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. 10,063,100

PETITION FOR POST-GRANT REVIEW

TABLE OF CONTENTS

LIST OF EXHIBITS

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

I. INTRODUCTION

Samsung Electronics Co., Ltd. ("Petitioner") requests post-grant review ("PGR") of claims 1-9, 12-20, and 22-25 of U.S. Patent No. 10,063,100 ("the '100 patent") (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. and Samsung Electronics America, Inc.

Related Matters: The specification of the '100 patent is identical to the specification of U.S. Patent No. 9,941,729 ("the '729 patent"), also assigned to Patent Owner, even though the two patents are not in the same family. 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. Petitioner is concurrently filing another petition challenging 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. ELIGIBILITY FOR POST-GRANT REVIEW & GROUNDS FOR STANDING UNDER 37 C.F.R. § 42.204(a)

The post-grant review provisions of the Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) ("AIA") apply to any patent containing claims with an effective filing date after March 16, 2013. *See* AIA §§ 3(n)(1) and 6(f)(2)(A). The '100 patent stems from U.S. Application No. 14/821,157, filed on August 7, 2015. Moreover, Petitioner is filing this PGR within nine months of the issue date (August 28, 2018) of the '100 patent. Therefore, the '100 patent is available for PGR. Moreover, Petitioner is not barred or estopped from requesting PGR 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, 12-20, and 22-25 ("challenged claims") of the '100 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, 2, 5-9, 13-15, 17, 18, 20, and 22 are unpatentable under post-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 4, 15, and 25 are unpatentable under post-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 12 is unpatentable under post-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 16 is unpatentable under post-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 23 is unpatentable under post-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 1-3, 5-9, 13-15, 17-20, 22, and 24 are unpatentable under post-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 4, 15, and 25 are unpatentable under post-AIA 35 U.S.C. § 103(a) as being obvious over Riehl, Yu, and Riehl IEEE;

Ground 8: Claim 12 is unpatentable under post-AIA 35 U.S.C. § 103(a) as being obvious over Riehl, Yu, and Kanno;

Ground 9: Claim 16 is unpatentable under post-AIA 35 U.S.C. § 103(a) as being obvious over Riehl, Yu, and Sung;

Ground 10: Claim 23 is unpatentable under post-AIA 35 U.S.C. § 103(a) as being obvious over Riehl, Yu, and Kazuya.

The '100 patent issued from U.S. Application No. 14/821,157 ("the '157 application") filed August 7, 2015. (Ex. 1001, Cover). The '100 patent does not claim priority from any other application.

Riehl was filed on August 1, 2013 and published on February 6, 2014. Kanno was filed on March 29, 2011 and published on October 6, 2011. Sung was filed on November 1, 2011 and published on November 1, 2012. Thus, Riehl, Mukherjee, Kanno, and Sung qualify as prior art at least under AIA 35 U.S.C. §§ 102(a)(1) and

102(a)(2). Kazuya was published on May 16, 2013, and Yu was published May 3, 2013. Thus, Kazuya and Yu qualify as prior art at least under AIA 35 U.S.C. § 102(a)(1).

Riehl 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 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 bears the markings "MARCH 2015" (Ex. 1006 at 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 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 that was published before August 2015, cites Riehl and specifies "IEEE Transactions on Microwave Theory and Techniques, vol.63, no.3, pp.780-790, Mar. 2015" as citation information for Riehl. (Ex. 1013 at 1 ("©2015 IEEE"), 6 (citation information regarding Riehl); Ex. 1014 at 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").) Therefore, Riehl is prior art to the '100 patent under pre-AIA 35 U.S.C. § 102(a).

Out of the references being relied upon in this petition, only Kanno was considered by the Patent Office during prosecution of the '100 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 '100 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.) More education can supplement practical experience and vice versa. (*Id.*)[1]

VII. OVERVIEW OF THE '100 PATENT

A. The '100 Patent

The '100 patent is entitled "Electrical System Incorporating a Single Structure Multimode Antenna for Wireless Power Transmission Using Magnetic Field Coupling." The '100 patent generally relates to an electrical system that includes "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, 10:15-21; Ex. 1002, ¶¶26-32; *see also id.*, ¶¶22-25.)

The '100 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, 3:1-2.) At the time of the alleged invention of the '100 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.*, 2:33-55, 3:5-

[1] Petitioner submits the declaration of R. Jacob Baker, Ph.D., P.E. (Ex. 1002), an expert in the field of the '100 patent. (Ex. 1002, ¶¶5-15; Ex. 1003.)

11.) According to the '100 patent, however, these "multi mode" antennas had "a relatively large footprint" and were "ideally not suited for incorporation within small electronic devices . . . ." (*Id.*, 3:26-42.) An example of such a multi-mode antenna is set forth in figure 1 and according to the '100 patent, these prior art antennas had discrete antenna structures that operate independently with separate terminal connections. (*Id.*) For example, the prior art antenna of figure 1 has two coils, where each coil has separate terminals that allow for individual electrical connections to each of the two coils.

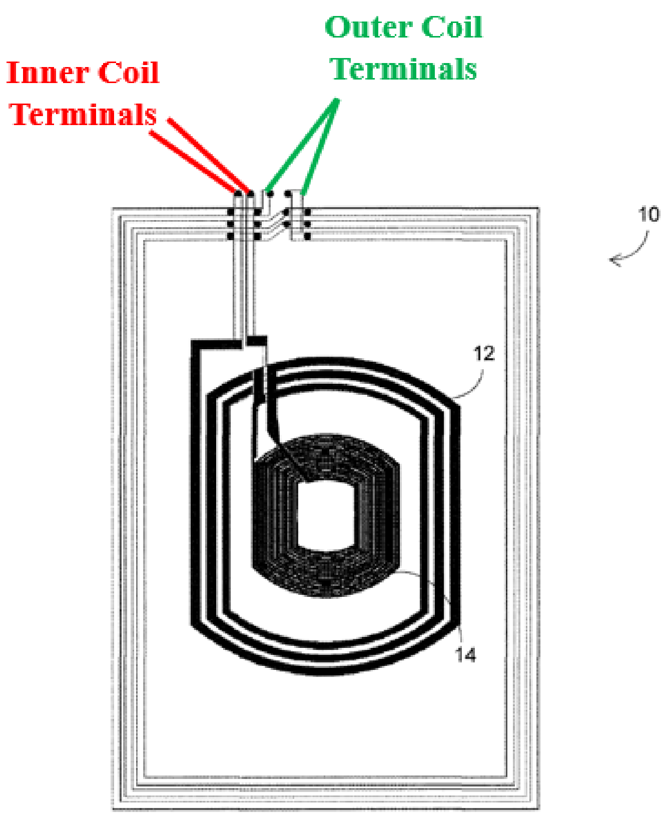

FIG. 1
PRIOR ART

(Ex. 1001, FIG. 1 (annotated); Ex. 1002, ¶27.)

The ’100 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, 3:26-32, 12:60-65.) Figure 3 of the ’100 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.*, 12:60-65.)

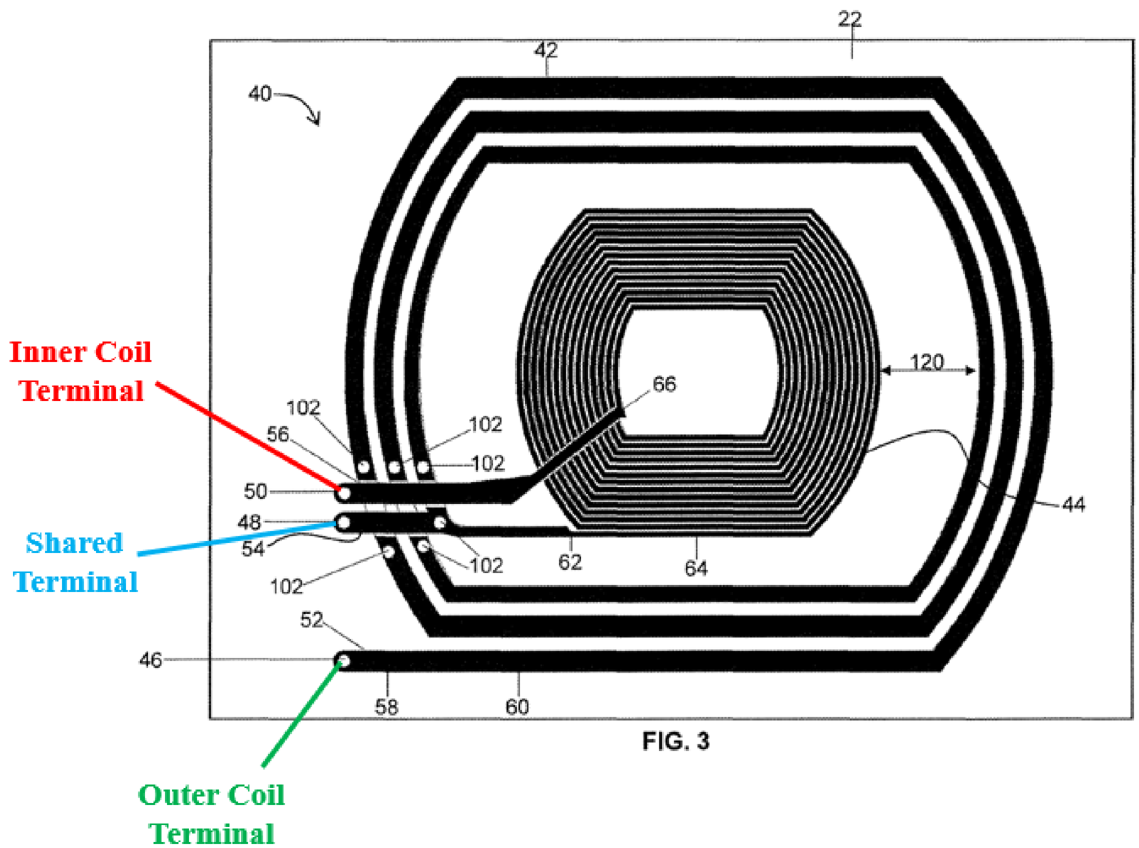

FIG. 3

(Ex. 1001, FIG. 3 (annotated); Ex. 1002, ¶28.)

The ’100 patent states that “by electrically connecting the first terminal 46 to the second terminal 48, a first inductance may be produced that is generally suitable for operation at a first operating frequency” and “[e]lectrically connecting the first terminal 46 to the third terminal 50 produces a second inductance that is generally suitable for operation at a second operating frequency." (*Id.*, 13:35-41.) As further disclosed by the '100 patent, "[i]n general, the first outer inductor coil 24 contributes to the reception and/or transmission of higher frequencies in the MHz range whereas, the second interior inductor coil 26 contributes to the reception and/or transmission of frequencies in the kHz range." (*Id.*, 11:13-17.)

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, 2, 5-9, 13-15, 17, 18, 20, and 22 Obvious

1. Claim 1

a) **"An electrical system, comprising:"**

To the extent the preamble is limiting, Riehl discloses this feature. (Ex. 1005, ¶¶7-9, 16, FIGS. 3-6; Ex. 1002, ¶¶39-42; *see also id.*, ¶¶34-38.) Figure 3 of Riehl shows a dual-mode wireless power receiver.

[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.

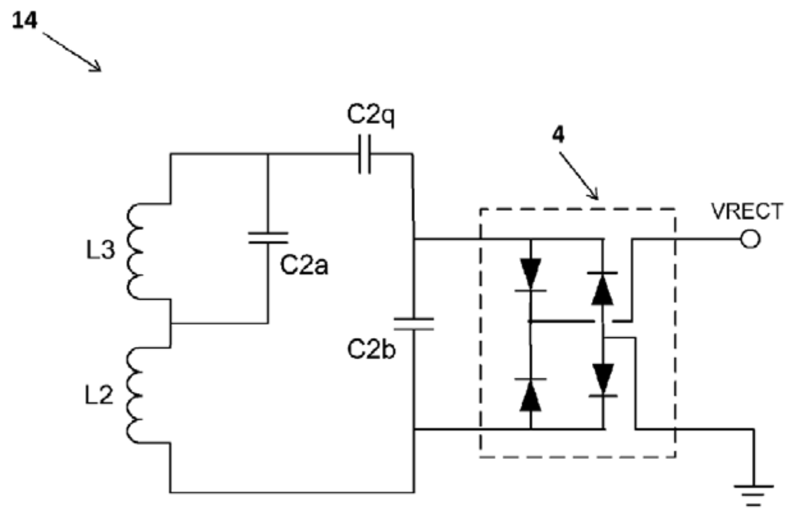

FIG. 3

(Ex. 1005, FIG. 3.)

Riehl discloses that "[t]he dual-mode wireless power receiver 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." (*Id.*, ¶16). The dual-mode wireless power receiver includes an electromagnetic resonator with two inductor coils. (*Id.*, ¶¶7-9, 16, FIGS. 3-6.) The "dual-mode wireless power receiver" of figure 3 is an "electrical system." (Ex. 1002, ¶42; *see also infra*, analysis and citations for the remaining limitations of this claim.)

b) **"a) an antenna, comprising:"**

Riehl discloses this feature. (Ex. 1002, ¶43.) For example, 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 '100 patent, which describes a combination of two inductor coils connected in series as an "antenna." (Ex. 1001, 2:6-9, 4:5-7; *see also infra* Sections IX.A.1(c)-(f).)

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

Riehl discloses these features. (Ex. 1002, ¶¶44-62.)

<u>"a first conductive wire forming a first coil having N_1 number of turns with spaced apart first and second, first coil ends that are disposed on a substrate surface"</u>

Figure 3 of Riehl discloses the circuit topology of Riehl's "inventive 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 . . . ." (Ex. 1005, ¶¶12, 14, 28, FIGs. 3, 5).

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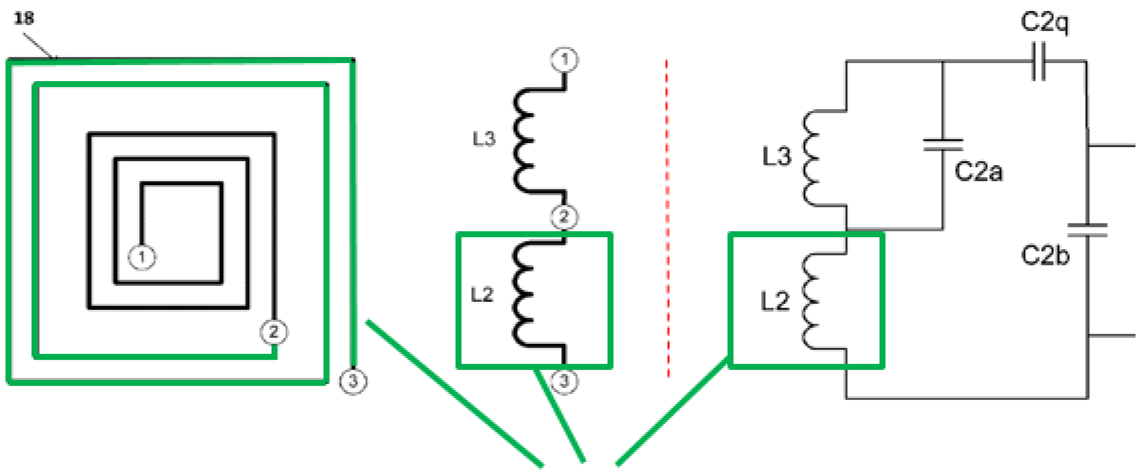
[3] The claim language is reproduced below.



First Coil

FIG. 5 FIG. 3 (excerpt)

(*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), where the first and second inductors L2 and L3 are formed on a printed circuit board. (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 ("The two coils have mutual inductance to each other.").) Moreover, a POSITA would have understood that each of the inductors L2 and L3 would be formed using conductive material that constitutes 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.) Furthermore, a POSITA would have understood that each of the coils forming inductors L2 and L3 constitutes a "wire" as the coils are conductive traces on a printed circuit board. (*Id.*, ¶48; Ex. 1005, ¶28.) Such conductive traces constituting "wires" is consistent with the '100 patent. (Ex. 1001, 4:18-22; Ex. 1002, ¶48.)

Furthermore, inductor L2 is a coil that includes two adjacent turns ("N_1 number of turns").

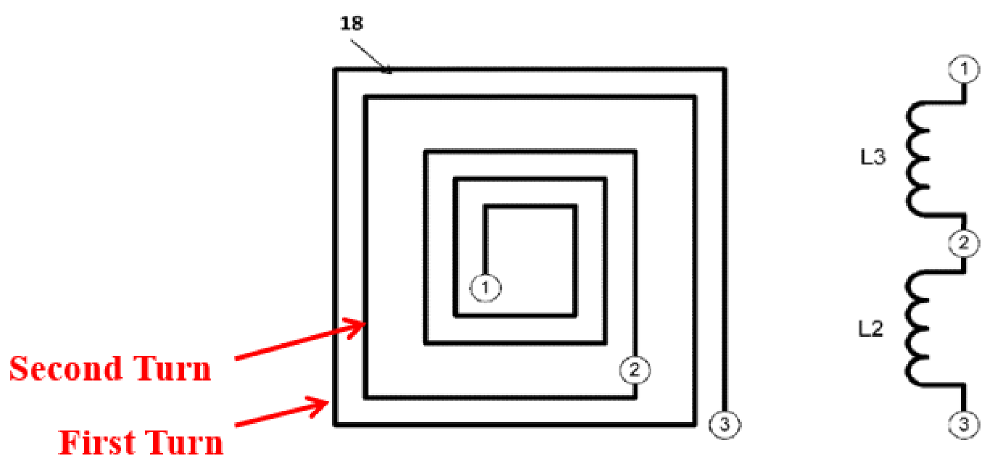
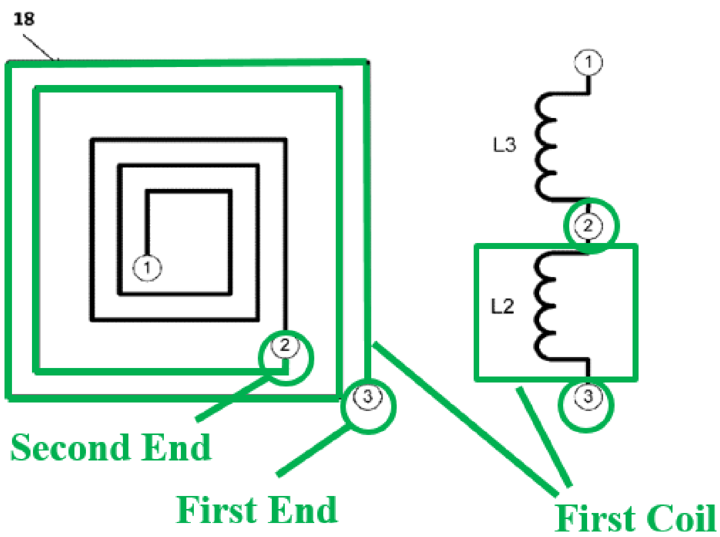


FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶49.)

Moreover, as seen from figure 5 (reproduced below), Riehl discloses that the inductor coil (L2) in figure 5 ("first coil") forms a continuous spiral-shape extending from an outer end at connection point 3 to an inner end at connection point 2. Connection points 2 and 3 are "spaced apart first and second, first coil ends." (Ex. 1002, ¶50.) The connection points "are disposed on a substrate surface" as claimed because the two coils are formed "in the same plane of a printed circuit board . . . ." (*Id*; Ex. 1005, ¶¶12, 14, 28, FIGs. 3, 5.)



(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶50.)

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

Riehl discloses that the first coil L2 that is included in the dual mode power receiver of figure 3 is configured to generate a first inductance and a first resonant frequency. (Ex. 1002, ¶¶51-61; Ex. 1005, ¶¶12, 17-18, 20, 23 ("inductance of L2"), FIGs. 3, 5.)

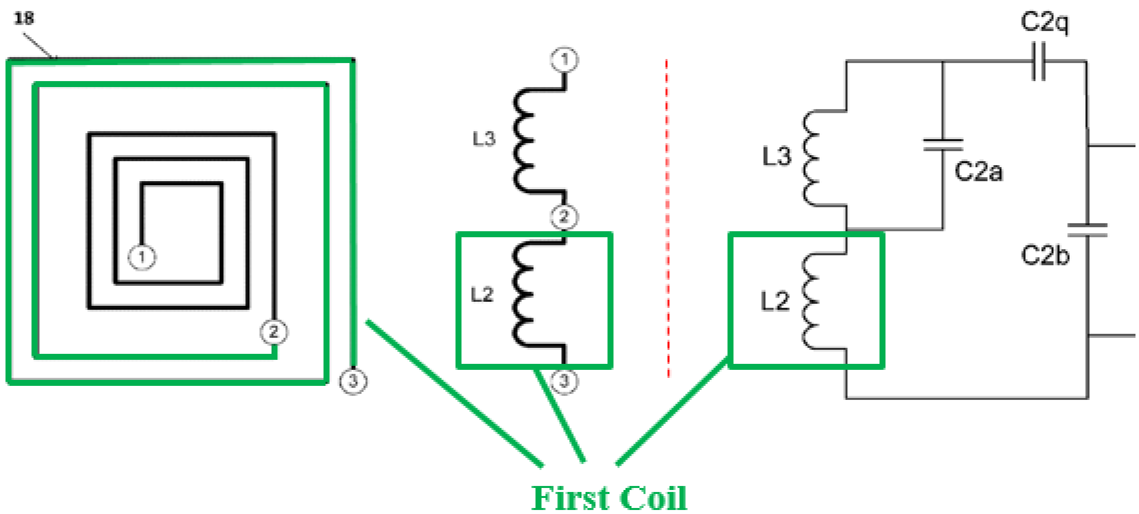
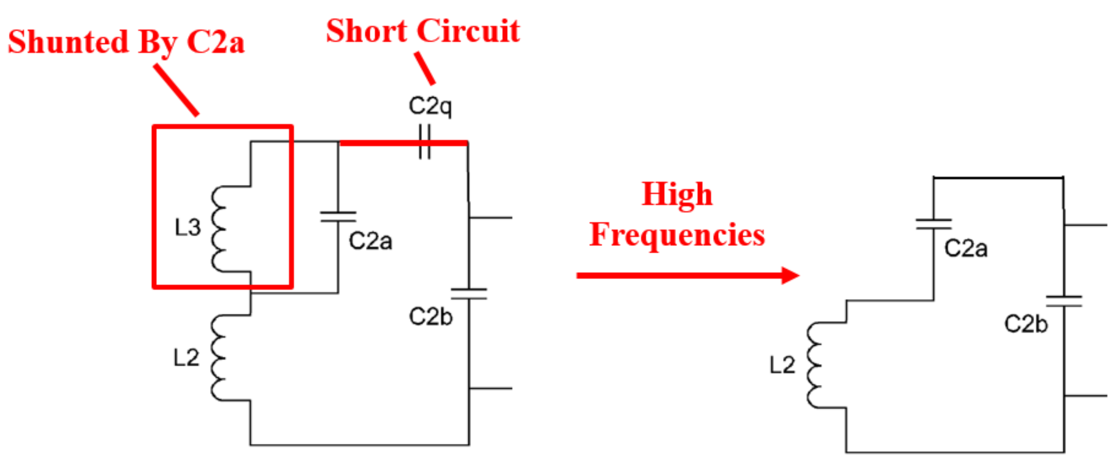


FIG. 5 **FIG. 3 (excerpt)**

(Ex. 1005, FIGs. 5 (left) (annotated), 3 (right) (excerpt, annotated); Ex. 1002, ¶51.)

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"), equal to the operating frequency of a wireless power system. (Ex. 1002, ¶52; Ex. 1005, ¶¶17-18, 20, 25.) As disclosed by Riehl, "the invention describes a receiver-side circuit that can operate either in a low-frequency inductive charging system such as Qi or a higher-frequency resonant wireless power system." (Ex. 1005, ¶30.) The low-frequency operating range corresponding to the Qi standard is 110-205 kHz, whereas the high-frequency operation is at 6.78 MHz. (*Id.*)

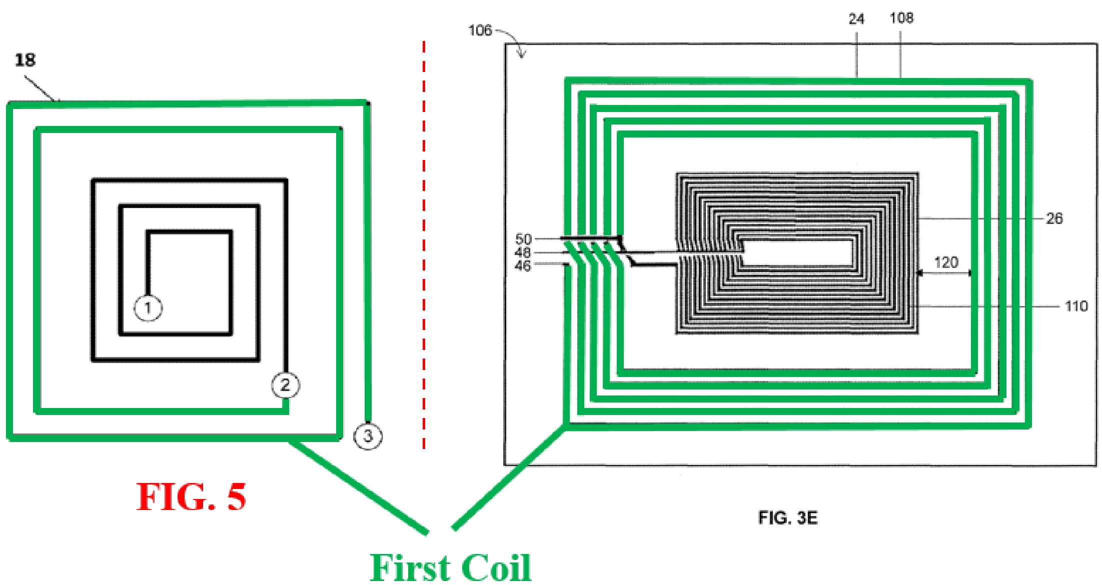
When operating in high-frequency mode, the C2*q* capacitor is effectively a short circuit and "the capacitor *C2a* has an impedance much lower than the inductor L3 at high frequencies, [and] thus it shunts L3." (*Id.*, ¶¶22, 25.) Therefore, at high frequencies, the circuit shown in figure 3 "can be reduced 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 a resonance at 6.78 MHz" and the inductance is approximately equal to L2. (*Id.*, ¶25.)



(*Id.*, FIG. 3 (excerpt, annotated); Ex. 1002, ¶53.)

Therefore, inductor L2 has an inductance, and in the high-frequency mode, L2 has a resonant frequency of 6.78 MHz. (Ex. 1002, ¶54.) 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).[4] (Ex. 1002, ¶¶55-59.)

In addition to being supported by Riehl IEEE, Riehl's disclosure of L2 as a first coil configured to generate a first inductance and a first resonant frequency is consistent with the disclosure of the '100 patent. (Ex. 1002, ¶¶60-61; Ex. 1001, 11:13-17, 18:62-19:1.) As shown in the demonstrative below, Riehl's outer coil L2 ("first coil") corresponds to the outer coil shown in figure 3E of the '100 patent.



[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 (excerpt, annotated); Ex. 1001, FIG. 3E (annotated); Ex. 1002, ¶61.)

"wherein a first gap extends between adjacent turns within the first coil;"

Riehl discloses this feature. (Ex. 1002, ¶62; Ex. 1005, FIG. 5, ¶28.) For example, as shown in figure 5, inductor L2 is a coil that includes two adjacent turns ("N_1 number of turns"). Figure 5 also depicts the two adjacent coil turns are separated by a gap or space ("wherein a first gap extends between adjacent turns within the first coil").

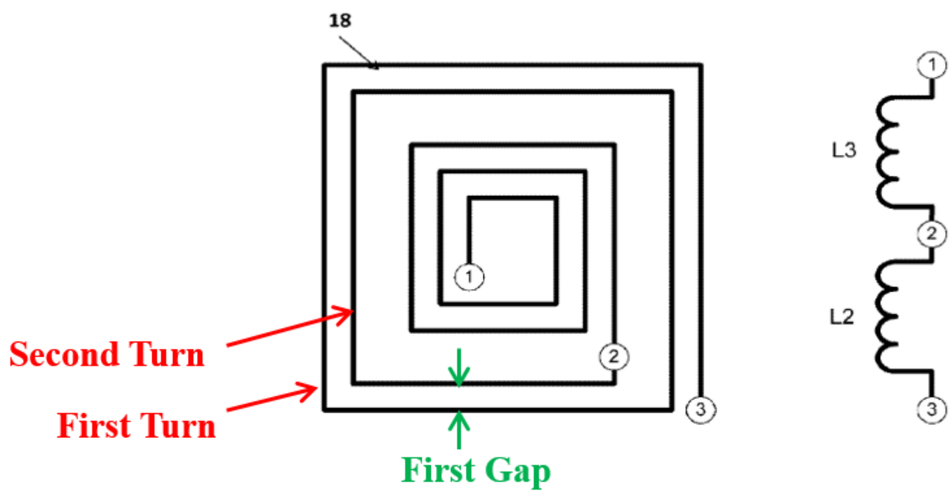


FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶62.)

d) **"ii) a second conductive wire forming . . . within the second coil;"[5]**

Riehl discloses these features. (Ex. 1002, ¶¶63-73.)

"a second conductive wire forming a second coil having N_2 number of turns with spaced apart first and second, second coil ends,"

As discussed above in Section IX.A.1(c), inductor L3 is a coil of conductive material. Therefore, Riehl discloses that L3 is "a second conductive wire forming a second coil." (Ex. 1002, ¶64; *supra* section IX.1(c); *see also* Ex. 1005, FIGs. 3, 5.) As seen in figure 5, L3 forms a continuous spiral-shape extending from an outer end at connection point 2 to an inner end at connection point 1. (Ex. 1005, FIGs. 3, 5, ¶28.) Therefore, connection points 2 and 1 constitute "spaced apart first and second, second coil ends." (Ex. 1002, ¶64.)

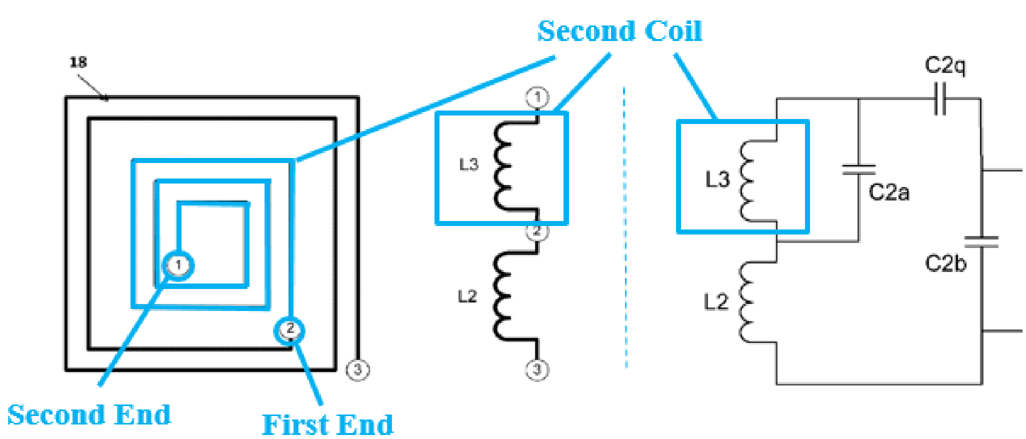


FIG. 5 FIG. 3 (excerpt)

[5] The full claim language is reproduced below.

(Ex. 1005, FIGs. 5 (annotated), 3 (excerpt, annotated); Ex. 1002, ¶64.)

Moreover, inductor L3 has three adjacent turns ("second coil having N_2 number of turns"). (Ex. 1005, FIG. 5; Ex. 1002, ¶65.)

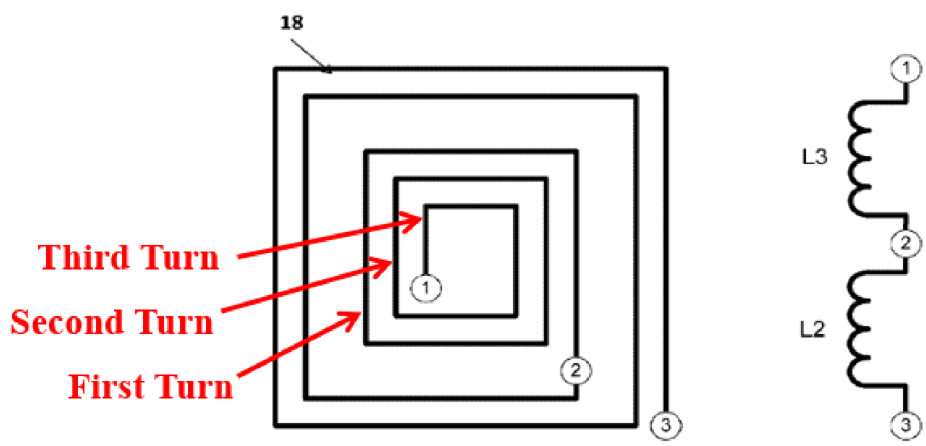
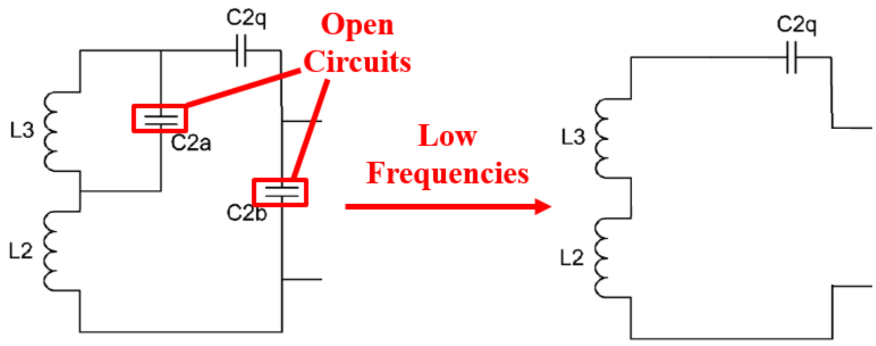


FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶65.)

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

Riehl discloses that 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, ¶¶66-70.) 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, ¶66.)

In an exemplary configuration, L3's inductance is chosen as 10 times the inductance of L2. (Ex. 1005, ¶23.) As disclosed by Riehl, "[o]ne can choose C2q to combine with this inductance to create a series resonance at 100kHz." (*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, ¶67.)

Riehl IEEE also supports the understanding that the inductor L3 in Riehl constitutes a second coil configured to generate a second inductance and a second resonant frequency. (Ex. 1002, ¶68.) For example, Riehl IEEE discloses that "[i]nductor L_X is optimized for operation in the 100-kHz range for the Qi and PMA standards. (Ex. 1006, 781.) Inductor L_X of Riehl IEEE corresponds to inductor L3 in Riehl. (*Id.*, FIGs. 4, 11; Ex. 1005, FIGs. 3, 5.)

Riehl's disclosure of L3 as a second coil configured to generate a second inductance and a second resonant frequency is also consistent with the disclosure of the '100 patent. (Ex. 1002, ¶¶69-70; Ex. 1001, 11:13-17.) The '100 patent discloses "a multi-mode antenna system wherein a first frequency mode is operating in the frequency range of f1+/−Δf1, and a second frequency mode is operating at f2+/−Δf2, wherein f1 is the resonating frequency of the first outer inductor coil, . . . **f2 is the resonating frequency of the second interior inductor coil**, and Δf2 is the bandwidth of the resonating frequency of the **second interior inductor coil formed between the first and second terminals 46, 48** (FIG. 3E) . . . ." (*Id.*, 18:62-19:5, emphasis added.)

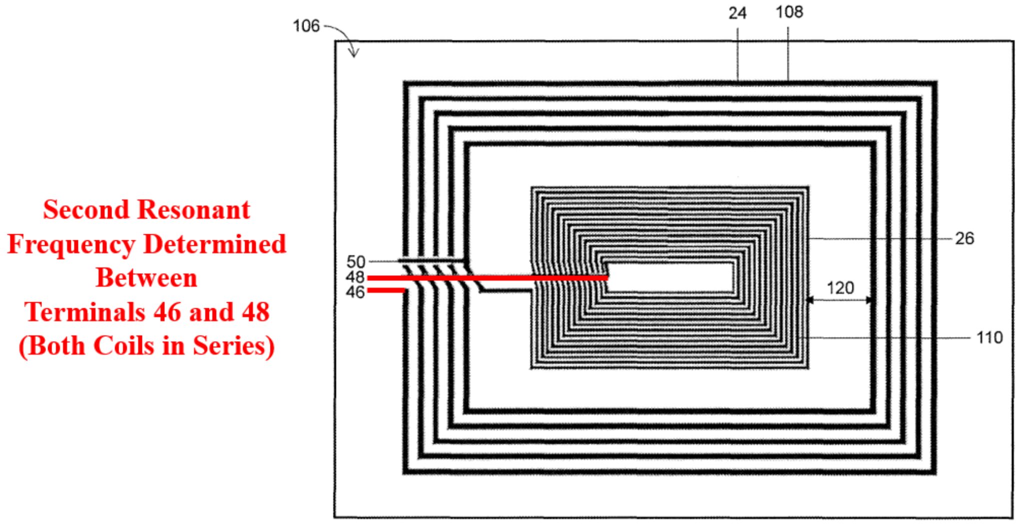


FIG. 3E

(Ex. 1001, FIG. 3E (annotated); Ex. 1002, ¶69.)

As shown in annotated figure 3E above, the resonant frequency of the second interior coil is determined based on a circuit where both inductors are connected in series between terminals 46 and 48 in the same manner as inductors L2 and L3 are connected in series in the circuit shown in figure 3 of Riehl at low frequencies when the resonant frequency of L3 is determined. (Ex. 1002, ¶70.)

“wherein the first resonant frequency is different than the second resonant frequency,”

Riehl discloses this feature because, as discussed above, the “first resonant frequency” is 6.78 MHz (*supra* Section IX.A.1(c)) whereas the “second resonant frequency” is 100 kHz. (Ex. 1002, ¶71.)

“the second coil positioned on the substrate surface and one of within an inner perimeter formed by the innermost turn of the first coil and adjacent the first coil,”

Riehl discloses this feature. (Ex. 1005, FIG. 5, ¶28; Ex. 1002, ¶72.) As described above, Riehl discloses using two inductor coils, L2 and L3, where L2 is the first coil and L3 is the second coil. (Ex. 1005, FIG. 5.) Particularly, Riehl discloses forming L2 and L3 on a printed circuit board (“the second coil positioned 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”). (*Id.*)

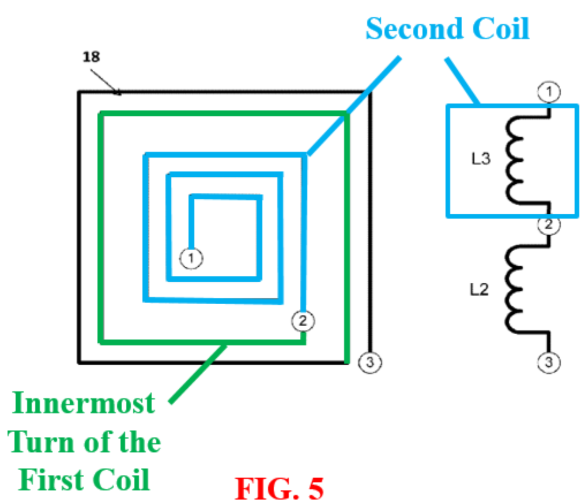


FIG. 5

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

“wherein a second gap extends between adjacent turns within the second coil,”

Riehl discloses this feature. (Ex. 1005, FIG. 5, ¶28; Ex. 1002, ¶73.) For example, figure 5 discloses inductor L3 formed from a coil having three adjacent turns ("second coil comprising N_2 number of turns"). (Ex. 1005, FIG. 5, ¶28.) Figure 5 also depicts the adjacent coil turns in the inductor L3 are separated by a gap or space ("wherein a second gap extends between adjacent turns within the second coil"). (*Id.*)

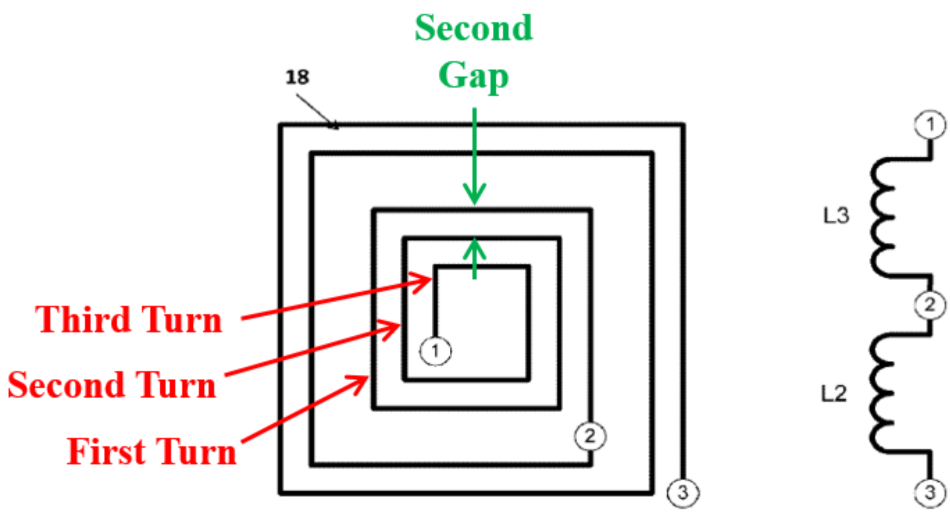


FIG. 5

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

e) **"iii) a third gap separating an 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, and wherein the first end of the second coil meets and joins the second end of the first coil forming a continuous junction therebetween;"**

Riehl discloses or suggests this feature. (Ex. 1002, ¶¶74-81.) 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.) Figure 5 of Riehl discloses that the third gap is larger than the first and second gaps. (Ex. 1002, ¶74.)

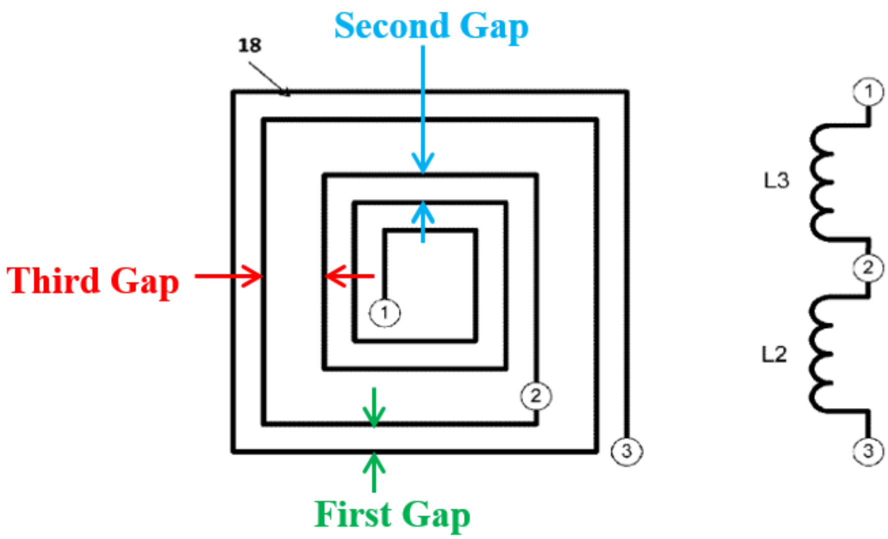


FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶74.)

A POSITA would have known that separation (a gap) between the first and second coils would reduce mutual inductance between the coils. (Ex. 1002, ¶75.) Such an understanding is supported by Riehl IEEE. (*Id.*; Ex. 1006, 786 "L_X and L_Y are physically spaced apart to minimize the mutual inductance between them".) Therefore a POSITA would have understood that is desirable to provide a gap between the coils. (Ex. 1002, ¶75.)

Moreover, a POSITA would have found it obvious to make the gap between the two coils L2 and L3 in Riehl greater than the gap between the individual turns in the coils to minimize the mutual inductance between them. (Ex. 1002, ¶¶76-80.) Small mutual inductance between L2 and L3 ensures that they do not behave like the primary and secondary coils of a transformer. A POSITA would have understood that increasing the gap between L2 and L3 ensures that L2 and L3 behave as individual inductors. (*Id.*, ¶76.)

The motivation for a POSITA to provide a larger gap is supported by Riehl IEEE, which demonstrates that a POSITA would have known that it is desirable to minimize the inductance between the coils. (*Id.*, ¶77; Ex. 1006, 786.) The understanding that a POSITA would have known that a larger gap is desirable between the coils is also supported by figure 5 of Riehl and figure 11 of Riehl IEEE, both of which illustrate the gap between the coils be larger than the gap between the turns within each of the coils. (Ex. 1005, FIG. 5; Ex. 1006, FIG. 11; Ex. 1002, ¶77.)

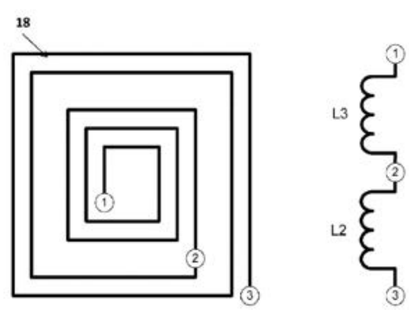


FIG. 5

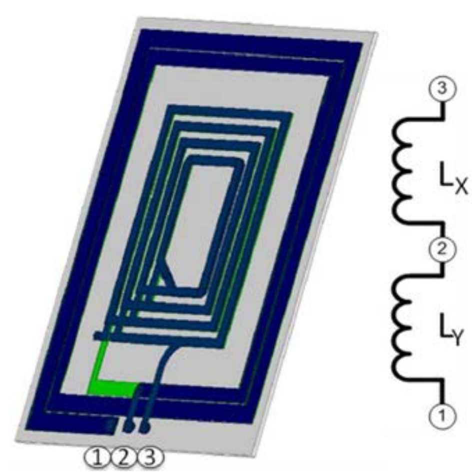


Fig. 11. Multi-mode PRU coil design.

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

Further evidence in support of the understanding that a POSITA would have known that a larger gap is useful for reducing mutual inductance between the coils is provided by Mukherjee (Ex. 1010).[6] (Ex. 1002, ¶78.) Mukherjee is directed to a dual-mode antenna that "enables the use of a single antenna both for near field communications (NFC) and wireless charging." (Ex. 1010, ¶12). Like Riehl and Riehl IEEE, Mukherjee includes an outer antenna coil and an inner antenna coil concentrically arranged in a flat plane. (*Id.*, FIG. 1, ¶12.) The outer coil of Mukherjee contains N1 turns separated by a distance d1, while the inner coil contains N2 turns separated by a distance d2. (*Id.*) The inner and outer coils are separated by a distance D, where "the distance D is greater than d1 and d2" in order to "reduce the mutual coupling between the . . . outer antenna structure 105 and . . . inner antenna structure 110." (*Id.*)

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 "a third gap separating the outermost turn of the second coil from the innermost turn of

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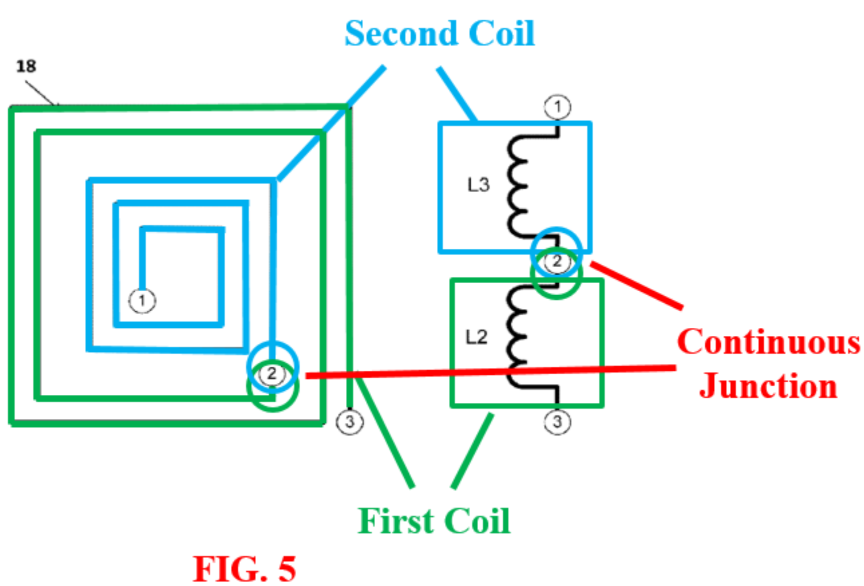
[6] Mukherjee is cited as evidence supporting the knowledge of a POSITA at the relevant time.

the first coil, wherein the third gap is greater than the first and second gaps." (Ex. 1002, ¶79.)

Moreover, choosing a third gap that is greater than the "first and second gaps" have been obvious because it would have been one of a "finite number of identified, predictable solutions." (Ex. 1002, ¶80.) *Perfect Web Techs., Inc. v. InfoUSA, Inc.*, 587 F.3d at 1331 (finding that a claimed step was obvious when it was one of three available choices).

As seen from figure 5, 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."



(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶81.)

f) **"iv) 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, ¶¶82-86.) 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; Ex. 1002, ¶82.) 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, ¶83.) 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 10 of the '100 patent. (*Id.*; Ex. 1001, 33:52-60.)

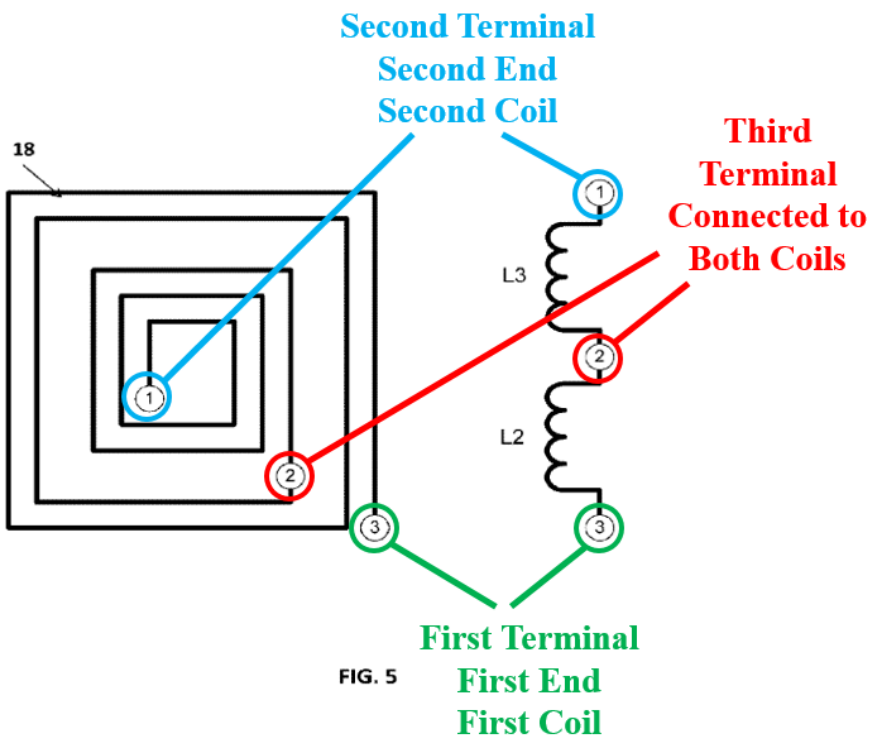


FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶82.)

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, ¶84.)

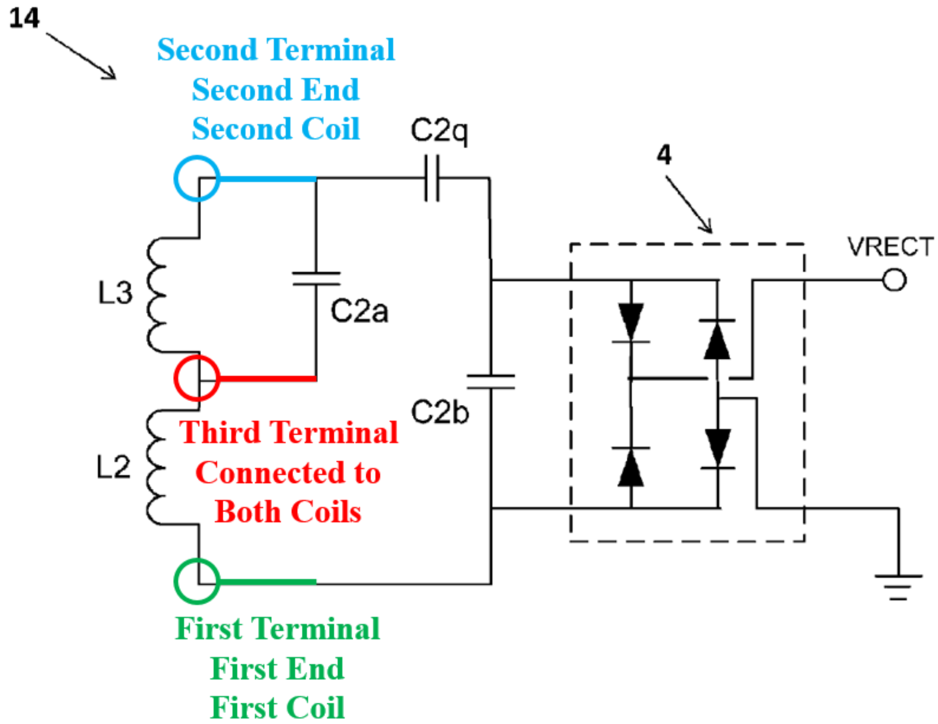


FIG. 3

(Ex. 1005, FIG. 3 (annotated); Ex. 1002, ¶84.)

Riehl's disclosure of this feature is consistent with the disclosure of the '100 patent. (Ex. 1002, ¶¶85-86.) For example, as shown in annotated figure 2 of the '100 patent below, the '100 patent discloses forming the outer coil 24 with first terminal 34 on its outer end. (Ex. 1001, 11:52-59.) The '100 patent further discloses forming the inner coil 26 with second terminal 36 on its inner end. (*Id.*) As also disclosed by the '100 patent and depicted in annotated figure 2 below, the first end of coil 30 and the second end of coil 26 are connected to the third terminal 35. (*Id.*)

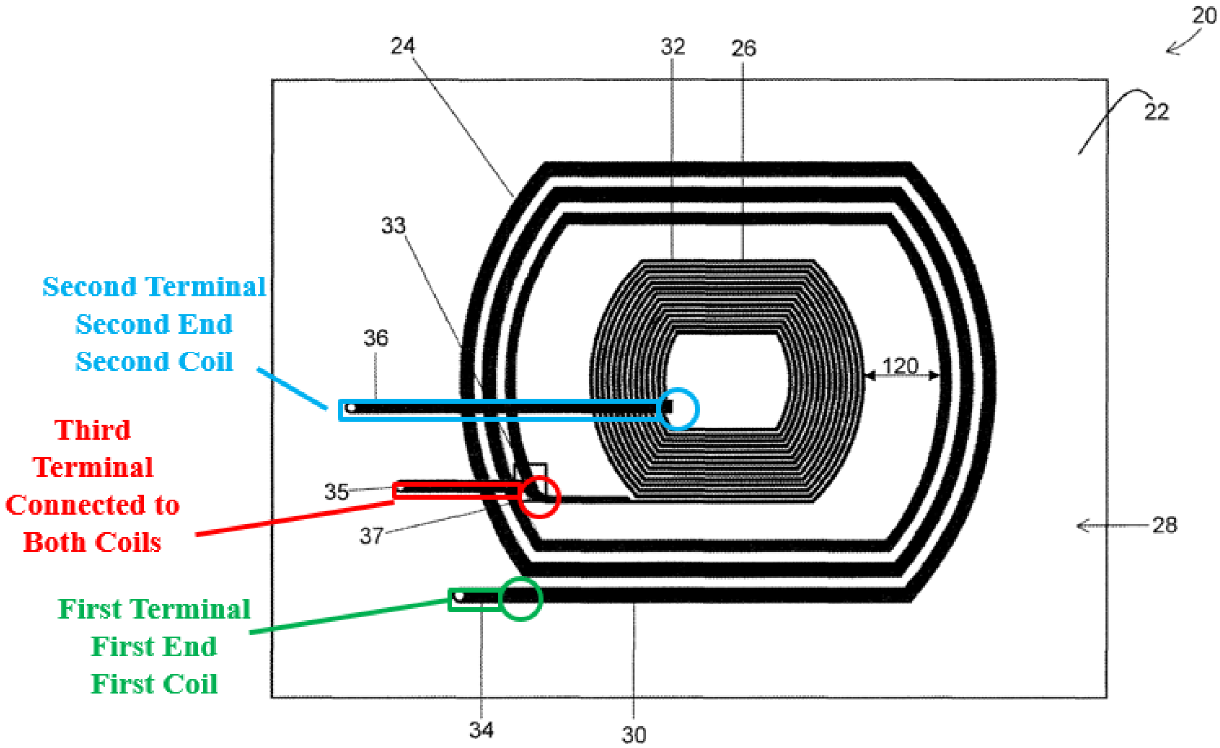


FIG. 2

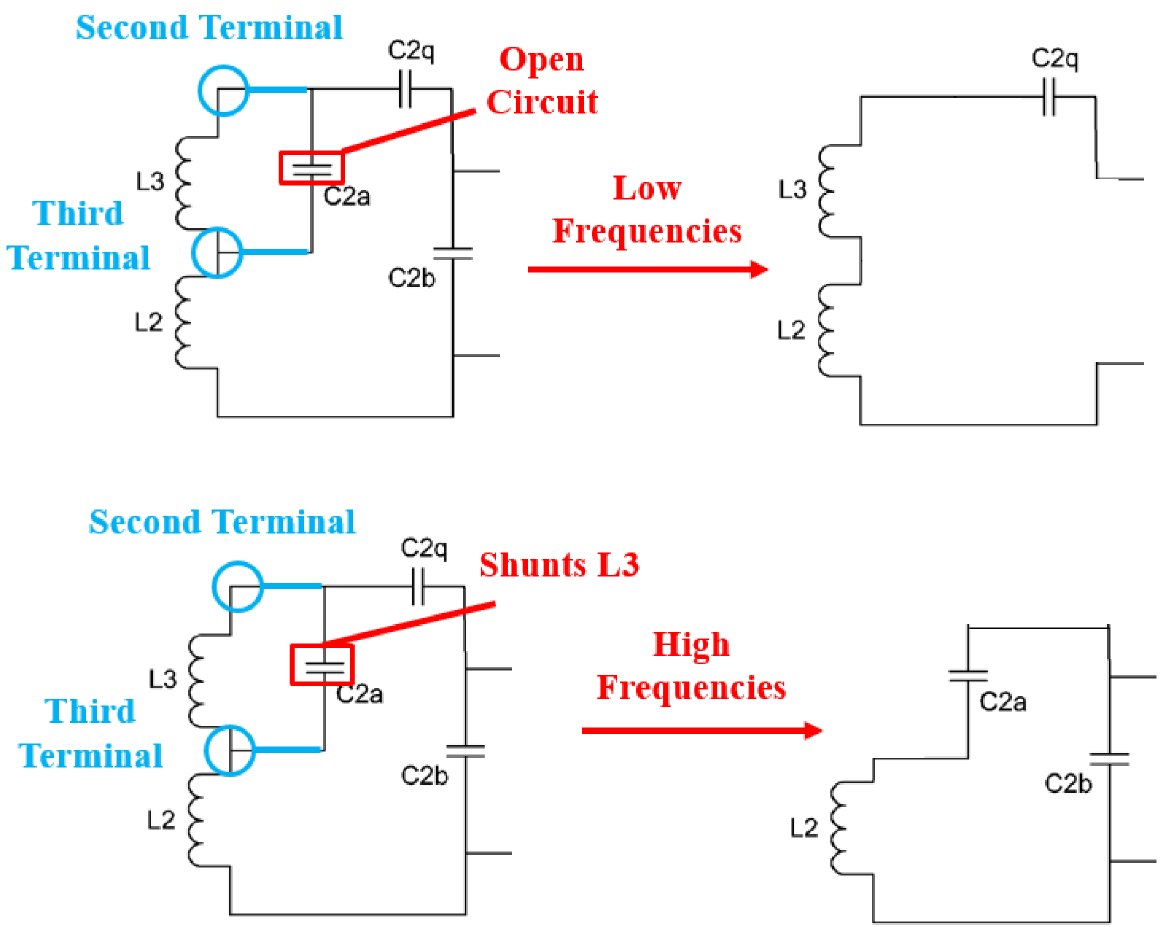
(Ex. 1001, FIG. 2 (annotated); Ex. 1002, ¶85.)

Like the '100 patent, Riehl discloses a shared terminal corresponding to where the outer coil meets and joins the inner coil, where the single shared terminal allows for connections to both the inner coil and the outer coil. Riehl, like the '100 patent, only requires three terminals as one of the connection points is shared by the inside of the outer coil and the outside of the inner coil. (Ex. 1002, ¶86.)

g) **"b) a control circuit electrically connected to at least one of the first, second, and third antenna terminals, wherein the control circuit is configured to control the operation of the antenna;"**

Riehl discloses this feature. (Ex. 1002, ¶¶87-89.) For example, capacitor C2*a* of Riehl is a "control circuit" as that term is used in the context of the '100 patent.

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.) In contrast, at high frequencies, C2*a* provides a low-impedance path around inductor L3 and therefore, the effective inductance is simply the inductance of inductor L2. (*Id.*, ¶25.) Therefore, capacitor C2*a*, which, as shown in the demonstrative below, is connected to the second and third terminals ("connected to at least one of the first, second, and third antenna terminals") and determines whether the antenna operates with a high inductance value or a low inductance value ("is configured to control the operation of the antenna"). (Ex. 1002, ¶87.)

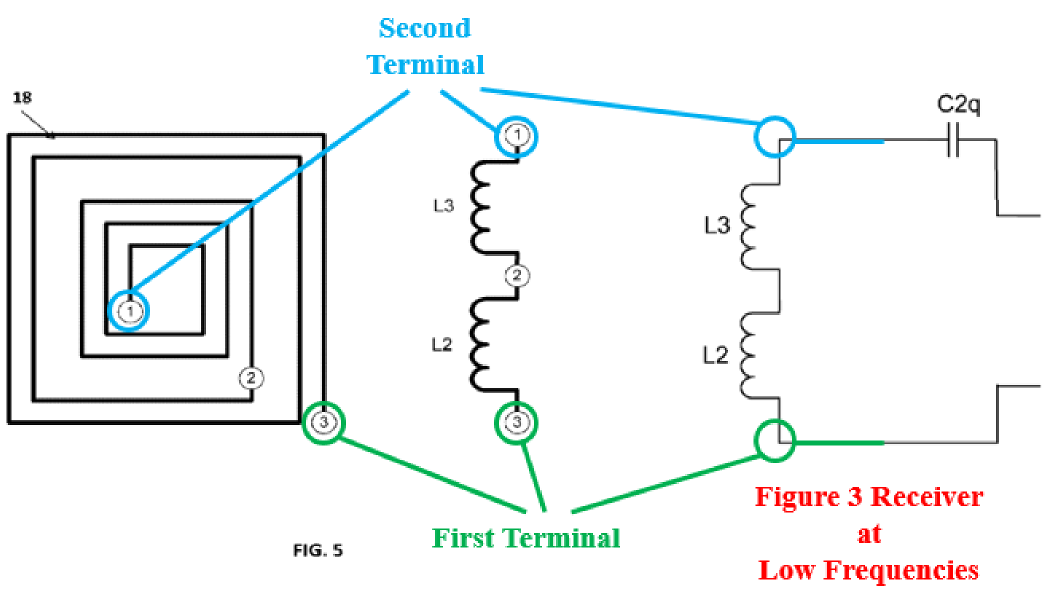


(Ex. 1005, FIG. 3 (excerpt, annotated); Ex. 1002, ¶87.)

Further, capacitor C2*a* of Riehl corresponding to a "control circuit" is consistent with the disclosure of the '100 patent. (Ex. 1001, 5:58-65; Ex. 1002, ¶88.) Moreover, claim 2 of the '100 patent also supports the understanding that a capacitor constitutes a "control circuit" as that term is used in the '100 patent. (*See infra* section IX.A.2; Ex. 1002, ¶89.)

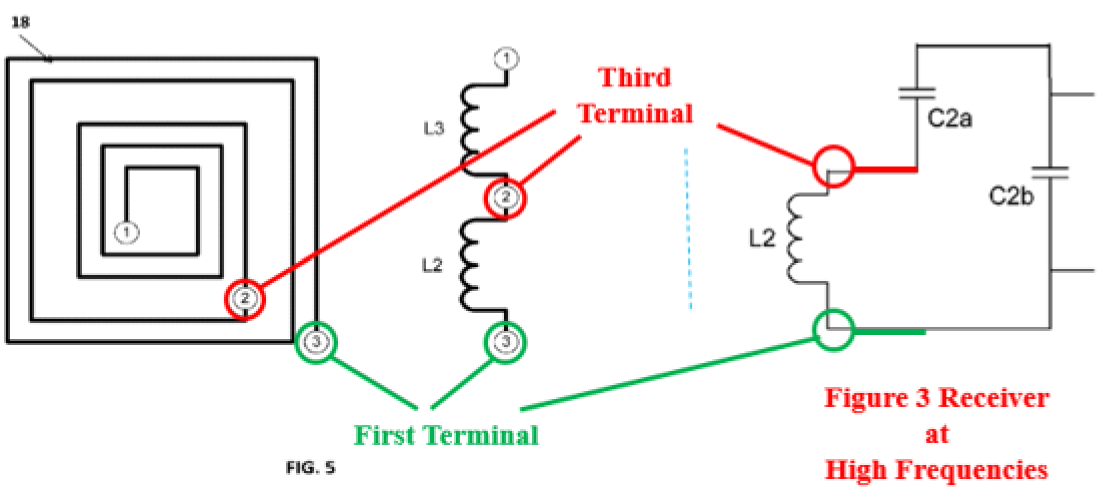
h) **"c) wherein a tunable inductance is generatable by electrically connecting two of the first, second and third terminals;"**

Riehl discloses this feature. (Ex. 1002, ¶¶90-97.) 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. Therefore, the inductance seen by the rectifier circuit corresponds to connections to first and second terminals, where at low frequencies that inductance is the series inductance of L2 plus L3, which, in the example where L3 has an inductance 10 times that of L2, is equal to 11 times L2. (*Id.*, ¶24; Ex. 1002, ¶90.)



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

As shown in the demonstrative below, at high frequencies, C2*a*'s capacitance is selected so that its 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 corresponds to connections to first and third terminals, which is a low inductance value approximately equal to the inductance of inductor L2. (*Id.;* Ex. 1002, ¶¶91-92.)



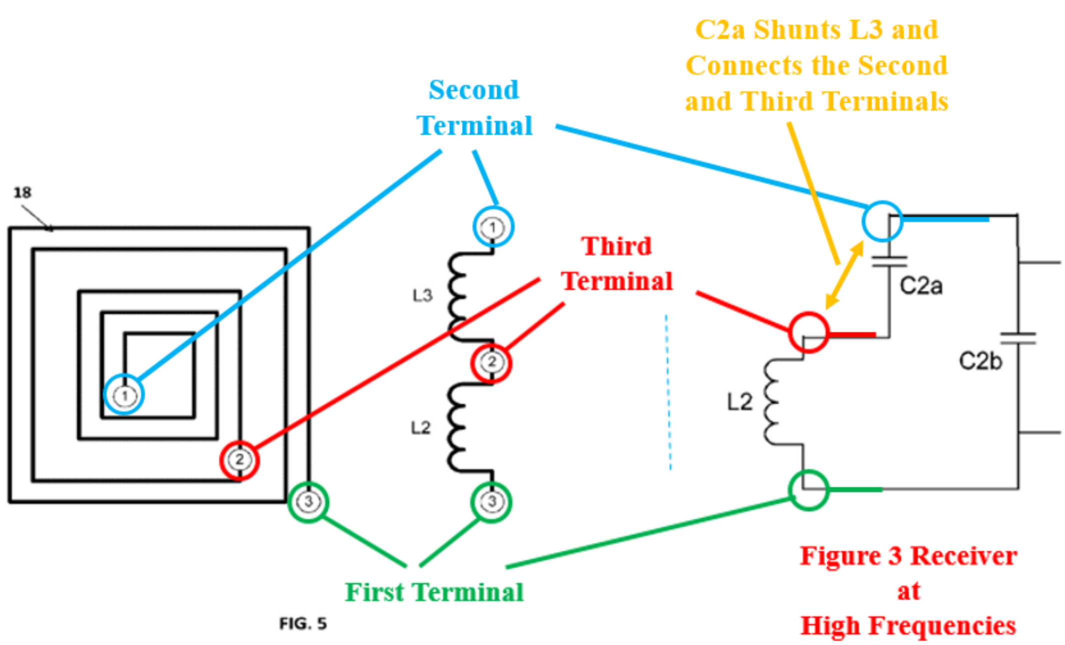
(Ex. 1005, FIGs. 5 (left) (annotated), 3 (right) (excerpt, annotated); Ex. 1002, ¶92.)

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, ¶93.)

To the extent that Patent Owner argues that claim feature 1(h) 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, ¶¶94-97.) 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

[7] Notably, the Examiner recognized a lack of clarity with respect to the recitation of "wherein a tunable inductance is generatable by selecting a connection between two of the first, second and third terminals" in then-pending claim 1. (Ex. 1004, 415, "It is unclear what is meant by this limitation. Are two of the terminals being directly connected to each other? Are two of the terminals being connected to a ground and a source?") In response, Applicant simply amended the claim language to recite "wherein a tunable inductance is generatable by electrically connecting two of the first, second and third terminals," but provided no further explanation or response to the Examiner's comments regarding lack of clarity.

terminals. However, at high frequencies, capacitor C2a shunts inductor L3 such the second and third terminals are connected. (Ex. 1005, ¶¶22-25.) 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, ¶95.)



(Ex. 1005, FIGs. 5 (left) (annotated), 3 (right) (excerpt, annotated); Ex. 1002, ¶95.)

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 '100 patent's disclosure that electrical connections between the terminals can be made using a selection circuit that includes one or more capacitors that provide a high or low impedance path based on the frequency. (Ex. 1001, 30:64-67, 6:18-22, 18:32-47; Ex. 1002, ¶96.) The capacitors C2*a*, C2*b*, and C2*q* in Riehl operate in the same way to provide a high or low impedance path depending on the frequency of operation. For example, at low frequencies, capacitors C2*a* and C2*b* act as open circuits (high impedance paths), and at high frequencies, C2*a* has a much lower impedance than inductor L3 and shunts inductor L3 (low impedance path). (Ex. 1005, ¶¶22-25; Ex. 1002, ¶97.)

i) **"d) 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, ¶¶98-101.) 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 with a resonant frequency of 100 kHz ("the second resonant frequency") ("differs . . . by at least 100 kHz"). (Ex. 1005, ¶17-18, 20.)

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, ¶99.) 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, as noted above in Section IX.A.1(d), Riehl's disclosure is consistent with the disclosure of the '100 patent in that the resonating frequency of the second interior 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(d); Ex. 1001, 19:1-5; Ex. 1002, ¶¶99-101.)

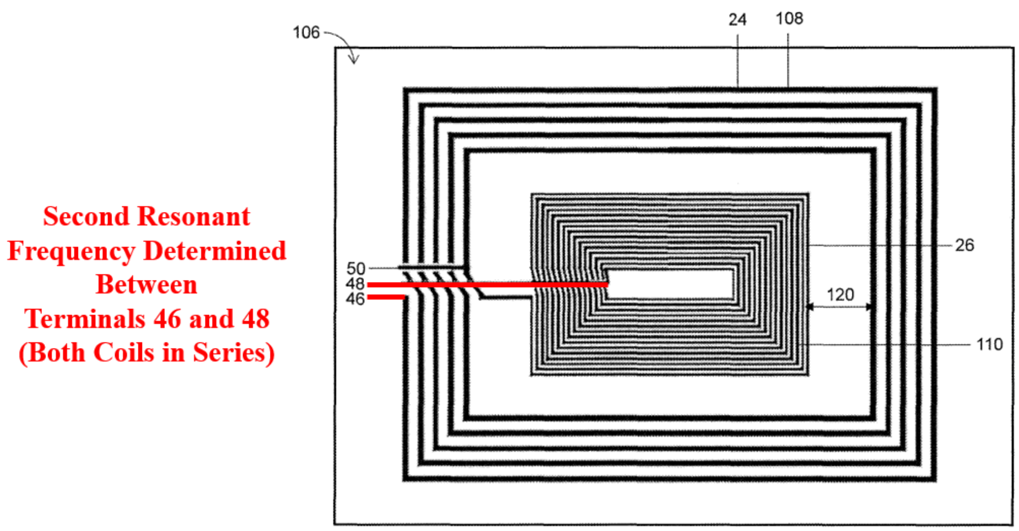


FIG. 3E

(*Id.*, FIG. 3E (annotated); Ex. 1002, ¶100.)

Therefore, while both inductors L2 and L3 contribute to the inductance of the circuit when the circuit is resonating at low frequency (e.g. 100 kHz) in Riehl, both inductors also contribute to the inductance in the circuit shown in figure 3E of the '100 patent between terminals 46 and 48 when the resonant frequencies of the inner inductor is determined. (Ex. 1002, ¶101.) Stated differently, the '100 patent discloses that a resonant frequency of an interior coil can be the resonant frequency of the interior coil when the interior coil is connected in series with an outer coil. (*Id.*)

j) **"e) 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, ¶102.) For example, Riehl discloses that in the low frequency mode, inductor L3 ("second coil") operates at 100 kHz. (*Supra* Section IX.A.1(d); 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 2

a) **"The electrical system of claim 1, wherein the control circuit comprises at least one of an electrical resistor, a capacitor, and an inductor."**

Riehl discloses this feature. (Ex. 1002, ¶103.) As discussed above in Section IX.A.1(g), capacitor C2a is a "control circuit." (*See supra* section IX.A.1(g).)

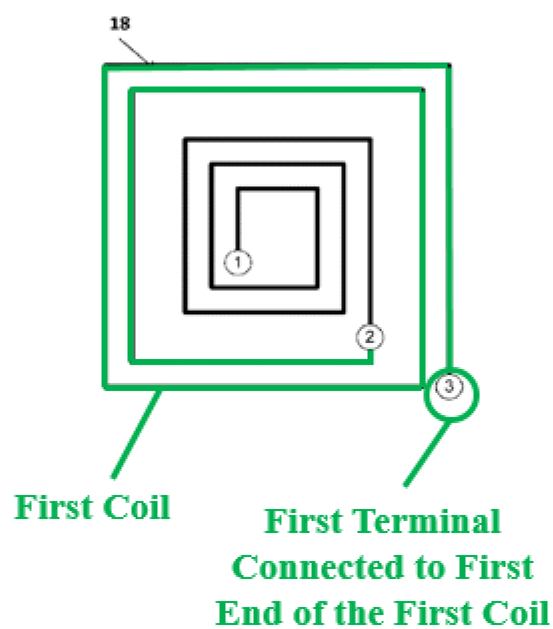
3. Claim 5

a) **"The electrical system of claim 1, wherein the first terminal is electrically connected to the first end of the first coil, wherein the first end of the first coil is 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."**

Riehl discloses these features. (Ex. 1002, ¶¶104-107.)

<u>"wherein the first terminal is electrically connected to the first end of the first coil, wherein the first end of the first coil is disposed at an end of the first wire of the first coil located at an outermost first coil perimeter"</u>

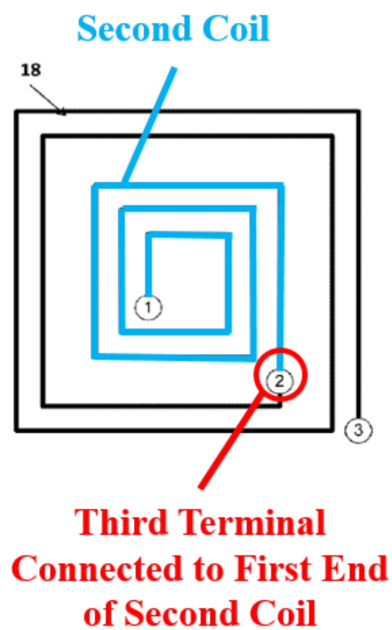
As shown in annotated figure 5 below, Riehl discloses that connection point 3 ("first terminal") is at the first end of inductor L2 ("electrically connected to the first end of the first coil"). Riehl further discloses that the first end of coil L2 is positioned on L2's outermost end ("the first end 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. 1002, ¶105.)



(Ex. 1005, FIG. 5 (excerpt, annotated); Ex. 1002, ¶105.)

<u>"the third terminal is electrically connected to the first end of the second coil positioned at a second coil outer perimeter"</u>

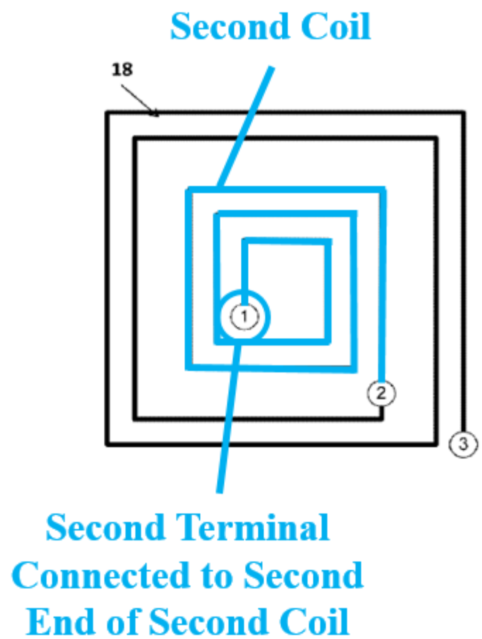
As shown in annotated figure 5 below, Riehl discloses that connection point 2 ("third terminal") is at the first end of inductor L3 ("electrically connected to the first end of the second coil"). Riehl further discloses that the first end of coil L3 is positioned on L3's outermost end ("the first end of the second coil positioned at a second coil outer perimeter"). (Ex. 1005, FIG. 5, ¶28; Ex. 1002, ¶106.)



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

"and the second terminal is electrically connected to the second end of the second coil located along an interior perimeter of the second coil"

As shown in annotated figure 5 below, Riehl discloses that connection point 1 ("second terminal") is at the second end of inductor L3 ("electrically connected to the second end of the second coil"). Riehl further discloses that the second end of coil L3 is positioned on L3's innermost end ("the second end of the second coil located along an interior perimeter of the second coil pattern"). (Ex. 1005, FIG. 5, ¶28; Ex. 1002, ¶107.)

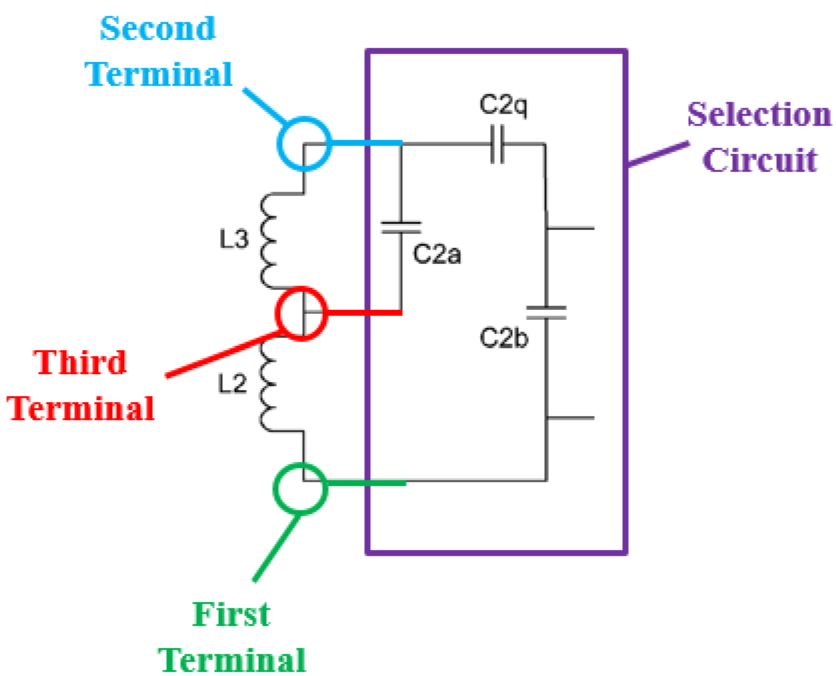


(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶107.)

4. Claim 6

a) **"The electrical system of claim 1, wherein a selection circuit is electrically connected to the first, second, and third terminals of the antenna, wherein actuation of the selection circuit electrically connects two of the three terminal ends so that an antenna operating frequency is modified."**

Riehl discloses this feature. (Ex. 1002, ¶¶108-118.) Riehl discloses that capacitors C2*a*, C2*b*, and C2*q* are electrically connected to the claimed first, second, and third terminals. (Ex. 1005, FIG. 3, ¶¶22, 24-25; *see supra* section IX.A.1(f).) As shown in annotated figure 3 below and discussed in more detail immediately following, capacitors C2*a*, C2*b*, and C2*q* form a "selection circuit" as that term is used in the '100 patent.[8] (Ex. 1002, ¶108.)



(Ex. 1005, FIG. 3 (excerpt, annotated); Ex. 1002, ¶108.)

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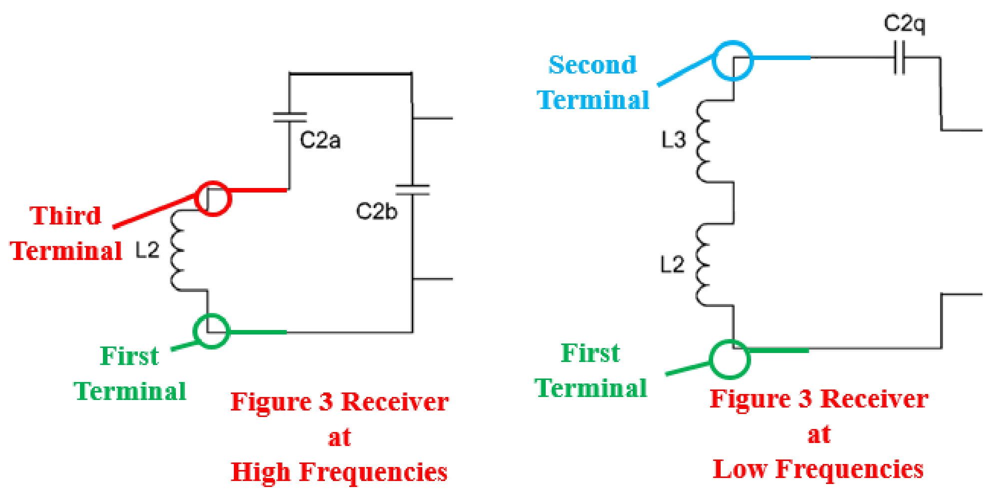
[8] It is not necessary that the claimed "selection circuit" and "control circuit" be mapped to different structures in the prior art. *See Powell v. Home Depot USA Inc.*, 663 F.3d 1221, 1231–32 (Fed. Cir. 2011). This is especially true when the '100 patent does not disclose non-overlapping structures for the two features. For instance, the '100 patent does not disclose both a "control circuit" and "selection circuit" connected to the three terminals.

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 above, 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, ¶109.)

Thus, capacitors C2*a*, C2*b*, and C2*q* act to select the manner in which the inductors L2 and L3 are connected to the rectifier circuit based on the operating frequency of the disclosed receiver circuit and therefore, constitute a "selection circuit." (Ex. 1002, ¶110.) Such an understanding is consistent with the disclosure of the '100 patent. (Ex. 1001, 18:32-47.)

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, 24, 30.) As explained below, selecting a connection between two of the first, second, and third terminals allows changing the operating frequency of Riehl's receiver circuit. (Ex. 1002, ¶111.)

For example, as discussed above in Section IX.A.1(f), the receiver circuit has a "first," "second," and "third terminal." (*Supra* section IX.A.1(f).)

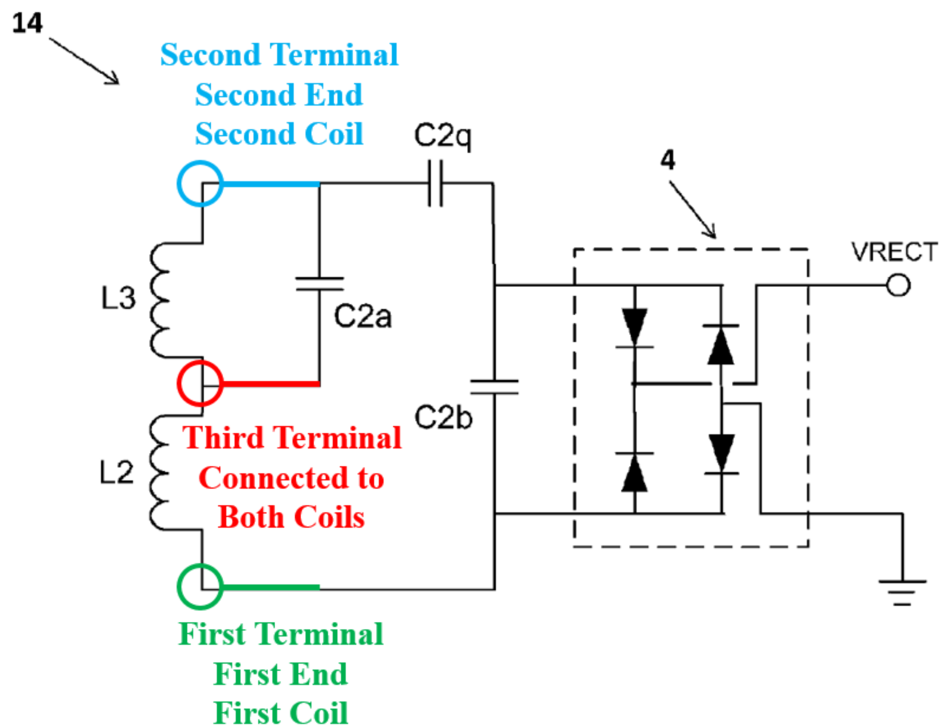


FIG. 3

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

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 "two inductors appear in series so as to give the required high inductance value" necessary for the receiver circuit "to create a series resonance at 100 kHz, as required by the Qi specification." (*Id.*)

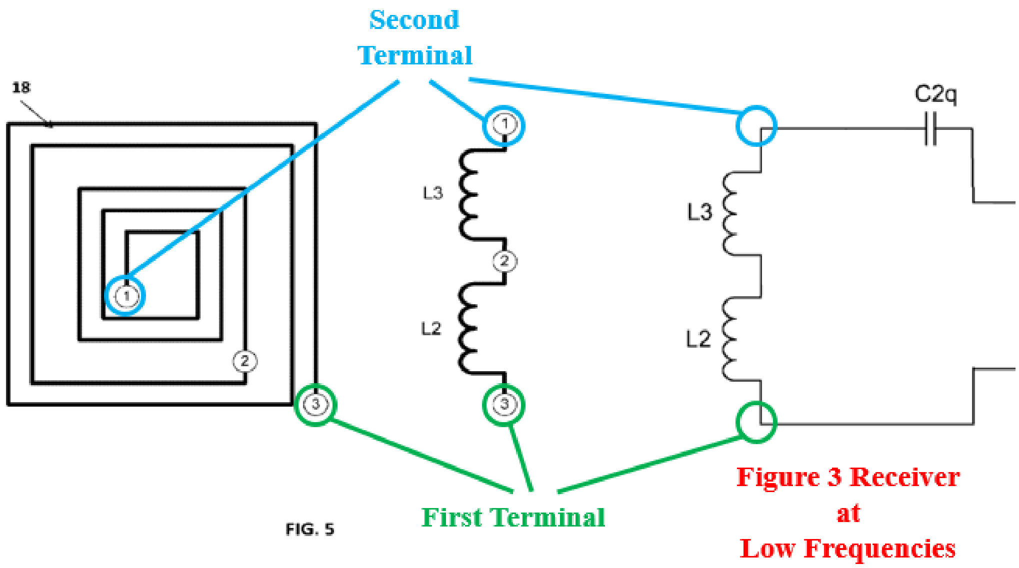
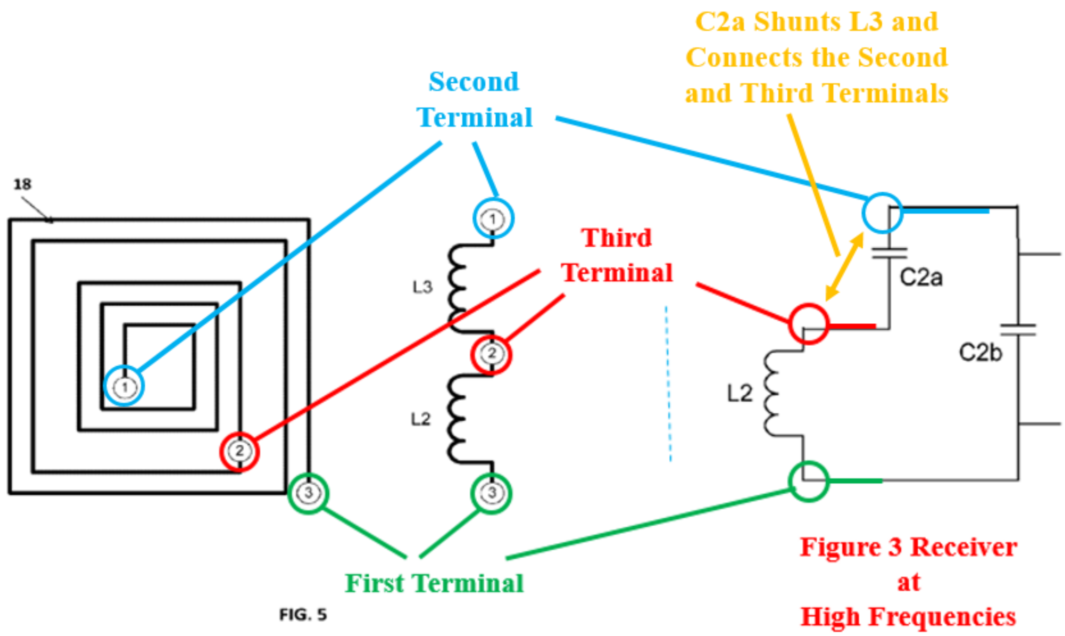


FIG. 5

(Ex. 1005, FIGs. 5 (annotated), 3 (excerpt, annotated); Ex. 1002, ¶113.)

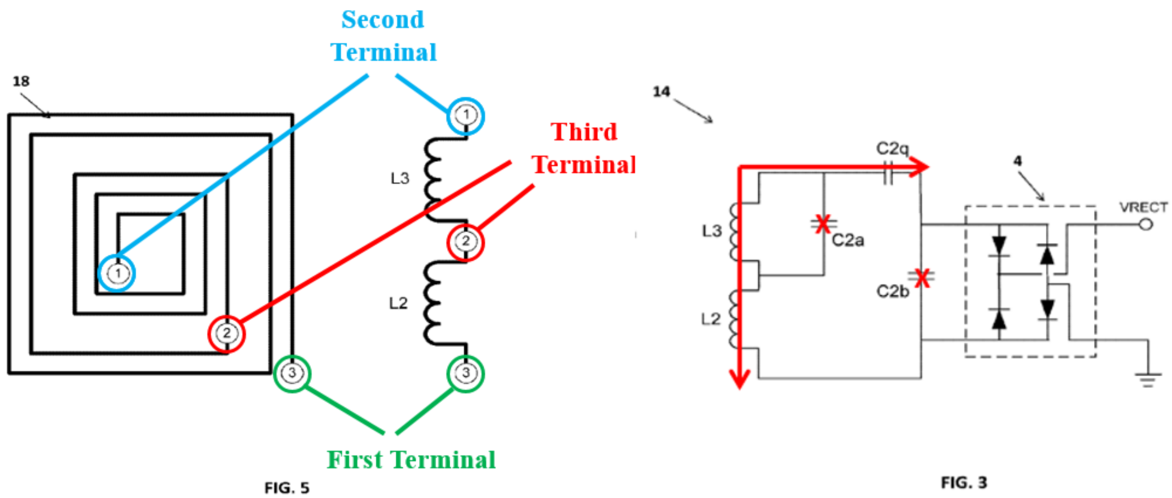
But when this electrical connection between the "first" and "second" terminals is modified because C2*a* shunts L3 so that the connection between these two terminals is through C2*a* and L2, as shown below, the effective inductance is reduced and the receiver circuit is able to resonate at 6.78 MHz.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



(Ex. 1005, FIGs. 5 (annotated), 3 (excerpt, annotated); Ex. 1002, ¶114.)

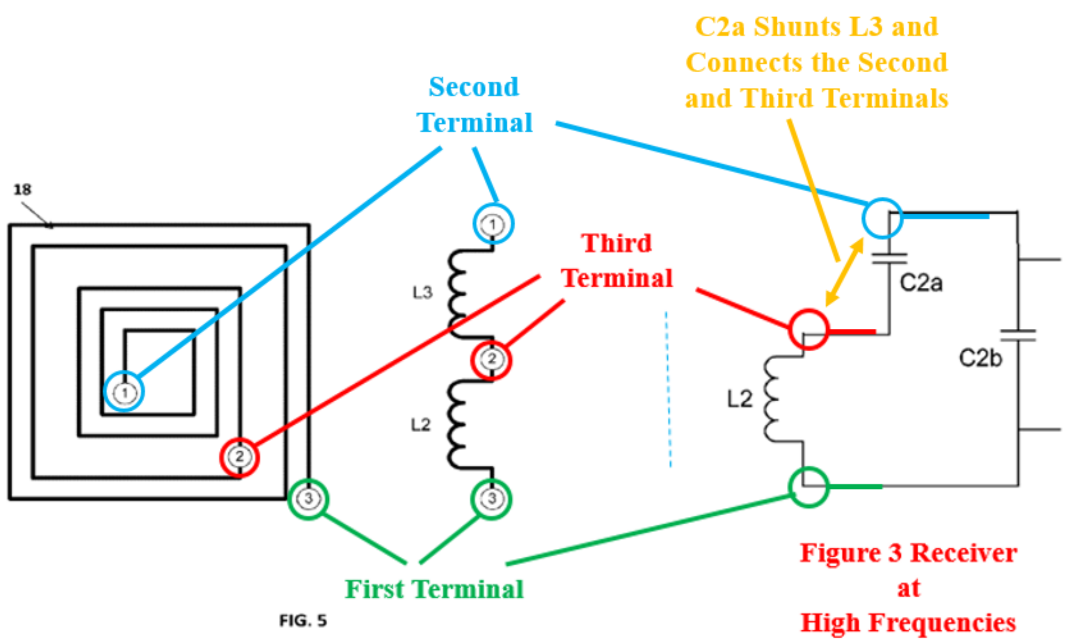
Therefore, as discussed above, selecting a connection between the "first" and "third" terminals in Riehl modifies an operating frequency of Riehl's antenna. (Ex. 1002, ¶115.) Riehl's above-described operation is consistent with the '100 patent because Riehl discloses selecting just one coil (and therefore, selecting the terminals associated with just that coil) for high frequency operation and selecting both coils (and therefore, selecting the end terminals associated with the series connection formed by the two coils) for low frequency operations. (*See* Ex. 1001, 14:44-53.)

Riehl discloses the above feature in an additional way. 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 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. (*Id.*)



(Ex. 1005, FIGs. 3, 5 (annotated); Ex. 1002, ¶116.)

But when this electrical connection between the "second" and "third" terminals is modified because C2*a* shunts L3 so that current does not flow through inductor L3 and instead flows between connection point 2 ("the third terminal") and connection point 1 ("the second terminal") through C2*a*, the antenna resonates at 6.78 MHz (Ex. 1005, ¶¶22, 25.)



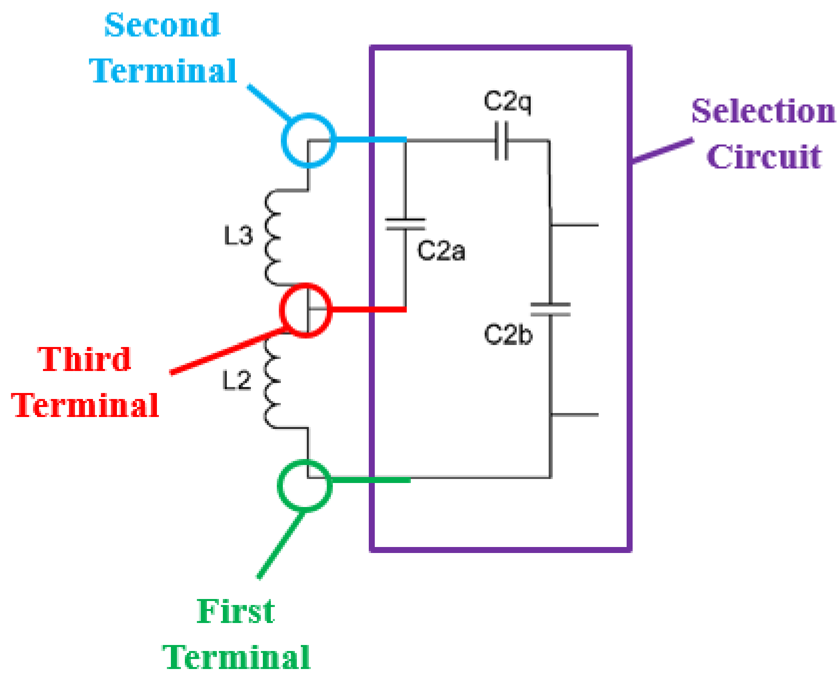
(Ex. 1005, FIGs. 5 (annotated), 3, (excerpt, annotated); Ex. 1002, ¶117.)

That is, selecting a connection between the "second" and "third" terminals via C2*a* instead of via L3 allows the operating frequency to be changed from low frequency to high frequency, and Riehl discloses the features of claim 6 for this alternative reason. (Ex. 1002, ¶118.)

5. Claim 7

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

Riehl discloses this feature. (Ex. 1002, ¶119.) As discussed above for claim 6, the selection circuit includes capacitors C2*a*, C2*b*, and C2*q*. (*See supra* Section IX.A.4; Ex. 1005, FIG. 3, ¶¶22-25.)

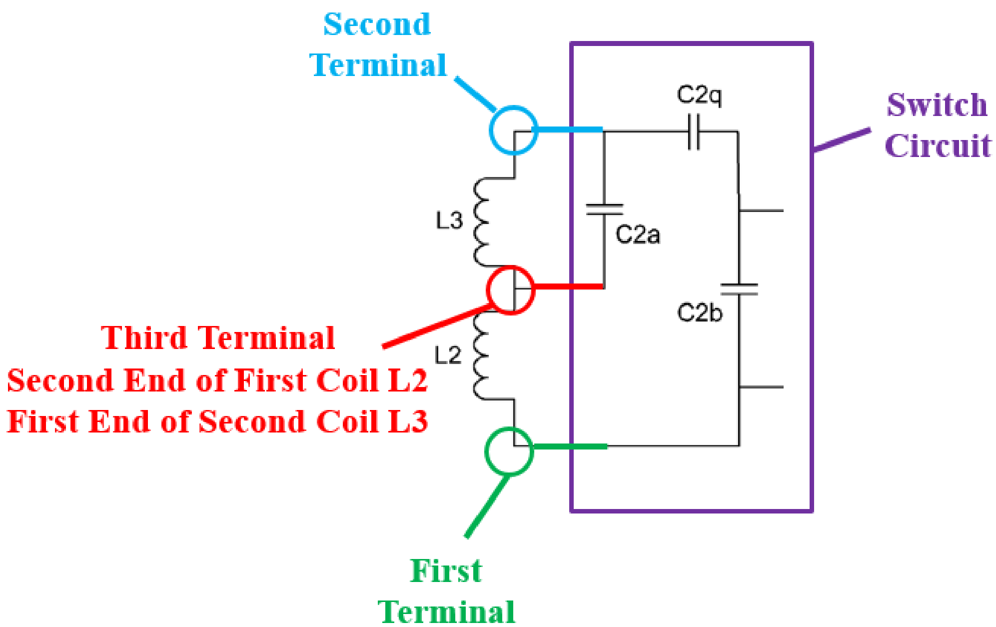


(Ex. 1005, FIG. 3 (excerpt, annotated); Ex. 1002, ¶119.)

6. Claim 8

a) **"The electrical system of claim 1, wherein the third terminal of the antenna is electrically connected to an electrical switch circuit comprising at least one capacitor, wherein the electrical switch circuit is electrically connected to the second end of the first coil and the first end of the second coil, and wherein actuation of the electrical switch electrically connects two of the three antenna terminal ends so that an antenna operating frequency is modified."**

Riehl discloses this feature. (Ex. 1002, ¶¶120-124.) For example, as discussed above with respect to claim 6, the "selection circuit" disclosed by Riehl includes capacitors C2*a*, C2*b*, and C2*q*. (*Supra* Section IX.A.4.) Those capacitors also constitute an "electrical switch circuit" in the context of claim 8. As shown in the demonstrative below, terminal 2 ("the third terminal of the antenna") is connected to the switch circuit, where the switch circuit "compris[es] at least one capacitor." The switch circuit is also connected to the inside end of coil L2 and the outside end of claim L3 ("connected to the second end of the first coil and the first end of the second coil") at the third terminal.



(Ex. 1005, FIG. 3 (excerpt, annotated); Ex. 1002, ¶120.)

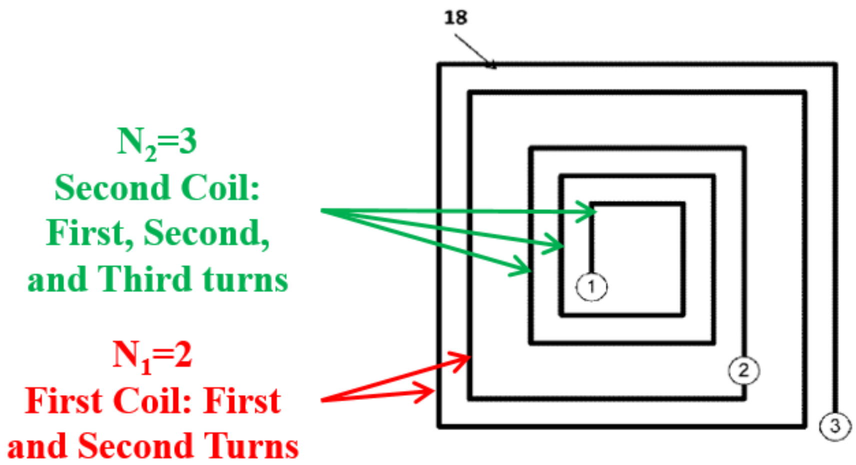
As discussed above with respect to claim 6, capacitors C2*a*, C2*b*, and C2*q* select different interconnections between the terminals corresponding to the ends of the inductors based on the frequency of operation. (*See supra* section IX.A.4.) Therefore the "electrical switch circuit" that includes C2*a*, C2*b*, and C2*q* "electrically connects two of the three antenna terminal ends so that an antenna operating frequency is modified," where "actuation of the electrical switch" corresponds to the capacitors moving between high- and low-impedance states. For example, as disclosed by Riehl, C2a has a low impedance and shunts L3 at high frequencies but has a high impedance such that it acts as an open circuit a low frequencies. (Ex. 1005, ¶¶22, 24, 25; Ex. 1002, ¶121.)

Thus, capacitors C2*a*, C2*b*, and C2*q* act to select the manner in which the inductors L2 and L3 are connected to the rectifier circuit based on the operating frequency of the disclosed receiver circuit and therefore, constitute an "electrical switch circuit." (Ex. 1002, ¶122.) Such an understanding is consistent with the disclosure of the '100 patent. (*Id.*; Ex. 1001, 11:64-12:27, FIG. 2.)

7. Claim 9

a) **"The electrical system of claim 1, wherein N_2, of the second coil, is greater than N_1, of the first coil."**

Riehl discloses or suggests this feature. (Ex. 1002, ¶¶125-126.) According to claim 1, from which claim 9 depends, N_1 is the number of turns in the first coil (the outer coil) and N_2 is the number of turns in the second coil (the inner coil). (Ex. 1001, Claim 1.) As shown in figure 5 of Riehl, the inner coil L3 has three turns and outer coil L2 has two turns ("N_2 . . . is greater than N_1").



(Ex. 1005, FIG. 5 (excerpt, annotated); Ex. 1002, ¶125.)

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, ¶126.) As disclosed by Riehl, the coil L3 ("second coil"), which is the inner coil shown in figure 5 of Riehl, has a higher inductance value than the coil L2. (Ex. 1005, ¶23 ("Let us assume that the inductance of L3 is 10x the inductance of L2.") A POSITA would have known that increasing the number of turns of a coil can be used to 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 the coil L3. (Ex. 1002, ¶126.)

8. Claim 13

a) **"The electrical system of claim 1, wherein the antenna is capable of exhibiting a quality factor greater than 10 at an antenna operating frequency of at least 10 kHz."**

Riehl discloses this feature. (Ex. 1002, ¶¶127-130.) For example, Riehl discloses the circuit topology for a resonant power receiver circuit in figure 2. (Ex. 1005, FIG. 2, ¶18.)

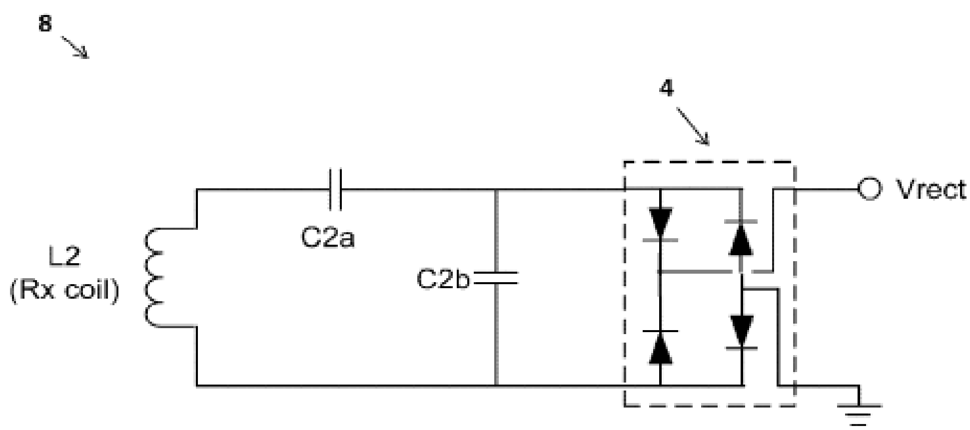


FIG. 2

(Ex. 1005, FIG. 2.)

With respect to the resonant power receiver shown in figure 2, Riehl discloses that the "inductor L2 and the capacitors C2*a* and C2*b* 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 that operating the circuit at "a relatively high frequency," will maximize the quality factor and that 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, ¶128; Ex. 1005, ¶¶18-20.)

As discussed above in section IX.A.1(c), 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(c).)

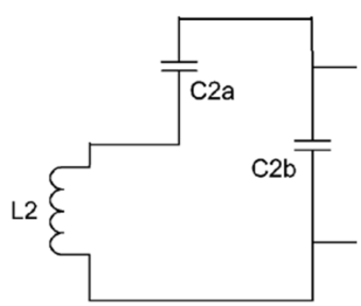


Figure 3 Receiver at High Frequencies

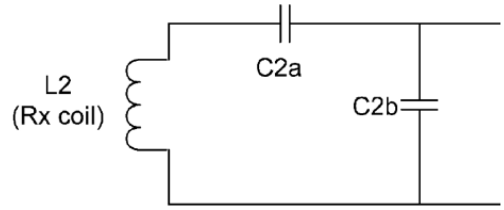


Figure 2 Receiver

(Ex. 1005, FIGs. 2, 3 (excerpts, annotated); Ex. 1002, ¶129.)

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, ¶130.) 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, ¶130; 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, ¶130.)

9. Claim 14

a) **"The electrical system 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 one of the first and second coils."**

Riehl discloses or suggests this feature. (Ex. 1002, ¶¶131-132.) 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, work by utilizing 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. (*Id.*, ¶24; *see supra* section IX.A.1(d).)

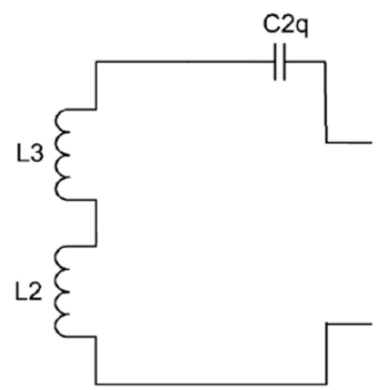


Figure 3 Receiver at Low Frequencies

(Ex. 1002, ¶131; Ex. 1005, FIG. 3 (excerpt, annotated).)

In low-frequency mode, power is received by both inductor coil L2 ("the first coil") and inductor coil L3 ("the second coil"). (*Id.*, ¶¶16, 22, 24.) Power (W) equals voltage (V) multiplied by current (I), therefore power is a combination of current and voltage (W=IR). (Ex. 1002, ¶132.) Therefore, Riehl discloses or 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 one of the first and second coils."

10. Claim 15

a) **"The electrical system 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, ¶¶133-134.) For example, Riehl discloses that "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.)

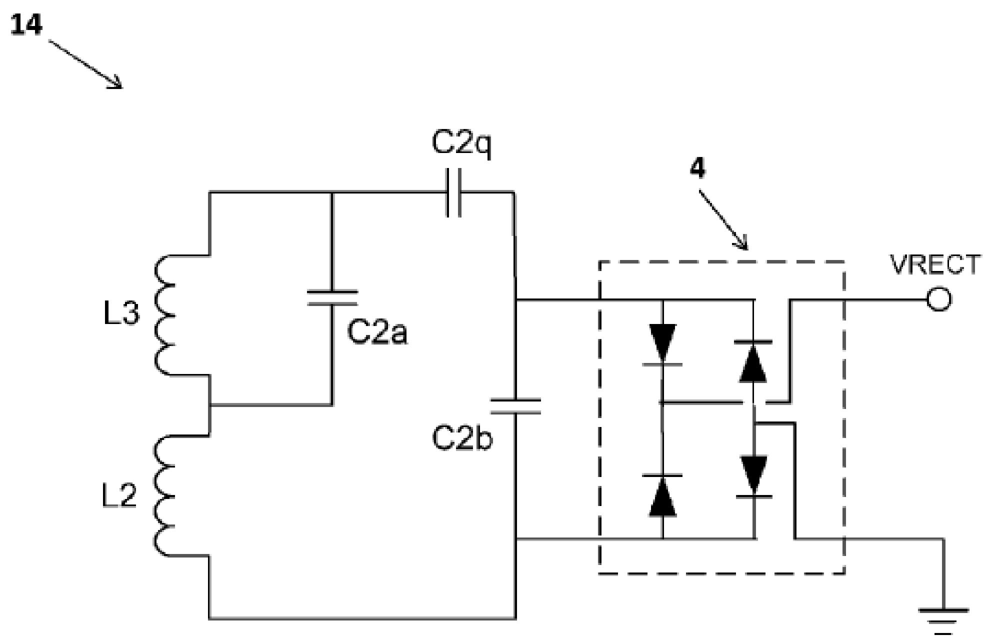


FIG. 3

(*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, ¶134.) 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.*)

11. Claim 17

a) **"The electrical system 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, ¶135.) For example, Riehl's exemplary configuration of the dual-mode power receiver shown in figure 3 receives power in the range of 110-205 kHz and at 6.78 MHz. (Ex. 1005, ¶20.)

12. Claim 18

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

Riehl discloses this feature. (Ex. 1002, ¶136.) Riehl discloses that the dual-mode power receiver 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, 30.)

13. Claim 20

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

Riehl discloses this feature. (Ex. 1002, ¶137.) As discussed above with respect to claim 14, 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; *see supra* section IX.A.9.) 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"). (*Id.*) Therefore, Riehl discloses "at least one of the first and second antenna coils is configured to receive[] a wirelessly transmitted electrical power."

14. Claim 22

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

Riehl discloses this feature. (Ex. 1002, ¶138.) As discussed above, the resonant frequency of L2 ("the first coil") is 6.78 MHz ("the first resonant frequency of the first coil of the antenna 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 of the antenna is on the order of a kHz"). (*See supra* sections IX.A.1(c)-(d).) The disclosure of this feature by Riehl is consistent with that of the '100 patent which describes similar resonant frequencies for the coils described therein. (Ex. 1001, 19:44-51.)

B. Ground 2: Riehl and Riehl IEEE Render Claims 4, 15, and 25 Obvious

1. Claim 4

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

Riehl in combination with Riehl IEEE discloses or suggests this feature. (Ex. 1002, ¶¶139-149.) As discussed above, Riehl discloses a first conductive wire forming a first coil. (*See supra* Section IX.A.1(c).)

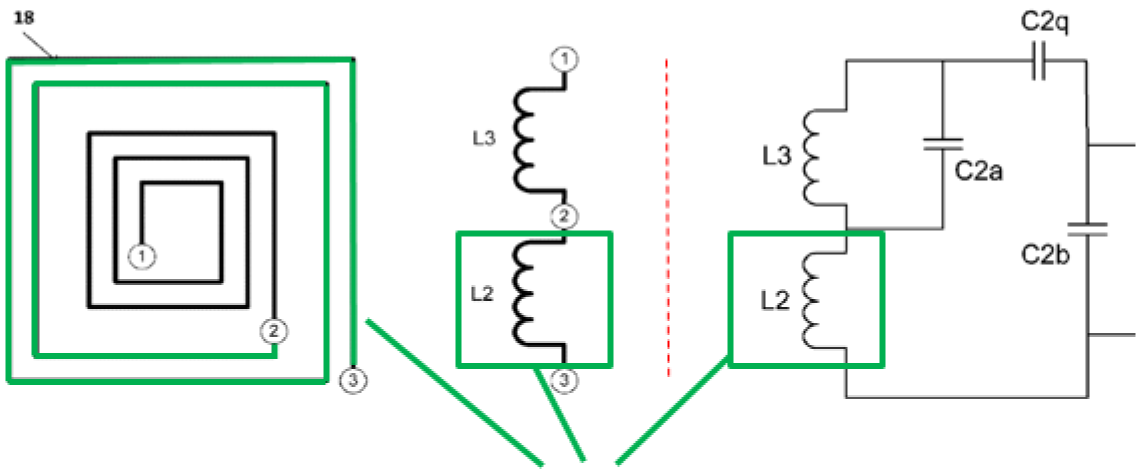


FIG. 5

FIG. 3 (excerpt)

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

Riehl, however, does not disclose the specifics as to the conductor used to form the coil corresponding to inductor L2. (Ex. 1002, ¶140.) However, as discussed below, 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.*)

Riehl IEEE, like Riehl, describes a wireless power transfer system including 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, ¶141.)

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, ¶¶142-144.)

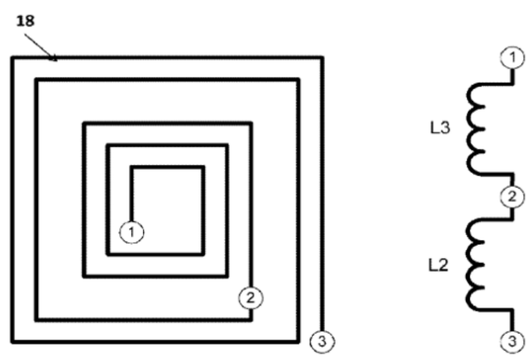


FIG. 5

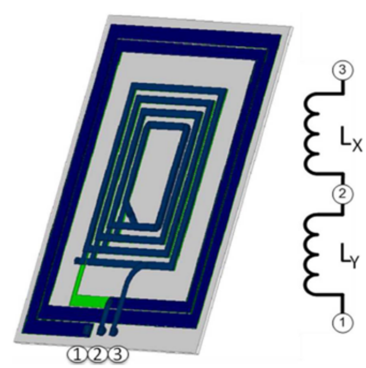


Fig. 11. Multi-mode PRU coil design.

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

Riehl IEEE further discloses that the outer coil in the dual-coil assembly is made up of multiple conducting layers that are connected in parallel. (*Id.*, 786 ("The colors in the drawing represent different conduc[t]ing layers use to make the coils. In the case of L_Y, the layers are in parallel to achieve high Q ….”).) As shown in annotated figure 11 below, the outer coil *Ly* has one conducting layer that is colored in blue that overlies and mostly obscures another conducting layer that is colored in green, where, as described by Riehl IEEE, the blue and green conducting traces are connected in parallel. (*Id.*, 786, FIG. 11.)

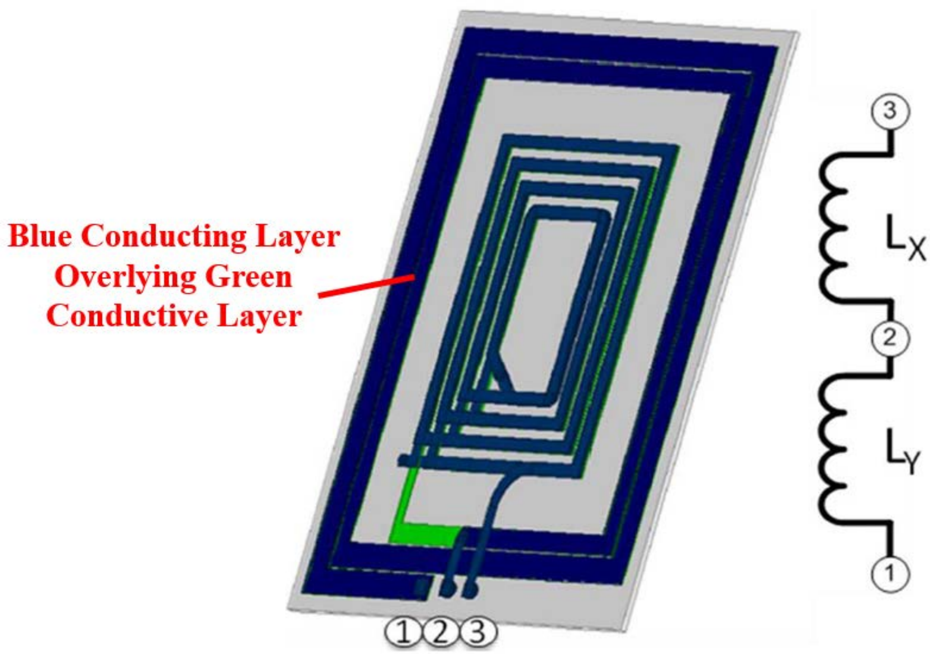


Fig. 11. Multi-mode PRU coil design.

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

Given the disclosure of a multi-conducting-layer coil in Riehl IEEE, a POSITA would have been motivated 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 as taught by Riehl IEEE. (Ex. 1002, ¶¶146, 148-149.) A POSITA would have been motivated to do so because a coil with multiple conductive traces coupled together in parallel provides for a high quality factor (Q), which is desirable in order to provide efficient power transfer in the wireless power transfer system. (*Id.*, Ex. 1006, 786, 781.) Indeed, "'if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.'" *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 (a wireless power receiver) ready for improvement to achieve the expected and desired result of an increased Q factor. *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416-17 (2007) ("*KSR*").

Moreover, a POSITA would have understood that including multiple conductive traces or wires in parallel was commonplace in inductors at the time of the alleged invention. (Ex. 1002, ¶147.) Such an understanding is supported by Kanno, which the Examiner relied upon during prosecution of the '100 patent. (Ex. 1004, 313, 442 ("Kanno further teaches . . . wherein the first or second conductive wire comprises two or more filars electrically connected in parallel (see Figs. 12 and 13, wires 20).").) Indeed, during prosecution Applicant agreed that Kanno teaches "a parallel wiring structure." (Ex. 1004, 370-371, citing Ex. 1007, ¶60.)

Therefore, in the Riehl-Riehl IEEE combination it would have been obvious to form the outer coil L2 using multiple conductive traces coupled together in parallel such that the Riehl-Riehl IEEE combination discloses "the first conductive wire comprises two or more filars electrically connected in parallel" as recited in claim 4.

2. Claim 15

a) "The electrical system 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 Riehl IEEE discloses or suggests this feature. (Ex. 1002, ¶¶150-155.) As demonstrated above in section IX.A.10, this feature is disclosed or suggested by Riehl. However, to the extent Patent Owner argues or the Board finds that the Riehl does not disclose or suggest the feature recited in claim 15, Riehl IEEE discloses this transmitting data using the coils of the power receiver and it would have been obvious for a POSITA to modify the dual-mode power receiver of Riehl based on the disclosure of Riehl IEEE to include such a feature. (Ex. 1002, ¶150.)

Riehl IEEE discloses that in addition to the in-band signaling 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 that is used to transmit data back to the power transmitter.

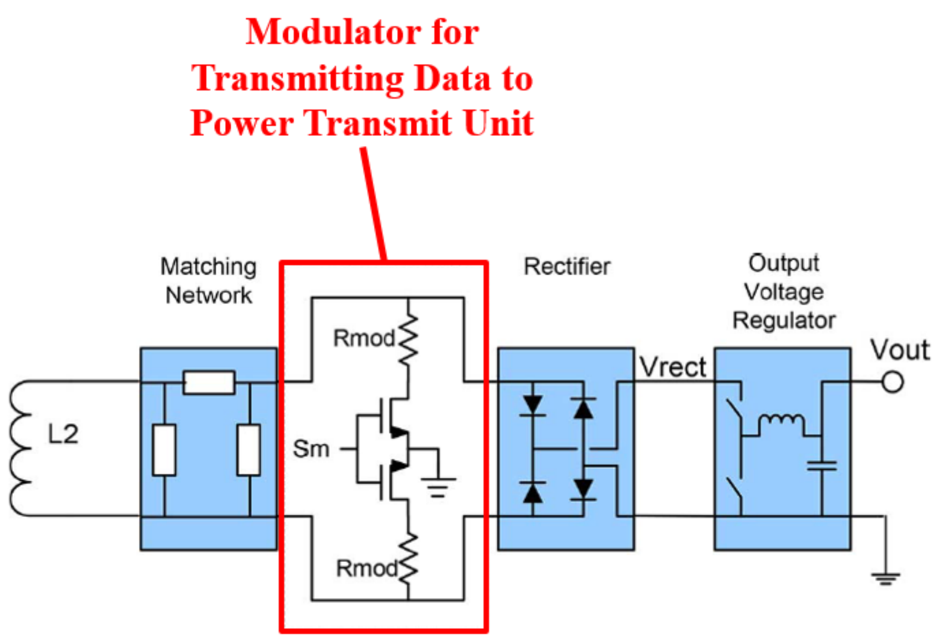


Fig. 6. In-band communications modulator (in dashed box).

(Ex. 1006, FIG. 6 (annotated); Ex. 1002, ¶151.)

As discussed above with respect to claim 4, 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 as disclosed 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, ¶152.) Moreover, a POSITA would have understood that 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.)

Riehl does not provide specific disclosure as to transmission of data from the disclosed dual-mode receiver to the transmitter, such as data used to identify power receiving units that want to receive power or other information used by the power transmitter. (Ex. 1002, ¶153.) Therefore, a POSITA would have looked to teachings associated in-band data communications, such as those disclosed by Riehl IEEE, so that the receiver in Riehl could support data transmission capabilities. (*Id.*) Accordingly, a POSITA would have combined the teachings of Riehl and Riehl IEEE as 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. (*Id.*) *Unwired Planet*, 841 F.3d at 1003.

Including data transmission capabilities, such as those supported by the in-band communication modulator shown in figure 6 of Riehl IEEE, in the dual-mode power receiver of the Riehl-Riehl IEEE combination would have merely been the application of a known technique (providing circuitry for data transmission in a power receiver as disclosed in Riehl IEEE) to a similar device (a wireless power receiver as disclosed in Riehl) ready for improvement to achieve an expected and desired result (data transmission capability). (Ex. 1002, ¶154-155.) *KSR*, 550 U.S. at 417.

3. Claim 25

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 suggest this feature. (Ex. 1002, ¶¶156-160.) Riehl does not explicitly disclose inductor coils L2 or L3 operating at a current exceeding 500 mA. Riehl IEEE, however, discloses this feature, and it would have been obvious for a POSITA to combine the teachings of Riehl IEEE with Riehl such that the at least one of the inductor coils L2 and L3 operates at a current exceeding 500mA.

Riehl IEEE discloses that "[t]he multi-mode PRU converts 5W 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 (1A, or

1,000 mA) as current equals power divided by voltage. (Ex. 1002, ¶157.) A POSITA would also have understood that, based on the circuit topology of Riehl IEEE's power receiver, all of the 1A of current would flow through at least one of the coils included in the power receiver. (*Id.*; Ex. 1006, FIGs. 4, 8, 14.) Therefore, Riehl IEEE discloses that 1A of current would flow through the respective coils when operating in either high-frequency Rezence mode or low frequency Qi or PMA mode.

Riehl, however, does not disclose the specifics as to the voltages, current, and power levels corresponding to the dual-mode power receiver illustrated in figure 3. As discussed above with respect to claim 4, 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, ¶158.)

Given the disclosure of the example voltages and currents used during power transfer in Riehl IEEE, it would have been obvious for a POSITA to operate the power receiver in Riehl such that 1A of current flows through one or both of the coils as taught by Riehl IEEE. (Ex. 1002, ¶159.)

C. Ground 3: Riehl and Kanno Render Claim 12 Obvious

1. Claim 12

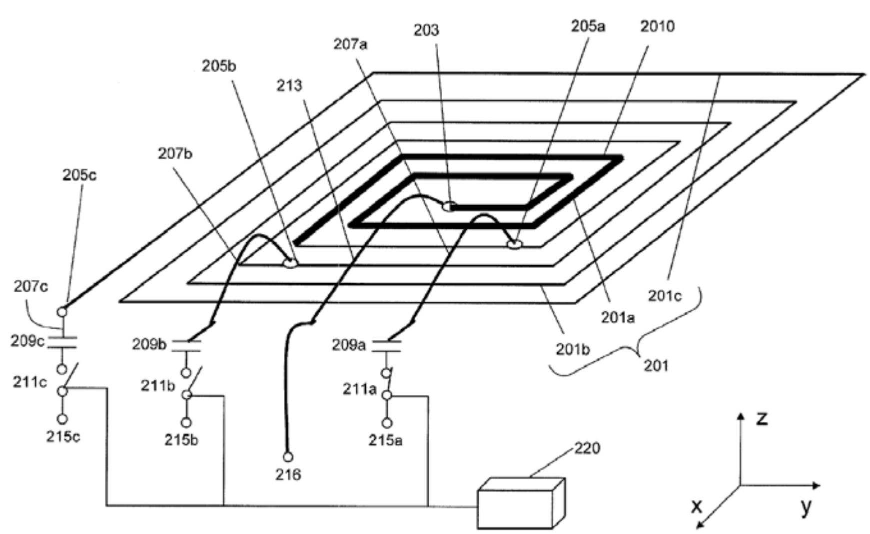
a) **"The electrical system of claim 1, wherein at least the first or second coil has a variable wire width."**

Riehl in combination Kanno discloses or suggests this feature. (Ex. 1002, ¶¶161-165.) 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 and, in view of Kanno, a POSITA would have been motivated to use a variable wire width for at least one of the first and second conductive wires corresponding to the coils in Riehl. (*Id.*)

Kanno, like Riehl, relates to a wireless power transfer using a resonant magnetic field. (Ex. 1007, ¶13.) Therefore, a POSITA implementing the receiver of Riehl would have had reason to look to Kanno. (Ex. 1002, ¶162.)

Kanno discloses a coil structure that is made up of a wire having a variable wire width. 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, ¶163.)

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, ¶164.) 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, ¶164.)

It would have been obvious for a POSITA 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, ¶165.) 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.*)

D. Ground 4: Riehl and Sung Render Obvious Claim 16

1. Claim 16

a) **"The electrical system of claim 1, wherein the antenna substrate is a flexible substrate that comprises a material composed of an electrically insulative material selected from the group consisting of a polyimide, an acrylic, fiberglass, polyester, polyether imide, polyetheretherketone (PEEK), polyethylene napthalate, fluropolymers, copolymers, a ceramic material, a ferrite material, and combinations thereof."**

Riehl in combination with Sung discloses or suggests this feature. (Ex. 1002, ¶¶166-170.) Riehl discloses that its receiver can be implemented on a printed circuit board or any planar mass-production process. (Ex. 1005, ¶28.) Particularly, Riehl discloses that because of the limited area available within a portable electronic device, it is advantageous to minimize the thickness of the coil assembly. (*Id.*) Riehl, however, does not explicitly disclose that the substrate on which the coils are formed is a flexible substrate or is made of one of the materials listed in claim 16. Sung, however, discloses the use of a flexible substrate, and it would have been obvious for a POSITA to implement the wireless power receiver of Riehl such that the coils are formed on a flexible substrate based on the disclosure of Sung. (Ex. 1002, ¶¶166-170.)

Similar to Riehl, Sung is directed to a wireless power transfer device for use in mobile devices. (Ex. 1002, ¶167; Ex. 1008, Abstract, ¶¶54-61, FIGs. 1, 7A.)

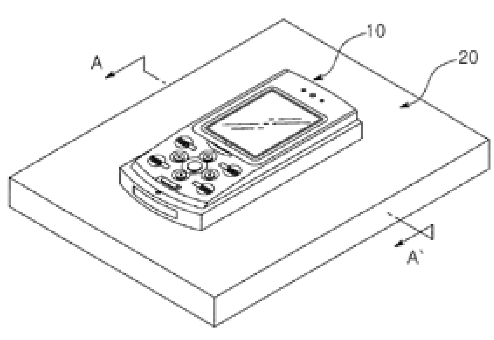


FIG. 1

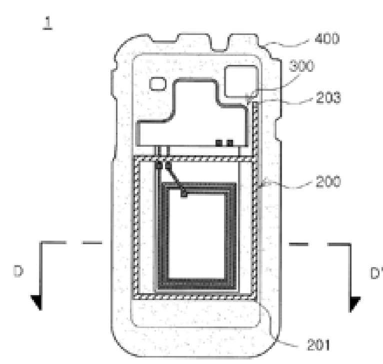


FIG. 7A

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

Sung identifies that there is a need to develop a contactless power transmission device having a reduced thickness.[9] (Ex. 1008, ¶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.) Sung discloses an embodiment wherein the flexible substrate is a flexible printed circuit board (FPCB) made of polyimide ("composed of an electrically insulative material selected from the group consisting of a polyimide . . . ."). (*Id.*, ¶¶21, 65.) Sung explains that 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 the two 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, which discloses specific materials that can be used as a substrate such as a PCB. (Ex. 1002, ¶168.)

It would have been obvious for a POSITA to use a polyimide flexible PCB as disclosed Sung for the printed circuit board disclosed in Riehl. (Ex. 1002, ¶¶169-170.) As taught by Sung, having a flexible PCB provides a number of benefits (e.g.

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

reduced costs, reduced thickness). Therefore, in view of Sung, a POSITA would have been motivated to use a polyimide flexible printed circuit board in a power receiver as disclosed in Riehl. (*Id.*) Indeed, implementing the printed circuit board disclosed in Riehl as a polyimide flexible printed circuit board according to the teachings of Sung would have been nothing more than using a known technique (using a polyimide flexible printed circuit board as described in Sung) for a known device (the printed circuit board used for the coils in the power receiver disclosed by Riehl) to yield a predictable result (an coil arrangement that provides reduced cost and reduced thickness). (*Id.*)

E. Ground 5: Riehl and Kazuya Render Claim 23 Obvious

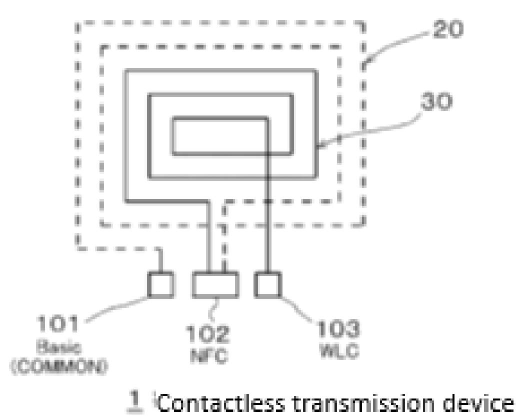
1. Claim 23

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 in combination with Kazuya discloses or suggests these features. (Ex. 1002, ¶¶171-175.) Riehl does not explicitly disclose the inductance of either of the coils L2 and L3 when the receiver operates at low frequency (e.g. 100 kHz). (Ex. 1005, ¶24.) But Kazuya discloses using a coil with an inductance value within the claimed inductance range when operating within the claimed frequency range, and, in view of Kazuya, a POSITA would have been motivated to implement at least one of the coils in Riehl according to the teachings of Kazuya. (Ex. 1002, ¶¶171-175.)

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.").) As shown in figure 3 below, Kazuya's device includes a first coil 20, which is shown as the outer coil in figure 3, and a second coil 30, which corresponds to the inner coil, where the first and second coils share a common terminal 102 (Ex. 1009, ¶22, FIG. 3). As disclosed by Kazuya, "[f]irst coil 20 is positioned outside of second coil 30, and both are substantially concentrically arranged and substantially rectangular as viewed from above." (*Id.*, ¶24.) Kazuya's configuration is therefore similar to figure 3 of Riehl, and a POSITA implementing the receiver of Riehl would have had reason to look to Kazuya. (Ex. 1002, ¶171.)

[FIG. 3]



(Ex. 1009, FIG. 3.)

Kazuya discloses that the transmission device 1 can operate as "contactless communication coil" for sending and receiving signals from other devices and as a "contactless power supply coil" for supplying power of the mobile device's battery. (*Id.*, ¶25.) When transmission device 1 operates as a "contactless communication coil," only the outer coil (i.e., first coil 20) is used whereas when the device 1 operates as a "contactless power supply coil," both coils 20 and 30 are used. (*Id.*, ¶¶25-29.) Kazuya explains that the inductance of the outer coil 20 is between 1 – 4μH. (*Id.*, ¶29.) But the inductance of both coils 20 and 30 is "8 – 24μH (at 100 – 300kHz)." (*Id.*) This is because "the inductance for the contactless power supply coil must be 8 – 24μH" and the "contactless power supply coil" is a series connection of the coils 20 and 30. (*Id.*, FIG. 3; Ex. 1002, ¶172.) Accordingly, a POSITA would have understood that the inductance of the inner coil 30 is between 4 – 23 μH in Kazuya because when two inductors are in series, the total inductance is the sum of the individual inductances. (Ex. 1002, ¶172.) Accordingly, Kazuya discloses "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" because it discloses that the inner coil 30 has an inductance between 4 – 23 μH at 100 – 300kHz. (*Id.*)

It would have been obvious for a POSITA to implement the coils disclosed in the power receiver of Riehl based on Kazuya such that at least one of the coils L2 and L3 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. (Ex. 1002, ¶173.) 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. 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(d)) does not disclose any specific inductance values for the inductors L2 and L3 when the operating frequency is 100 kHz (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 23. (Ex. 1002, ¶173.)

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). (*Id*., ¶174.) *KSR*, 550 U.S. at 416-21. Using such coils with particular inductance values in Riehl's power receiver would have been straightforward for a POSITA to implement, and a POSITA would have thus had reason and the capability to implement the one or more of the coils L2 and L3 based on Kazuya as noted above. (Ex. 1002, ¶174.)

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, ¶175.) This is confirmed by Riehl, which discloses that the inductor and capacitor values are selected in order to establish the desired resonance at the power transfer frequencies, including the 100 kHz frequency used in conjunction with the Qi specification. (*Id.*; Ex. 1005, ¶24.)

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." *In re Boesch*, 617 F.2d 272, 276 (C.C.P.A. 1980); *In re Aller*, 220 F.2d

454, 456 (C.C.P.A. 1955); *see also In re Applied Materials, Inc.*, 692 F.3d 1289, 1295 (Fed. Cir. 2012). This is especially true given that the '100 patent provides no evidence that the claimed inductance range produces a new or unexpected result (Ex. 1002, ¶176) and thus the claimed range cannot form the basis of patentability given the claimed inductance range for the specified frequency range is a result-effective variable. *In re Boesch*, 617 F.2d at 276; *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990). Indeed, there is no criticality associated with this range because the '100 patent does not even provide any disclosure of the claimed range. (Ex. 1002, ¶176.)

F. Ground 6: Riehl and Yu Render Claims 1-3, 5-9, 13-15, 17-20, 22, and 24 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(e).) Figure 5 of Riehl depicts the third gap as larger than the first and second gaps, and, as discussed above with respect to claim feature 1(d), Riehl discloses or suggests "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." (*See supra* section IX.A.1(e).)

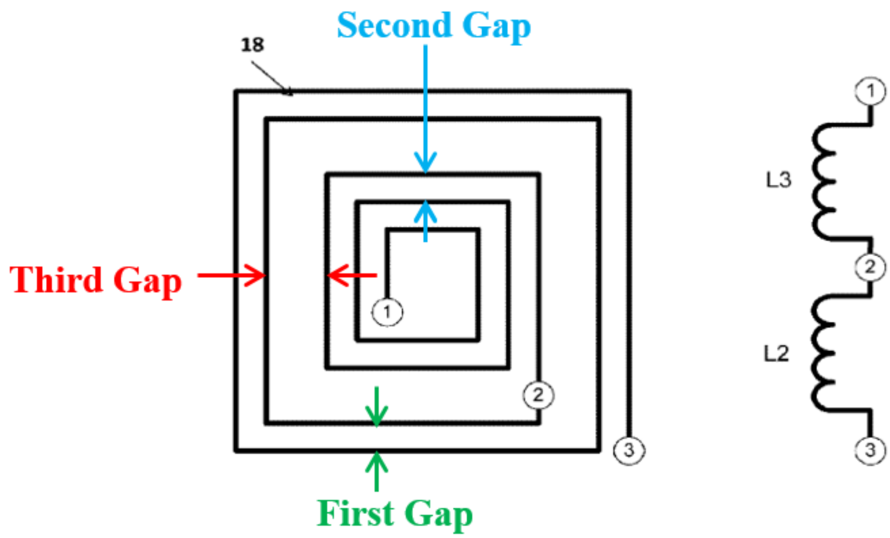


FIG. 5

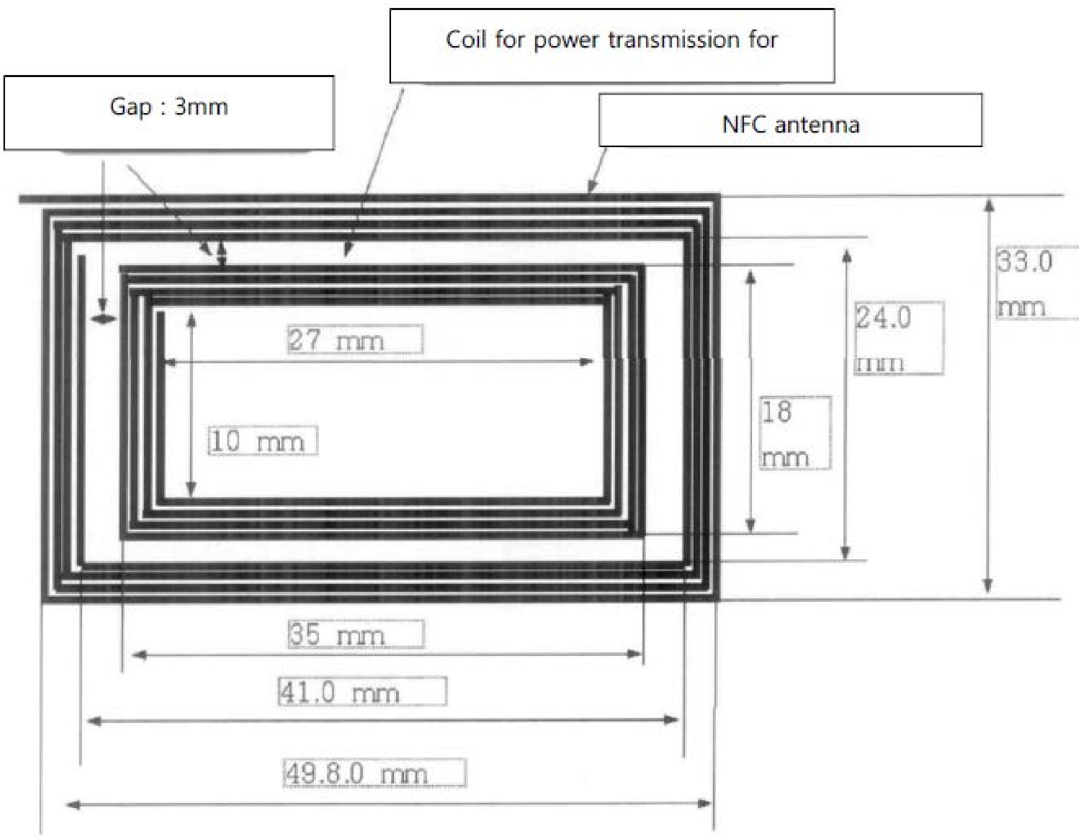
(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶177.)

However, to the extent that Patent Owner argues or the Board finds that Riehl does not disclose or suggest that the third gap depicted in annotated figure 5 above is greater than the first and second gaps, it would have been obvious in view of Yu to make the third gap greater than the first and second gaps. (Ex. 1002, ¶¶177-185.)

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.)

Fig. 6

Example of a coil for power transmission for wireless charging mounted within an NFC antenna



(*Id.*, FIG. 6.)

Like the '100 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 turns of the outer coil are separated by 0.2 mm, while the turns in the inner coil are separated by 0.1 mm. (*Id.*, ¶¶143-160; Ex. 1002, ¶181.) The inner and outer coils are separated by 3.0 mm. (Ex. 1011, ¶¶159-160; Ex. 1002, ¶181.) 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. (*Id.*; Ex. 1002, ¶182.) As Yu discloses, 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 . . . ." (*Id.*, ¶36, ¶165.)

Yu 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 '100 patent. (Ex. 1001, 21:16-17; *see also*, *e.g.*, *id.*, 20:54-59; Ex. 1002, ¶183.) Riehl IEEE and Mukherjee further confirm this. (Ex. 1006, 786 ("LX and LY are physically spaced apart to minimize the mutual inductance between them."); *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 than the gap between the turns within the individual coils. (Ex. 1002, ¶184.) 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. (*Id.*)

Forming the coils L2 and L3 such that the third gap between the coils is greater than the gaps between turns in each of the coils would have merely been the use of a known technique (having a larger gap between the coils than the gap between the turns in the coils as disclosed in Yu) to a similar device (the coil arrangement of the dual mode power receiver of Riehl) ready for improvement to achieve the expected and desired result of an operational antenna. (*Id.*, ¶185.) *See KSR*, 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, ¶185.)

2. Claims 2, 5-9, 13-15, 17, 18, 20, and 22

Riehl in combination with Yu discloses or suggests the limitations of these claims for reasons similar to those discussed in Sections IX.A.2-14; Ex. 1002, ¶186.) 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. (Ex. 1002, ¶186.) The combination of Yu with Riehl does not affect the analysis for these claims as set forth in Section IX.A.

3. Claim 3

a) **"The electrical system 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, ¶¶187-193.) As discussed above, Riehl discloses a third gap between the first and second coils. (*See supra* section IX.A.1(e).)

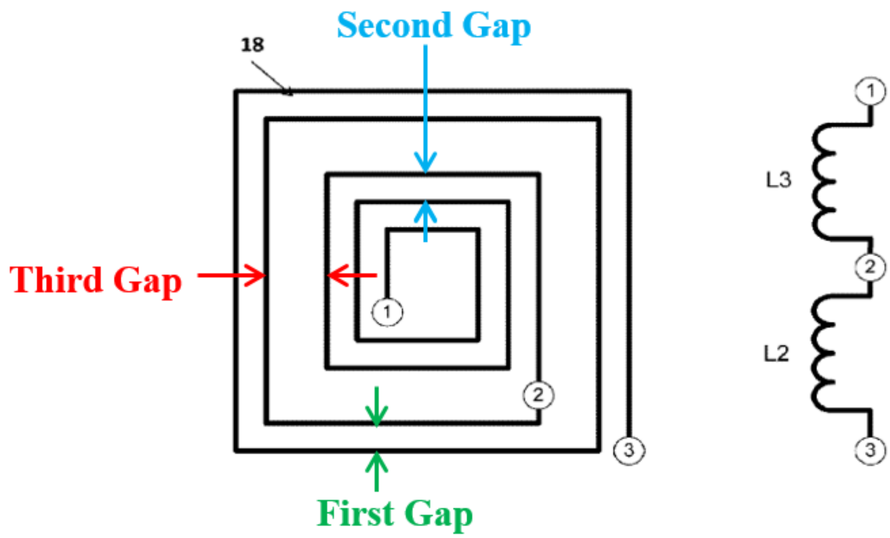
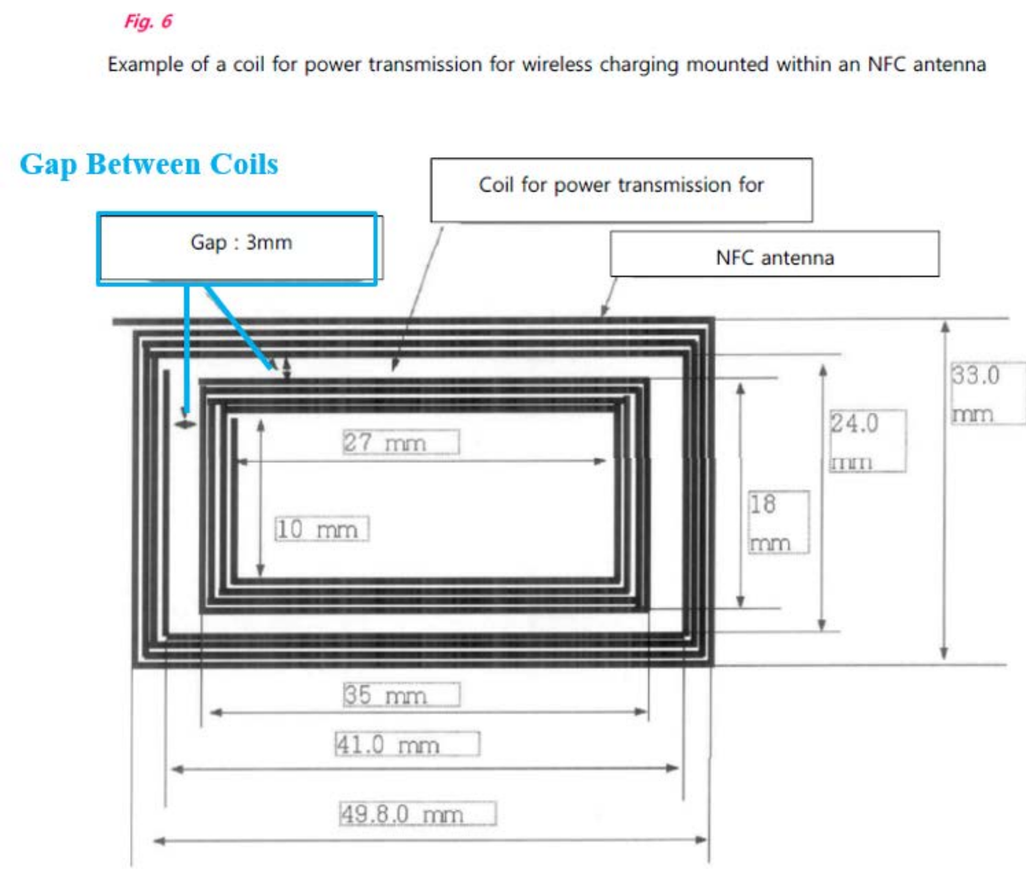


FIG. 5

(Ex. 1005, FIG. 5 (annotated); Ex. 1002, ¶187.)

Riehl, however, does not disclose the specific dimensions of the coil assembly 18 depicted in figure 5, including the size of the third gap. (Ex. 1002, ¶188.) However, as discussed above, Yu discloses a coil assembly having dimensions corresponding to 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, ¶189.)

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 that another embodiment where the gap is "2.0 to 9mm." (*Id.*, ¶36.) Therefore, Yu discloses that the gap between the two coils in Yu is "at least 0.1 mm." (Ex. 1002, ¶190.)

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, ¶191.) A POSITA at the time of the alleged invention of the '100 patent 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 (disclosing that the distance D between the coils is used to reduce the mutual coupling between the inner and outer parts of the antenna structure)[10].) 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, ¶191.) 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 receiver in which the mutual inductance between the coils is reduced by the gap. (*Id.*) *Unwired Planet,* 841 F.3d at 1003.

Forming the inductor coils disclosed by the Riehl-Yu with a gap of at least 0.1 mm would have merely been the application of a known technique (providing separation between the coils of at least 0.1 mm) to a similar device (a wireless power

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

receiver) ready for improvement to achieve the expected and desired result reduced mutual inductance between the coils. (Ex. 1002, ¶192.) *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 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 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, ¶193.) 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." *In re Aller*, 220 F.2d at 456. This is especially true given that the '100 patent provides no evidence that the *entirety* of the claimed range produces a new or unexpected result; thus the claimed range cannot form the basis of patentability. *In re Boesch*, 617 F.2d at 276; *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990).

4. Claim 19

a) **"The electrical system of claim 1, wherein the third gap disposed between the inner perimeter of the first coil and the outer perimeter of the second coil of the antenna ranges from about 0.1 mm to about 10 mm."**

Riehl in combination with Yu discloses or suggests this feature. (Ex. 1002, ¶¶194-199.) As discussed above with respect to claim 3, Yu provides example dimensions corresponding to the coil arrangement disclosed, and Yu provides numerous examples where the "gap disposed between the inner perimeter" of the outer coil and the "outer perimeter" of the inner coil has a dimension that is within the claimed range of 0.1 to 10mm. (*See supra* section IX.F.3; Ex. 1011, FIG. 6, ¶¶36, 159-160, 165; Ex. 1002, ¶¶194-196.)

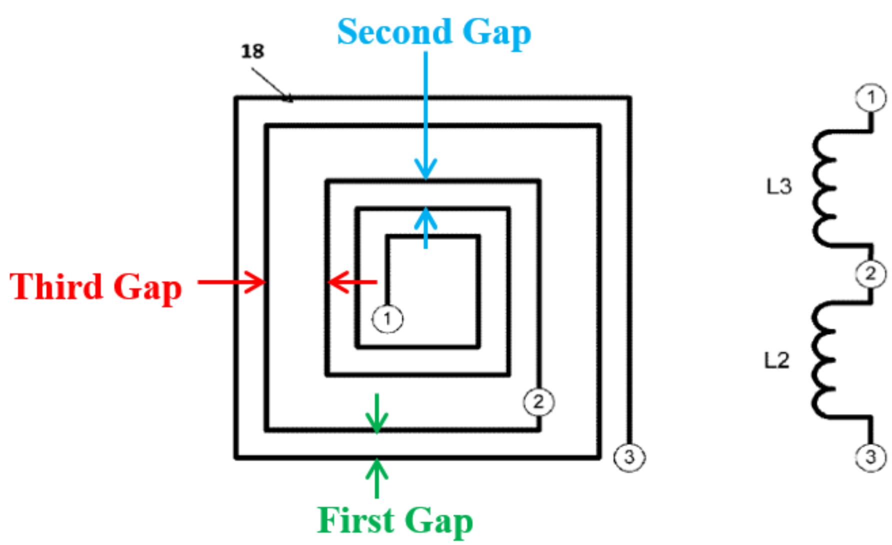


FIG. 5

(Ex. 1004, FIG. 5 (annotated); Ex. 1002, ¶194.)

As also discussed above with respect to claim 3, a POSITA would have understood that while a larger gap between the coils minimizes mutual inductance between the coils, space concerns dictate the need to limit the size of the coil arrangement. (*See supra* section IX.F.3; Ex. 1002, ¶197; Ex. 1011, ¶¶28-29, 36, 165; *see also* Ex. 1010, ¶12.)

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, ¶198.) 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 coils such as those disclosed in Riehl 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, ¶198.) *Unwired Planet,* 841 F.3d at 1003.

Forming the inductor coils disclosed by the Riehl-Yu combination such that the gap between the coils ("the third gap disposed between the inner perimeter of the first coil and the outer perimeter of the second coil of the antenna") "ranges from about 0.1 mm to about 10 mm" would have merely been the use of a known technique (providing separation between the coils of between 0.1 mm and 10 mm) to a similar device (a wireless power receiver having two coils) ready for improvement to achieve the expected and desired result reduced mutual inductance between the coils. *KSR*, 550 U.S. at 417.

Moreover, the claimed range is rendered obvious based on the teachings of Riehl and Yu because, as discussed above with respect to claim 3 (*supra* section IX.F.3), the size of the gap between the coils is a result-effective variable that determines the amount of mutual inductance between the coils 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, ¶199.) *In re Aller*, 220 F.2d at 454. The '100 patent provides no evidence that the entirety of the claimed gap-size range produces a new or unexpected result and thus the claimed range, which involves a result-effective variable, cannot form the basis of patentability. *In re Boesch*, 617 F.2d at 276; *In re Woodruff*, 919 F.2d at 1578.

As disclosed by the '100 patent, the patentee experimented with different gap-sizes and found that the claimed range reduces of the amount of mutual inductance between the first and second coils. (Ex. 1001, 21:20:54-22:47.) But such experimentation cannot establish that the claimed range produced an "unexpected result" because those "test results were [not] unexpected in light of the state of scientific knowledge at the time" (as demonstrated by Yu, Riehl IEEE, and Mukherjee). *See In re Geisler*, 116 F.3d 1465, 1470 (Fed. Cir. 1997).

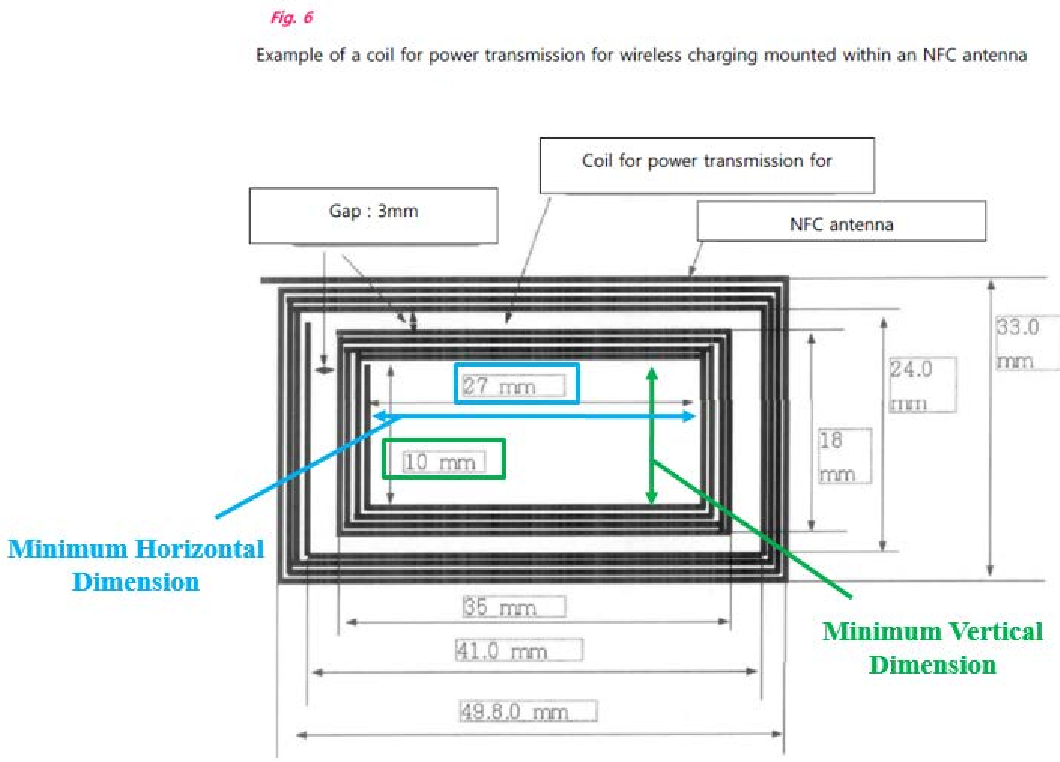
Accordingly, because the claimed gap-size range is recognized as a result-effective variable and the '100 patent does not disclose any criticality or unexpected results associated with the claimed inductances, and the claimed range overlaps with the prior art range, claim 19 is rendered obvious for this additional reason.

5. Claim 24

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, ¶¶200-204.) Riehl does not provide any specific dimensions associated with the coils L2 and L3 shown in the dual-mode power receiver of figures 3 and 5. As discussed in detail below, Yu discloses example dimensions for coils used in a two-coil structure similar to that disclosed in Riehl, where Yu's disclosure includes examples of coils having a surface area exceeding 120 mm^2, and it would have been obvious for a POSITA to implement at least one of the coils L2 and L3 in Riehl to have a surface area exceeding 120 mm^2 in view of Yu. (*Id.*)

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, ¶201.)

As further disclosed by Yu, 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, even assuming that all of the turns have the minimum width and height dimensions of the innermost turn (27 mm and 10 mm), the length of the trace for each turn is at least 10 + 27 + 10 + 27 = 74 mm in order to account for both vertical sides of the turn and both horizontal sides of the turn. (Ex. 1002, ¶202.) Therefore, even if the surface area for the coil corresponds to only the surface area of the traces of the turns of the coil, the surface area of the inner coil in figure 6 of Yu is at least (74 mm (total length of the turn) x

0.9 mm (width of the turn) = 66.6 mm^2 per turn) x 4 turns = 266.4 mm^2. If the surface area for each coil includes the gaps between the turns and/or the space within the innermost turn of the coil, then the surface area is even larger. Notably, the outer coil, which has larger dimensions and the same trace width, has an even greater surface area. Therefore, Yu discloses coils having a surface area exceeding 120 mm^2. (*Id.*)

As discussed above with respect to claim 1, a POSITA would have had reason to look to Yu when implementing the dual-mode receiver of Riehl. (*See supra* section IX.F.1.) Given the disclosure of the coil size in Yu, 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 24. (Ex. 1002, ¶203.) As Yu discloses, one of the inductors illustrated in figure 6 is used to support power transfer at 100 kHz. The 100 kHz same power transfer frequencies are used in Riehl, and a POSITA would have understood that inductors having the characteristics used in Yu would also be appropriate for use in Riehl. 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 24. (*Id.*)

Indeed, implementing one or both of L2 and L3 of Riehl according to the teachings of Yu would have been nothing more than using a known technique (using inductors with dimensions providing a surface area greater than 120 mm^2 as described in Yu) 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, ¶204.) *KSR*, 550 U.S. at 416-21. Using such a coil with a surface area greater than 120 mm^2 in Riehl's power receiver would have been straightforward for a POSITA to implement, and a POSITA would have thus had reason and the capability to implement the one or more of the coils L2 and L3 based on Yu as noted above. (Ex. 1002, ¶204.)

G. Ground 7: Riehl, Yu, and Riehl IEEE Render Claims 4, 15, and 25 Obvious

The combination of Riehl, Yu, and Riehl IEEE discloses or suggests the features of claims 4, 15, and 25 for similar reasons to those discussed above in section IX.B. (Ex. 1002, ¶205.) 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 12 Obvious

The combination of Riehl, Yu, and Kanno discloses or suggests the features of claim 12 for similar reasons to those discussed above in section IX.C. (Ex. 1002, ¶206.) 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 16 Obvious

The combination of Riehl, Yu, and Sung discloses or suggests the features of claim 16 for similar reasons to those discussed above in section IX.D. (Ex. 1002, ¶207.) 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 23 Obvious

The combination of Riehl, Yu, and Kazuya discloses or suggests the features of claim 12 for similar reasons to those discussed above in section IX.E. (Ex. 1002, ¶208.) 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, 12-20, and 22-25 of the ’100 patent based on each of the grounds specified in this petition.

Respectfully submitted,

Dated: May 28, 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 Post-Grant Review of U.S. Patent No. 10,063,100 contains, as measured by the word processing system used to prepare this paper, 18,588 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: May 28, 2019

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

CERTIFICATE OF SERVICE

I hereby certify that on May 28, 2019, I caused a true and correct copy of the foregoing Petition for Post-Grant Review of U.S. Patent No. 10,063,100 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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