 below includes a terminal lead portion that extends between a coil connection point (marked by circles in figure below) and a terminal end.

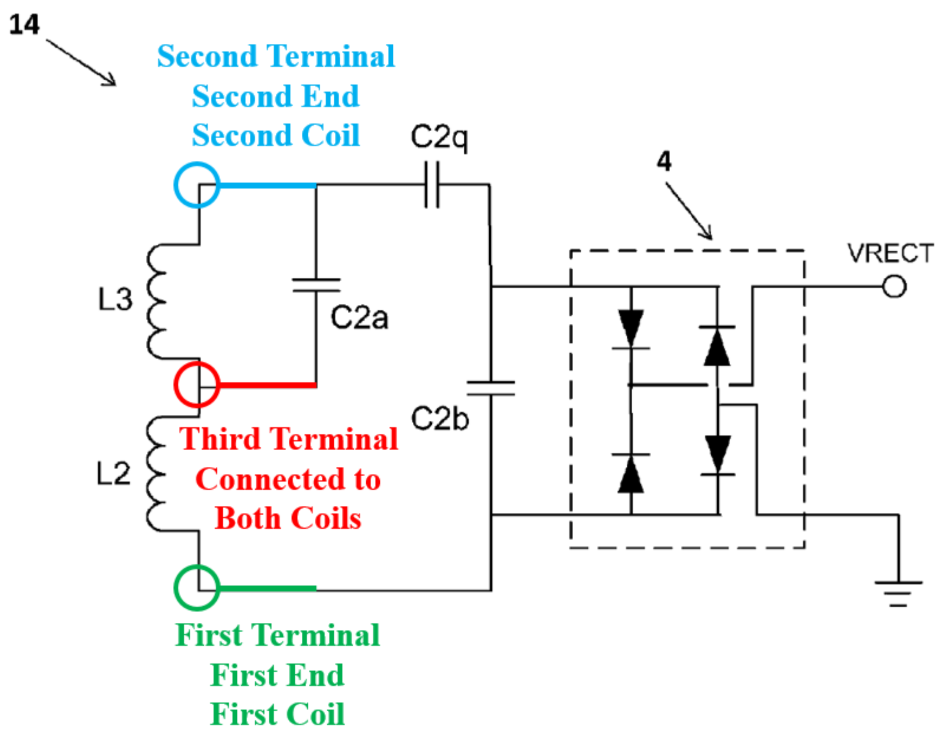


FIG. 3

(Ex. 1005, FIG. 3 (annotated); Ex. 1002, ¶143.) Furthermore, figure 11 of Riehl IEEE shows that each terminal includes a terminal lead portion between the terminal end and coil connection point.

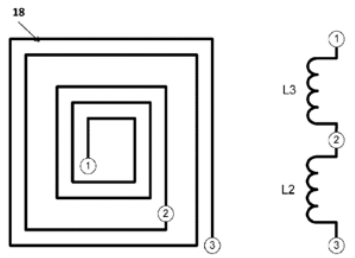


FIG. 5

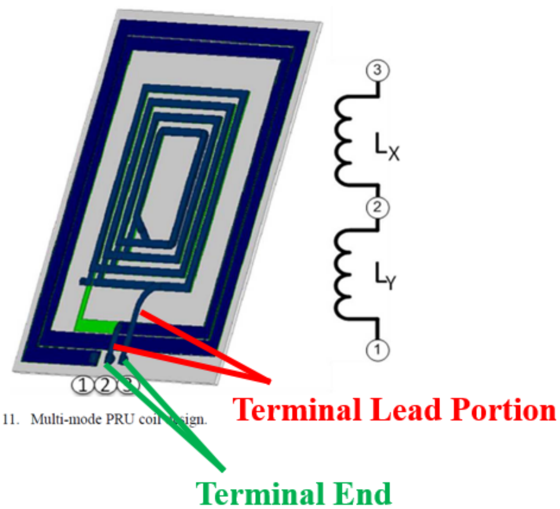


Fig. 11. Multi-mode PRU coil design.

(Ex. 1005, FIG. 5; Ex. 1006, FIG. 11 (annotated); Ex. 1002, ¶145.)

As discussed above (*supra* Section IX.B.1), a POSITA would have found it obvious to combine the teachings of Riehl and Riehl IEEE. Therefore,

Furthermore, as discussed above in Section IX.A.1(e) each coil connection point is electrically connected to one of L2 and L3. While Riehl IEEE shows that two of the three terminals extend over at least a portion of one of the coils, a POSITA would have had reason to configure the coils in figure 5 of Riehl such that the terminal lead portions of ***all three*** terminals extend over one or both coils. (Ex. 1002, ¶¶148-153.)

4. Claim 14

a) **"The antenna of claim 1, wherein an electrical signal selected from the group consisting of a data signal, an electrical voltage, an electrical current, and combinations thereof is transmittable by at least the first and second coils."**

Riehl in combination with Riehl IEEE discloses or suggests this feature. (Ex. 1002, ¶¶154-159.) As demonstrated above in section IX.A.8, this feature is disclosed or suggested by Riehl. However, to the extent PO argues or the Board finds that the Riehl does not disclose or suggest the feature recited in claim 14, Riehl IEEE discloses transmitting data using the coils of the power receiver. (Ex. 1002, ¶154.)

Riehl IEEE discloses that in addition to the in-band signaling, which involves transmitting information from the receiver to the transmitter, provided as a part of the requirements for Qi and Power Matters Alliance (PMA), additional "in-band signaling has been added as an enhancement to the Rezence operating mode of our wireless charging systems." (Ex. 1006, 783.) Therefore, Riehl IEEE demonstrates that "an electrical signal selected from the group consisting of a data signal, an electrical voltage, an electrical current, and combinations thereof is transmittable by at least the first and second coils" as at least one of the coils is used to send in-band data ("a data signal") to the power transmitter. (Ex. 1007, ¶151.) Annotated figure 6 of Riehl IEEE below shows the in-band communications modulator used to transmit data back to the power transmitter.

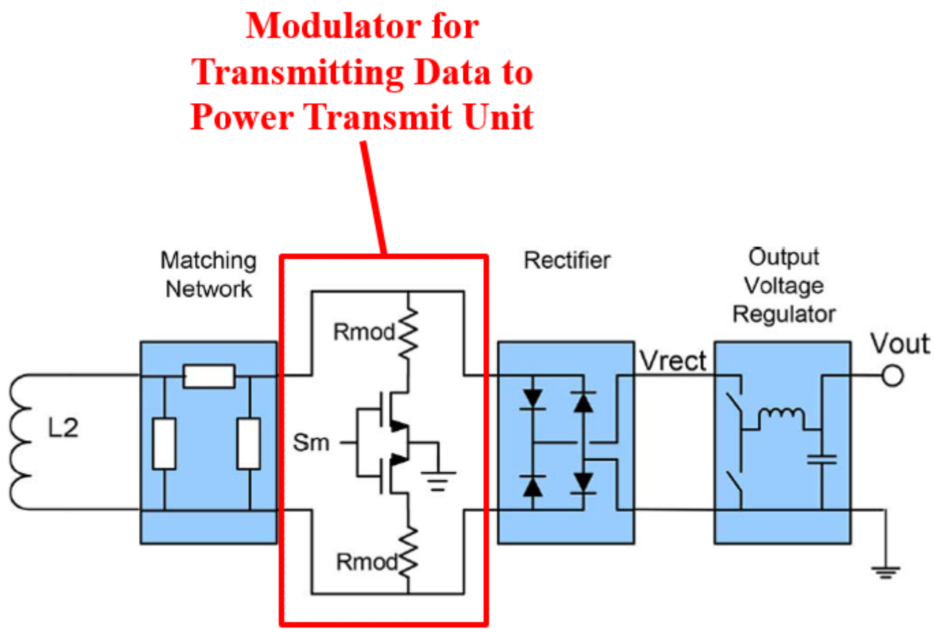


Fig. 6. In-band communications modulator (in dashed box).

(Ex. 1006, FIG. 6 (annotated); Ex. 1002, ¶155.)

As discussed above with respect to claim 3, Riehl IEEE is concerned with similar or the same subject matter disclosed in Riehl, and therefore a POSITA would have had reason to look to Riehl IEEE. (*Supra* section IX.B.1.) Given the disclosure of the transmission of data using in-band signaling in Riehl IEEE, a POSITA would have been motivated to combine the teachings of Riehl and Riehl IEEE such that at least one of the coils L1 and L2 shown in figures 3 and 5 of Riehl would be capable of transmitting data as is disclosed in Riehl IEEE. (Ex. 1002, ¶156.) For example, the transmitting data could be used to identify power receiving units that want to receive power or provided other information used by the power transmitter. (Ex. 1002, ¶157.) Indeed, using the coils in a power receiver to transmit data back to the transmitter was commonplace in power receivers at the time of the alleged invention as such in-band transmission capability was required by both the Qi and PMA standards. (Ex. 1006, 783.) Accordingly, a POSITA would have found it obvious to combine the teachings of Riehl and Riehl IEEE because Riehl IEEE explains how such data transmission can be accomplished using circuitry designed to operate in conjunction with the power receiver circuitry similar to that disclosed in Riehl. (Ex. 1002, ¶¶157-159.) *Unwired Planet*, 841 F.3d at 1003; *KSR*, 550 U.S. at 417.

5. Claim 26

a) **"The antenna of claim 1, wherein at least one of the first and second coils operates at a current exceeding 500 mA."**

Riehl in combination with Riehl IEEE discloses or suggests this feature. (Ex. 1002, ¶¶16-164.) Riehl does not explicitly disclose inductor coils L2 or L3 operating at a current exceeding 500 mA. Riehl IEEE, however, discloses such a feature.

Riehl IEEE discloses that "[t]he multi-mode PRU converts 5 W of ac power to a regulated 5-V output with an efficiency of up to 83% in Rezence mode and up to 86% in Qi mode." (Ex. 1006, 780 (Abstract).) A POSITA would have understood that 5 Watts of power at 5 Volts corresponds to a current flow of 1 Ampere (1 A, or 1,000 mA) as current equals power divided by voltage. (Ex. 1002, ¶161.) Based on the circuit topology of Riehl IEEE's power receiver, all of the 1 A of current would flow through at least one of the coils included in the power receiver. (*Id.*; Ex. 1006, FIGs. 4, 14.)

The power receiver in Riehl IEEE is very similar to that of Riehl, and therefore a POSITA would have understood that details disclosed with respect to Riehl IEEE's power receiver would be applicable to Riehl's power receiver. (*See supra* section IX.B.1; Ex. 1002, ¶162.) Given the disclosure of the example voltages and currents used during power transfer in Riehl IEEE and the absence of such specifics in Riehl, it would have been obvious for a POSITA to combine the teachings of Riehl and Riehl IEEE so that the power receiver in Riehl operates such that 1 A of current flows through one or both of the coils as taught by Riehl IEEE. (Ex. 1002, ¶163-164.) *KSR*, 550 U.S. at 416-21. Indeed, the claimed range cannot be patentable because the operating current of a coil is a result-effective variable given that it affects the amount of power produced by the coil (Ex. 1002, ¶163); and "discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art" especially when there is no evidence that the claimed range produces a new or unexpected result. *In re Aller*, 220 F.2d 454, 456 (C.C.P.A. 1955); *see also infra* Section IX.E for additional relevant case law.

C. Ground 3: Riehl and Kanno Render Claim 11 Obvious

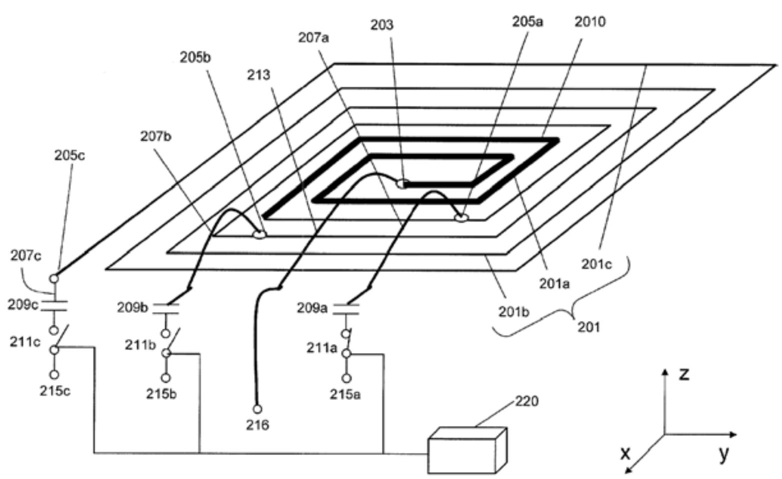
1. Claim 11

a) **"The antenna of claim 1, wherein at least the first conductive wire or the second conductive wire has a variable wire width."**

Riehl in combination with Kanno discloses or suggests this feature. (Ex. 1002, ¶¶165-169.) Riehl does not explicitly disclose that either of the conductive wires that form the coils L2 and L3 has a variable wire width. But Kanno discloses such a feature.

Kanno, like Riehl, relates to a wireless power transfer using a resonant magnetic field. (Ex. 1007, ¶13.) Kanno discloses a coil structure made of a variable-width wire. For example, figure 3 of Kanno shows a coil with a wiring portion that has a lower resistance (thicker black line) than the remaining portion of the coil. (Ex. 1007, ¶59; Ex. 1002, ¶167.)

FIG.3



(Ex. 1007, FIG. 3.)

Kanno discloses that one way to make the low-resistance portion of the wire have a lower resistance is to make the wire wider than elsewhere without changing the number of wires. (*Id.*, ¶¶60-61; Ex. 1002, ¶168.) Kanno teaches that the transmission efficiency corresponds to the Q factor for the inductor, where the Q factor can be increased by reducing the resistance per unit length of the inductor's wire. (Ex. 1007, ¶77; Ex. 1002, ¶168.)

Hence, a POSITA would have been motivated and found it obvious to modify the coils disclosed in the power receiver of Riehl based on Kanno such that at least one of the coils is made of a wire that has a variable width. (Ex. 1002, ¶169.) As taught by Kanno, having a variable wire width can increase the Q factor for the inductor while avoiding some undesirable increase in weight, cost, and area of the inductor. Therefore, in view of Kanno, a POSITA would have been motivated to make some portion of the printed circuit board trace corresponding to one or both of the coils L2 and L3 wider in order to make that portion more conductive and boost the Q factor for the inductor. (*Id.*) *KSR*, 550 U.S. at 416-21.

D. Ground 4: Riehl and Sung Render Obvious Claim 15

1. Claim 15

a) **"The antenna of claim 1, wherein the substrate is a flexible substrate that comprises material composed of an electrically insulative material selected from the group consisting of a polyimide . . . ."**

Riehl in combination with Sung discloses or suggests this feature. (Ex. 1002, ¶¶170-174.) Riehl discloses that its receiver can be implemented on a printed circuit board (PCB). (Ex. 1005, ¶28.) Riehl, however, does not explicitly disclose that the PCB is a flexible substrate or is made of one of the materials listed in claim 15. Sung, however, discloses such a feature. (Ex. 1002, ¶170.)

Similar to Riehl, Sung is directed to a wireless power transfer device for use in mobile devices. (Ex. 1002, ¶171; Ex. 1008, Abstract, ¶¶54-61, FIGs. 1, 7A.)

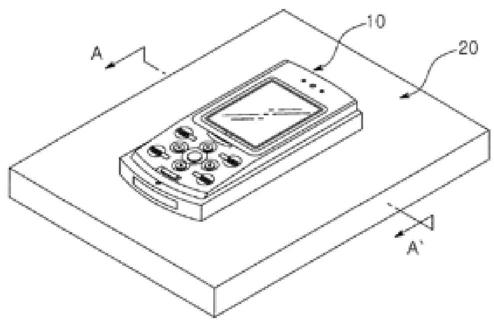


FIG. 1

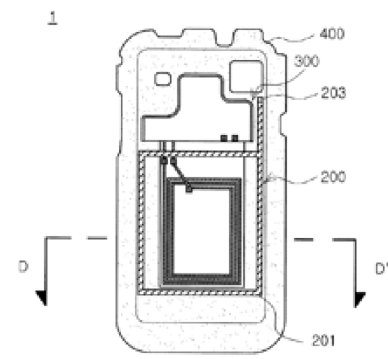


FIG. 7A

(Ex. 1008, FIGs. 1, 7A.)

Sung identifies a need to develop a contactless power transmission device having a reduced thickness.[8] (*Id.*, ¶13.) Sung achieves a reduced thickness, in part, by implementing a wireless power receiver coil formed on a flexible substrate ("substrate is a flexible substrate"). (*Id.*, ¶19.) Specifically, Sung discloses a flexible printed circuit board (FPCB) made of polyimide ("composed of an electrically insulative material selected from the group consisting of a polyimide . . . ."). (*Id.*,

[8] Sung uses the term "power transfer device" in reference to both transmitters and receivers. (Ex. 1008, ¶6.)

¶¶21, 65.) Sung explains a polyimide FPCB offers several benefits, including simple attachment methods and reduced costs. (*Id.*, ¶¶64-68.)

Riehl does not specify the material used to construct the PCB on which coils L2 and L3 are formed. (Ex. 1005, ¶28.) Accordingly, a POSITA implementing a power receiver as disclosed in Riehl would have reason to look to Sung and use a polyimide flexible PCB as disclosed in Sung for its PCB given the many benefits of such flexible PCBs. (*Id.*, ¶¶173-174; Ex. 1008, ¶¶64-68.) *KSR*, 550 U.S. at 416-21.

E. Ground 5: Riehl and Kazuya Render Claim 24 Obvious

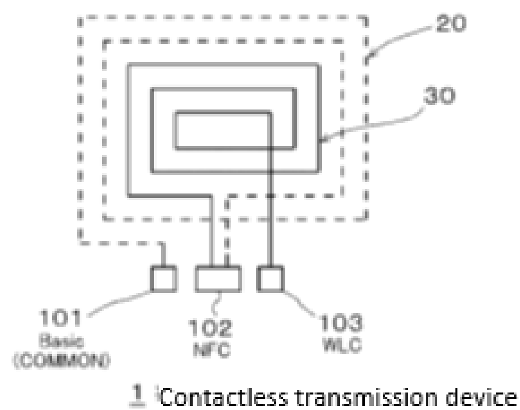
1. Claim 24

a) **"The antenna of claim 1, wherein at least one of the first and second coils has an unshielded inductance of between about 4.2 µH to about 8.2 µH when operating at about 100 kHz to about 500 kHz."**

Riehl and Kazuya disclose or suggest these features. (Ex. 1002, ¶¶175-181.) Riehl does not explicitly disclose the inductance of coils L2 and L3 when the receiver operates at low frequency (e.g. 100kHz). (Ex. 1005, ¶24.) But Kazuya discloses such a feature. (Ex. 1002, ¶175.)

Kazuya, like Riehl, relates to a wireless power transfer. (Ex. 1009, 1 (Means of Solution), ("In a contactless transmission device 1, … [f]irst coil 20 and second coil 30 are together used as a contactless power supply coil.").) Kazuya's device includes a first coil 20 and a second coil 30 sharing a common terminal 102 (Ex. 1009, ¶22, FIG. 3). Kazuya's configuration is similar to figure 5 of Riehl. Therefore, a POSITA implementing the receiver of Riehl would have had reason to look to Kazuya. (Ex. 1002, ¶176.)

[FIG. 3]



(Ex. 1009, FIG. 3.)

Kazuya explains that the inductance of the outer coil 20 is between 1 – 4μH. (*Id.*, ¶¶25-29.) But the inductance of both coils 20 and 30 when connected in series is "8 – 24μH (at 100 – 300kHz)." (*Id.*) Accordingly, a POSITA would have understood that the inductance of the inner coil 30 is between 4 – 23 μH at 100 – 300 kHz in Kazuya. (Ex. 1002, ¶177.)

As taught by Kazuya, an appropriate value for the combined inductance of two coils used together for wireless power transfer at 100-300 kHz is 8 – 24μH. (Ex. 1009, ¶¶25-29.) Riehl, which also discloses that two inductors (L2 and L3) are coupled in series for low frequency power transfer (*see supra* section IX.A.1(c)), does not disclose any specific inductance values for the inductors L2 and L3 when the operating frequency is 100kHz (Ex. 1005, ¶24). Therefore, in view of Kazuya, it would have been obvious for a POSITA to set the inductance of one or both of the coils L2 and L3 in Riehl according to the teachings of Kazuya, where the range of inductances disclosed by Kazuya at 100 kHz includes inductances within the range recited in claim 24. (Ex. 1002, ¶178.)

Indeed, implementing one or both of L2 and L3 of Riehl according to the teachings of Kazuya would have been nothing more than using a known technique (using inductors with a specified inductance value at a specified frequency as described in Kazuya) for a known device (one or more coils of the power receiver disclosed by Riehl) to yield a predictable result (an inductor that is capable of supporting power transfer at the specified frequency). (Ex. 1002, ¶179.) *KSR*, 550 U.S. at 416-21.

Moreover, the claimed range is rendered obvious based on the teachings of Riehl and Kazuya because, as described below, the inductance value of an inductor coil is a result-effective variable, there is no criticality associated with the claimed range, and the prior art range (from Kazuya) overlaps the claimed range. *See E.I. DuPont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1006-11 (Fed. Cir. 2018) (concluding that a *prima facie* case of obviousness exists when the prior art range overlaps a claimed range).

The inductance value for an inductor coil at a given frequency is a result-effective variable because the inductance value determines the resonant frequency of the inductor coil and therefore, affects the operating frequency of the circuit that includes the inductor. (Ex. 1002, ¶180.) Accordingly, a POSITA would have been motivated to experiment with several different values of the unshielded inductance and would have recognized that an unshielded inductance of between about 4.2 μH to about 8.2 μH at about 100 kHz to about 500 kHz is one possible configuration for the coils in figures 3 and 5 of Riehl. (*Id.*) In fact, determining the optimal value the unshielded inductance would have required only routine experimentation in which the POSITA would vary the inductance values (e.g., using software simulation tools) at the appropriate frequency ranges and determine the effect of this variation on the antenna performance. (*Id.*)

Therefore, the claimed range is obvious because "discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art" and the '729 patent provides no evidence that the claimed inductance range produces a new or unexpected result. *In re Aller*, 220 F.2d at 456; *In re Applied Materials, Inc.*, 692 F.3d 1289, 1295 (Fed. Cir. 2012). Indeed, the '729 patent does not disclose the claimed range. (Ex. 1002, ¶181.)

F. Ground 6: Riehl and Yu Render Claims 1, 2, 5-8, 12-14, 16-19, 21, 23, and 25 Obvious

1. Claim 1

As demonstrated above in Section IX.A, Riehl discloses or suggests all of the features of claim 1. For example, as discussed above, Riehl discloses a third gap separating the outermost turn of the second inductor coil, L3, from the innermost turn of the first inductor coil, L2. (Ex. 1005, FIG. 5; *see supra* section IX.A.1(d).) Figure 5 of Riehl depicts the third gap as larger than the first and second gaps, and, as discussed above, Riehl renders obvious "wherein the third gap is greater than the first and second gaps." (*See supra* section IX.A.1(d).)

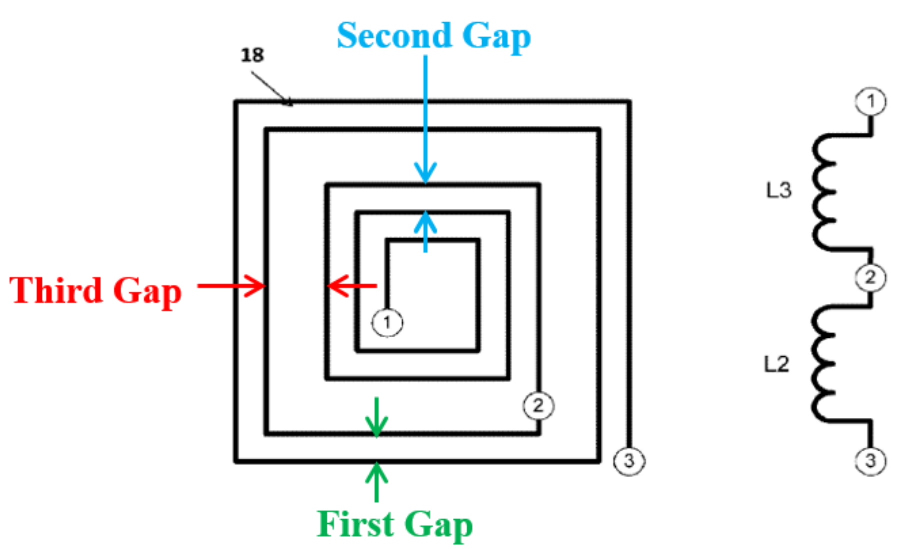
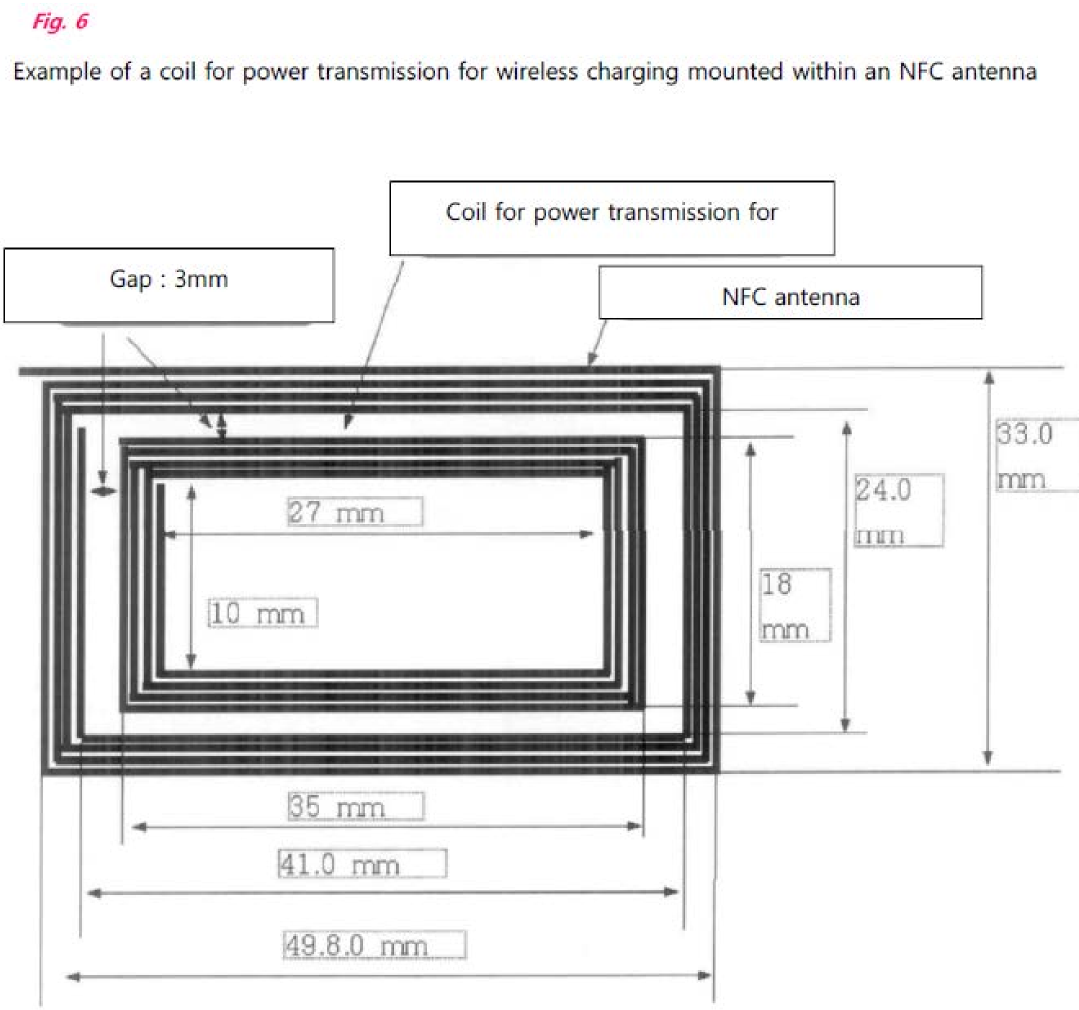


FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶182.)

However, to the extent that PO argues or the Board finds that Riehl does not render obvious such a feature, it would have been obvious in view of Yu to make the third gap greater than the first and second gaps in Riehl. (Ex. 1002, ¶¶183-190.)

Similar to Riehl, Yu is directed to a two-coil structure that includes "a coil for power transmission for wireless charging mounted within an NFC antenna." (Ex. 1011, Abstract , FIG. 6, ¶106.) For example, figure 6 of Yu "illustrates an apparatus which mounts a coil for power transmission for wireless charging within a space formed by an NFC antenna in order to reduce component mounting space." (*Id.*, ¶179.)



(*Id.*, FIG. 6.)

Like the '729 patent and Riehl, Yu includes an outer antenna coil and an inner antenna coil concentrically arranged in a flat plane. (*Id.*, FIG. 6, Abstract, ¶43.) In the embodiment shown in figure 6 of Yu, the outer coil turns are separated by 0.2 mm, while the inner coil turns are separated by 0.1 mm. (*Id.*, ¶¶143-160; Ex. 1002, ¶186.) The inner and outer coils are separated by 3.0 mm. (Ex. 1011, ¶¶159-160.) Therefore, Yu discloses an embodiment in which the gap between the two coils is greater than the gaps between the individual turns in each of the coils. (Ex. 1011, ¶¶159-160; Ex. 1002, ¶187.)

The purpose of the gap between the coils is to "prevent loss of performance due to mutual interference between the NFC antenna and the coil for power transmission for wireless charging . . . ." (Ex. 1011, ¶¶36, 165.) Yu, therefore, demonstrates that using a gap between the inner and outer coils to regulate the mutual interference between the two coils was known in the art prior to the alleged discovery of such a solution as described in the '729 patent. (Ex. 1001, 21:15-18; *see also*, *e.g.*, *id.*, 20:52-57; Ex. 1002, ¶188.) Riehl IEEE and Mukherjee confirm this. (Ex. 1006, 786; *see also* Ex. 1010 (Mukherjee), ¶12.) While figure 5 of Riehl depicts the third gap as larger than the first and second gaps, Riehl does not disclose specific dimensions for those gaps. Therefore, a POSITA would have looked to Yu, which indicates that mutual interference between the coils can be avoided by making the gap between the coils greater. (Ex. 1002, ¶189.) Accordingly, in view of Yu, it would have been obvious for a POSITA to make the gap between the coils L2 and L3 in Riehl greater than the gap between the individual turns within each of the coils L2 and L3. (*Id.*) As evidenced by Yu, Riehl IEEE, and Mukherjee, increasing the third gap (i.e., the gap between the first and second coils) such that it is larger than the first and second gaps, like in Yu, would have been a cheap and efficient way of minimizing the mutual inductance between the inner and outer coils in Riehl, while ensuring a minimum area occupied by the turns of the coils. (*Id.* ¶¶189-190; *see also id.,* ¶78; *see also supra* Section IX.A.1(d).) *See KSR*, 550 U.S. at 417-21.

Riehl also discloses that the concentric coils it describes have mutual inductance (or coupling) between them, and suggests accounting for the effects using a tuning network. (Ex. 1005, ¶28.) Yu provides an alternate solution to the same problem that does not require any circuitry. (Ex. 1011, ¶¶36,143-160,165). Applying Yu's teachings to Riehl, would merely have been a substitution of one known element (Yu's separation between concentric coils to reduce their mutual inductance) for another (Riehl's tuning network to account for mutual inductance) achieving the predictable result of overcoming the effects of mutual inductance between concentric inductors. (Ex. 1005, ¶28; Ex. 1010, ¶12.) *KSR*, 550 U.S. at 416-21.

Riehl in combination with Yu discloses or suggests the remaining limitations of claim 1 for the reasons discussed above for claim 1 in Ground 1, with the only modification to the analysis for claim 1 being that discussed above. (*Supra* Sections IX.A.1(a)-(h); Ex. 1002, ¶190.)

2. Claims 5-8, 12-14, 16-18, 21, and 23

Riehl in combination with Yu discloses or suggests the limitations of these claims for reasons similar to those discussed in Sections IX.A.2-13. (Ex. 1002, ¶191.) The same analysis presented above for these claims in Ground 1 is also applicable for the Riehl-Yu combination discussed above in Section IX.F.1. The combination of Yu with Riehl does not affect the analysis for these claims as set forth in Section IX.A.

3. Claim 2

a) **"The antenna of claim 1, wherein the third gap is at least about 0.1 mm."**

Riehl in combination with Yu discloses or suggests this feature. (Ex. 1002, ¶¶192-198.) Riehl discloses a third gap between the first and second coils. (*See supra* section IX.A.1(d).) But Riehl is silent on the size of the third gap.

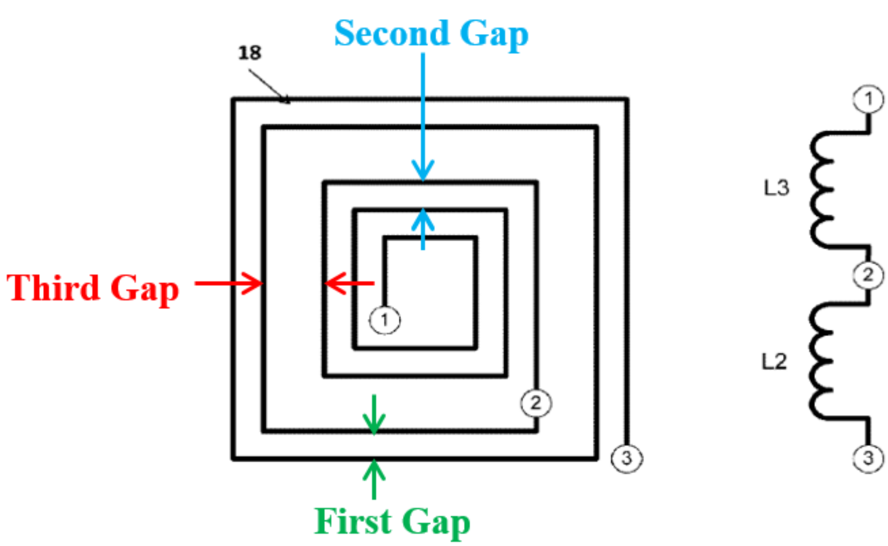


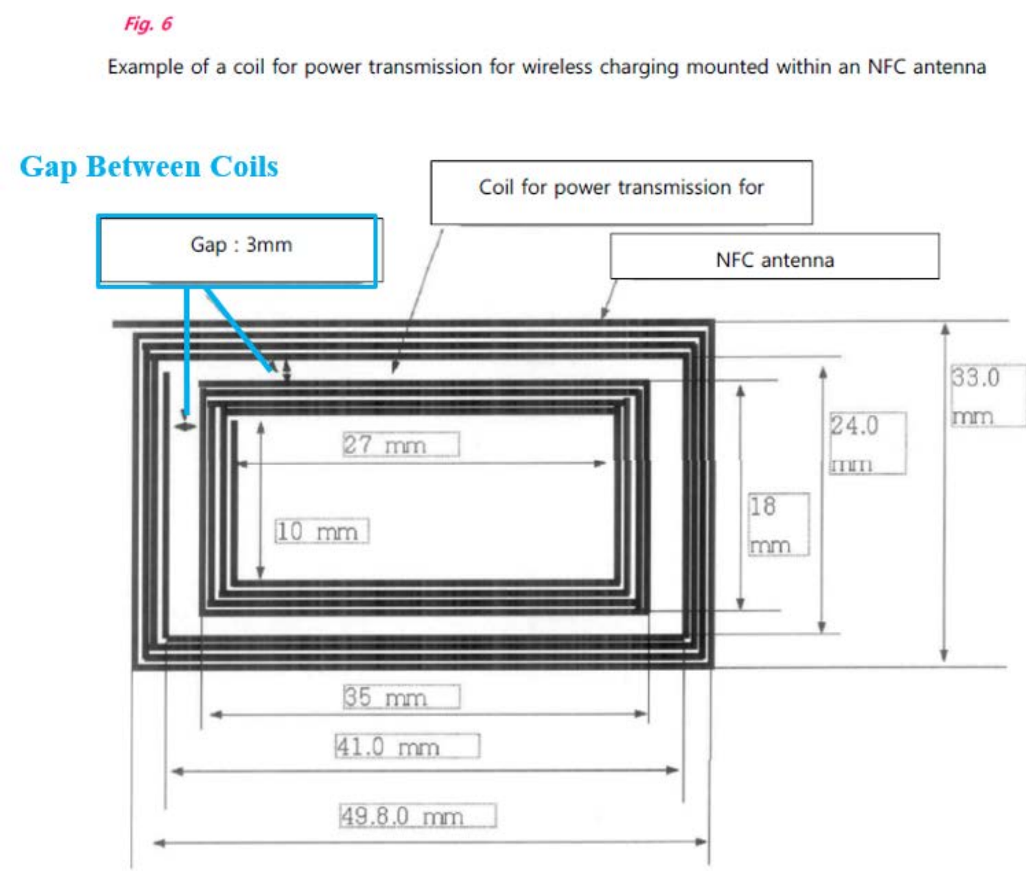
FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶192.)

Yu discloses a coil assembly having a gap between the two coils that is greater than 0.1 mm, and a POSITA would have found it obvious to form the coil assembly

18 shown in figure 5 of Riehl such that the gap between coils L2 and L3 ("the third gap") is greater than 0.1 mm. (*Id.*; *supra* section IX.F.1; Ex. 1011, ¶¶142-160.)

As discussed above with respect to claim 1, figure 6 of Yu "illustrates an apparatus which mounts a coil for power transmission for wireless charging within a space formed by an NFC antenna in order to reduce component mounting space." (Ex. 1011, ¶106; *see supra* section IX.F.1.)



(Ex. 1011, FIG. 6 (annotated); Ex. 1002, ¶194.)

In the example embodiment shown in figure 6 of Yu, the gap between the inner and outer coils is 3.0 mm. (Ex. 1011, FIG. 6, ¶¶159-160, 165.) Yu further discloses another embodiment where the gap is "2.0mm to 9mm." (*Id.*, ¶36.) Therefore, Yu discloses the gap between the two coils in Yu is "at least 0.1 mm." (Ex. 1002, ¶195.)

A POSITA would have been motivated to combine the teachings of Riehl and Yu such that the gap between the coils L2 and L3 in Riehl is at least 0.1 mm as disclosed or suggested by Yu. (Ex. 1002, ¶195.) A POSITA would have understood that the spacing between two concentric coils such as those shown in figure 5 of Riehl and figure 6 of Yu should be adjusted in order to limit the mutual inductance between them in order to ensure that each coil is able to operate properly. (*Id.*; Ex. 1011, ¶¶36, 165; *see also* Ex. 1010, ¶12.[9]) Based on the teachings of Yu, a POSITA would have understood that a gap of at least 0.1 mm between the two coils would have been one way of minimizing the mutual inductance between two concentric coils similar to coils L2 and L3 in figure 5 of Riehl. (Ex. 1002, ¶197.) Accordingly, a POSITA would have combined the teachings of Riehl and Yu when implementing a power receiver as disclosed in Riehl where the coils are separated by at gap that is greater than 0.1 mm as disclosed by Yu in order to realize a functional power

[9] Mukherjee (Ex. 1010) is cited as evidence as to the knowledge of a POSITA at the time of the alleged invention.

receiver in which the mutual inductance between the coils is reduced by the gap. (*Id.*, ¶¶197-198.) *Unwired Planet,* 841 F.3d at 1003; *KSR*, 550 U.S. at 417.

Moreover, the claimed range is rendered obvious based on the teachings of Riehl and Yu because, as described below, the third gap is a result-effective variable, there is no criticality associated with the claimed range, and the prior art discloses values within the claimed range of "at least 0.1 mm." *See Dupont*, 904 F.3d at 1006-11 (concluding that a *prima facie* case of obviousness exists when the prior art range overlaps a claimed range); *In re Aller*, 220 F.2d at 456. The third gap value is a result-effective variable because, as discussed above, it affects the amount of mutual inductance between the two coils. (Ex. 1002, ¶197.)

4. Claim 19

a) **"The antenna of claim 1, wherein the third gap ranges from about 0.1 mm to about 10 mm."**

Riehl in combination with Yu discloses or suggests this feature. (Ex. 1002, ¶¶199-204.) While Riehl does not disclose this feature, Yu does. (*See supra* section IX.F.3; Ex. 1011, FIG. 6, ¶¶36, 159-160, 165.)

A POSITA would have been motivated to combine the teachings of Riehl and Yu such that the gap between the coils L2 and L3 in Riehl ranges from about 0.1 mm to about 10 mm as is disclosed or suggested by Yu. (Ex. 1002, ¶¶200-203.) Riehl does not provide specific disclosure as to the dimensions of the gap between the coils L2 and L3 of the power receiver shown in figures 3 and 5. Therefore, a

POSITA would have looked to teachings associated with forming such coils, such as those disclosed by Yu, so that Riehl's coils L2 and L3 could be formed in a functional manner that supports the objectives of Riehl. (*Id.*) Yu discloses many examples of gaps between the coils that are within the claimed range and specifically discloses a gap range of "2.0mm to 9mm." (Ex. 1011, FIG. 6, ¶¶36, 159-160, 165.) Accordingly, a POSITA would have combined the teachings of Riehl and Yu when implementing a power receiver as disclosed in Riehl where the coils are separated by at gap that is within the range of 0.1 mm - 10 mm as disclosed by Yu in order to realize a functional power receiver in which the mutual inductance between the coils is reduced by the gap. (Ex. 1002, ¶203.) *Unwired Planet,* 841 F.3d at 1003; *KSR*, 550 U.S. at 417.

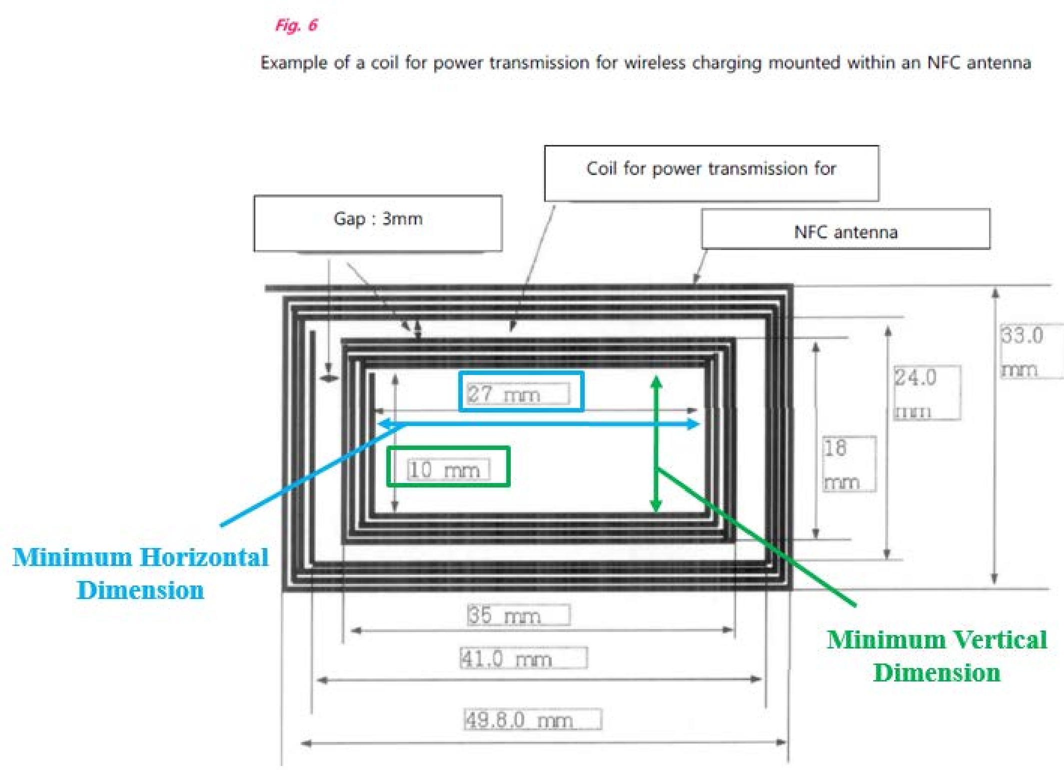
Moreover, the claimed range is rendered obvious based on the teachings of Riehl and Yu because the size of the gap between the coils is a result-effective variable (*supra* section IX.F.3) and "discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art." (Ex. 1002, ¶204.) *In re Aller*, 220 F.2d at 454; *Dupont*, 904 F.3d at 1006-11. Indeed, there is no evidence that the entirety of the claimed gap-size range produces a new or unexpected result.

5. Claim 25

a) **"The antenna of claim 1, wherein at least one of the first and second coils has a surface area exceeding 120 mm."**

Riehl in combination Yu discloses or suggests this feature. (Ex. 1002, ¶¶205-210.) Riehl does not discloses this feature but Yu does. (*Id.*, ¶205.)

The coils shown in figure 6 of Yu have a surface area that exceeds 120 mm^2. For example, Yu discloses that the interior coil has a minimum vertical dimension of 10 mm and a minimum horizontal dimension of 27 mm. (Ex. 1011, FIG. 6, ¶¶142-160.)



(Ex. 1011, FIG. 6 (annotated); Ex. 1002, ¶206.)

Yu further discloses the width of the traces ("lines") in the inner coil is 0.9mm (Ex. 1011, ¶154 ("Pattern line width 0.9mm")), and the inner coil has four turns (*id.*, FIG. 6, ¶156 ("Total turns : 4 turns")). Therefore, Yu discloses coils having a surface area exceeding 120 mm^2. (Ex. 1002, ¶207.)

A POSITA would have had reason to look to Yu when implementing the dual-mode receiver of Riehl and combine its teachings with Riehl because, *inter alia*, Riehl is silent on the coil dimensions. (*See supra* section IX.F.1.) Accordingly, a POSITA would have been motivated to combine the teachings of Riehl and Yu such that at least one of the coils L1 and L2 shown in figures 3 and 5 of Riehl would have a "surface area exceeding 120 mm" as recited in claim 25 in order to allow implementation of Riehl's receiver. (Ex. 1002, ¶¶208-209.) *KSR*, 550 U.S. at 416-21. Moreover, Yu discloses that one of the inductors illustrated in figure 6 is used to support power transfer at 100 kHz. (Ex. 1011, ¶¶6, 9, 178.) The same 100 kHz power transfer frequency is used in Riehl, and therefore, a POSITA would have understood that inductors having the characteristics used in Yu would also be appropriate for use in Riehl. (Ex. 1002, ¶208.) Therefore, the Riehl-Yu combination discloses or suggests that "at least one of the first and second coils has a surface area exceeding 120 mm" as recited in claim 25. (*Id.*)

The Riehl-Yu combination renders obvious claim 25 for an additional reason that the surface area of the coils is a result-effective variable given that the surface area determines the overall size of the device; discovery of an optimum value of such a variable is within ordinary skill; and there is no evidence that the claim range produces an unexpected result. (*Id.*, ¶210.) *In re Aller*, 220 F.2d at 456.

G. Ground 7: Riehl, Yu, and Riehl IEEE Render Claims 3, 4, 9, 14, and 26 Obvious

The combination of Riehl, Yu, and Riehl IEEE discloses or suggests the features of claims 3, 4, 14, and 26 for similar reasons to those discussed above in section IX.B. (Ex. 1002, ¶211.) The addition of Yu to the Riehl and Riehl IEEE combination does not affect the analysis for these claims as set forth in section IX.B because Yu is only relied upon for the teaching of a third gap being larger than the first and second gaps. (*Id.*)

H. Ground 8: Riehl, Yu, and Kanno Render Claim 11 Obvious

The combination of Riehl, Yu, and Kanno discloses or suggests the features of claim 11 for similar reasons to those discussed above in section IX.C. (Ex. 1002, ¶212.) The addition of Yu to the Riehl and Kanno combination does not affect the analysis for these claims as set forth in section IX.C because Yu is only relied upon for the teaching of a third gap being larger than the first and second gaps. (*Id.*)

I. Ground 9: Riehl, Yu, and Sung Render Claim 15 Obvious

The combination of Riehl, Yu, and Sung discloses or suggests the features of claim 15 for similar reasons to those discussed above in section IX.D. (Ex. 1002, ¶213.) The addition of Yu to the Riehl and Sung combination does not affect the analysis for these claims as set forth in section IX.D because Yu is only relied upon for the teaching of a third gap being larger than the first and second gaps. (*Id.*)

J. Ground 10: Riehl, Yu, and Kazuya Render Claim 24 Obvious

The combination of Riehl, Yu, and Kazuya discloses or suggests the features of claim 24 for similar reasons to those discussed above in section IX.E. (Ex. 1002, ¶214.) The addition of Yu to the Riehl and Kazuya combination does not affect the analysis for these claims as set forth in section IX.E because Yu is only relied upon for the teaching of a third gap being larger than the first and second gaps. (*Id.*)

X. CONCLUSION

For the reasons given above, Petitioner requests institution of *inter partes* review and cancellation claims 1-9, 11-19, 21, and 23-26 of the '729 patent based on each of the grounds specified in this petition.

Respectfully submitted,

Dated: June 19, 2019 By: /Naveen Modi/
Naveen Modi (Reg. No. 46,224)
Counsel for Petitioner

CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 9,941,729 contains, as measured by the word processing system used to prepare this paper, 13,849 words. This word count does not include the items excluded by 37 C.F.R. § 42.24 as not counting towards the word limit.

Respectfully submitted,

Dated: June 19, 2019

By: /Naveen Modi/
Naveen Modi (Reg. No. 46,224)
Counsel for Petitioner

CERTIFICATE OF SERVICE

I hereby certify that on June 19, 2019, I caused a true and correct copy of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 9,941,729 and supporting exhibits to be served via express mail on the Patent Owner at the following correspondence address of record as listed on PAIR:

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