UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD. AND SAMSUNG ELECTRONICS AMERICA, INC.,
Petitioners,

v.

AQ CORPORATION,
Patent Owner.

Case No. IPR2026-_____

U.S. PATENT NO. 11,728,564

PETITION FOR *INTER PARTES* REVIEW

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LIST OF EXHIBITS

Exhibit No.	Description
1001	U.S. Patent No. 11,728,564 ("'564 Patent")
1002	Declaration of David K. Choi, Ph.D
1003	*Curriculum Vitae* of David K. Choi, Ph.D
1004	File History of U.S. 11,728,564 (App. No. 17/955,126)
1005	PCT Publication 2017/175886 ("SeongPCT")
1006	Certified English Translation of PCT Publication 2017/175886 ("Seong")
1007	U.S. Pat. App. Pub. No. 2019/0109373 ("Ahn")
1008	U.S. Patent No. 10,269,005 ("005Lee")
1009	Korean Patent Publication 10-2017-0093670 ("ChoKPP")
1010	Certified English Translation of Korean Patent Publication 10-2017-0093670 ("Cho")
1011	U.S. Pat. App. Pub. No. 2017/0228721 ("721Lee")
1012	U.S. Pat. App. Pub. 2018/0198209 ("Kang")
1013	Comparison of the specifications of U.S. Patent No. 11,728,564 ("'564 Patent") and U.S. Pat. App. Pub. 2018/0198209 ("Kang")
1014	U.S. Pat. App. Pub. No. 2010/0090824 ("Rowell")
1015	Exhibit B to Patent Owner's Disclosure of Asserted Claims and Infringement Contentions in *AQ Corporation v. Samsung Electronics Co., Ltd. et al.*, Case No. 2:25-cv-01012-JRG (EDTX)
1016	William H. Hayt, Jr. and Jack E. Kemmerly, Engineering Circuit Analysis (1993)

1017	Mohamed M. El Rayes, et al., "A Review on Wireless Power Transfer," IJETT Vol. 40. No. 5 (2016)
1018	Sung-Gu Kang, et al., "Near-Field Communication in Biomedical Applications," Sensors (2021)
1019	Zebra, RFID Inlay Placement/Power Guidelines (2014)
1020	Constantine A. Balanis, "The Evolution of Antenna Technology," IEEE Antenna & Propogation Magazine (2024)
1021	G. Stojanovic and Lj. Zivanov, "Comparison of Optimal Design of Different Spiral Inductors," MIEL Vol. 2 (2004)
1022	Chandrasekharan Nataraj, et al., "General Analysis of Resonance Coupled Wireless Power Transer (WPT) Using Inductive Coils," Technical Gazette 25, 3 (2018).
1023	Zachariah Peterson, "How to Design a Printed Circuit Board in 10 Easy Steps," (2025), https://resources.altium.com/p/10-easy-steps-comprehensively-designing-circuit-board-altium-designer
1024	"The Discovery of Radio Waves – 1888," Spark Museum, http://www.sparkmuseum.com/BOOK_HERTZ.HTM
1025	"How Do Checkpoint Labels and Hard Tags work?," Loss Prevention Systems, https://www.losspreventionsystems.com/checkpoint-labels-hard-tags-work/
1026	"Qi: Mobile Charging Empowered," Wireless Power Consortium, https://www.wirelesspowerconsortium.com/standards/qi-wireless-charging/
1027	"Wireless Charging," NFC Forum, https://nfc-forum.org/build/specifications/wireless-charging/
1028	"Qi Wireless Charging," Lenhardt, https://ib-lenhardt.com/kb/qi-wireless-charging
1029	U.S. Patent No. 649,621
1030	U.S. Patent No. 1,119,732

1031	U.S. Patent No. 4,937,585
1032	Chinese Patent No. CN209266128
1033	Korean Patent No. KR20180113064
1034	PCT WO 2019/070090
1035	Korean Patent No. KR101832344
1036	U.S. Patent No. 4,313,152
1037	U.S. Patent No. 1,563,731
1038	Performance Specification: MIL-PRF-55110F (1993)

LIST OF CHALLENGED CLAIMS

Reference Number	Claim Limitation
Claim 1	
[1pre]	A smartphone antenna module comprising:
[1a]	a substrate having a first major surface and a second major surface facing away from the first major surface;
[1b]	a first antenna pattern formed on the first major surface and comprising an inner coil and an outer coil surrounding the inner coil;
[1c]	a second antenna pattern formed on the second major surface and comprising an inner antenna pattern, and an outer antenna pattern;
[1d]	the inner antenna pattern comprising a plurality of concentric circular lines and defining a radially-extending inner gap into which the plurality of concentric circular lines of the inner antenna pattern does not extend, wherein at least part of the concentric circular lines of the inner antenna pattern overlaps the inner coil formed on the first major surface and is connected to the inner coil through vias; and
[1e]	the outer antenna pattern comprising a plurality of concentric circular lines and defining a radially-extending outer gap into which the plurality of concentric circular lines of the outer antenna pattern does not extend, wherein at least part of the concentric circular lines of the outer antenna pattern overlaps the outer coil formed on the first major surface and is connected to the outer coil through vias,
[1f]	wherein at least part of the concentric circular lines of the outer antenna pattern generally surround at least part of the concentric circular lines of the inner antenna pattern,
[1g]	wherein the radially-extending outer gap and the radially-extending inner gap are connected and aligned in a direction.
Claim 2	
[2pre]	The smartphone antenna module of claim 1, further comprising an inner extension line formed on the second major surface and extending through the radially-extending outer gap and further through at least part of the radially-extending inner gap; and
[2a]	an outer extension line formed on the second major surface and extending through at least part of the radially-extending outer gap.
Claim 3	

Reference Number	Claim Limitation
[3]	The smartphone antenna module of claim 2, wherein the inner extension line and the outer extension line extend generally in parallel, and wherein each of the inner extension line and the outer extension line formed on the second major surface comprises a portion that overlaps the outer coil formed on the first major surface.
Claim 4	
[4]	The smartphone antenna module of claim 2, wherein the inner extension line is electrically connected to a terminal of the inner coil, wherein at least part of the concentric circular lines of the inner antenna pattern is in a C shape.
Claim 5	
[5]	The smartphone antenna module of claim 2, wherein the outer extension line is electrically connected to a terminal of the outer coil, wherein at least part of the concentric circular lines of the outer antenna pattern is in a C shape.
Claim 6	
[6]	The smartphone antenna module of claim 2, wherein at least one of the inner extension line and the outer extension line is electrically connected to the first antenna pattern formed on the first major surface through at least one via.
Claim 7	
[7]	The smartphone antenna module of claim 2, wherein the inner extension line is referred to as a first inner extension line and is electrically connected to a first terminal of the inner coil, wherein the smartphone antenna module further comprises a second inner extension line formed on the second major surface, wherein the second inner extension line is electrically connected to a second terminal of the inner coil and extends through at least part of the radially extending outer gap.
Claim 8	
[8]	The smartphone antenna module of claim 1, wherein the inner coil and the outer coil are electrically connected in parallel.
Claim 9	
[9]	The smartphone antenna module of claim 1, wherein the inner coil includes a wire line having a width different from that of a wire line of the outer coil, wherein the inner coil has a first number of turns,

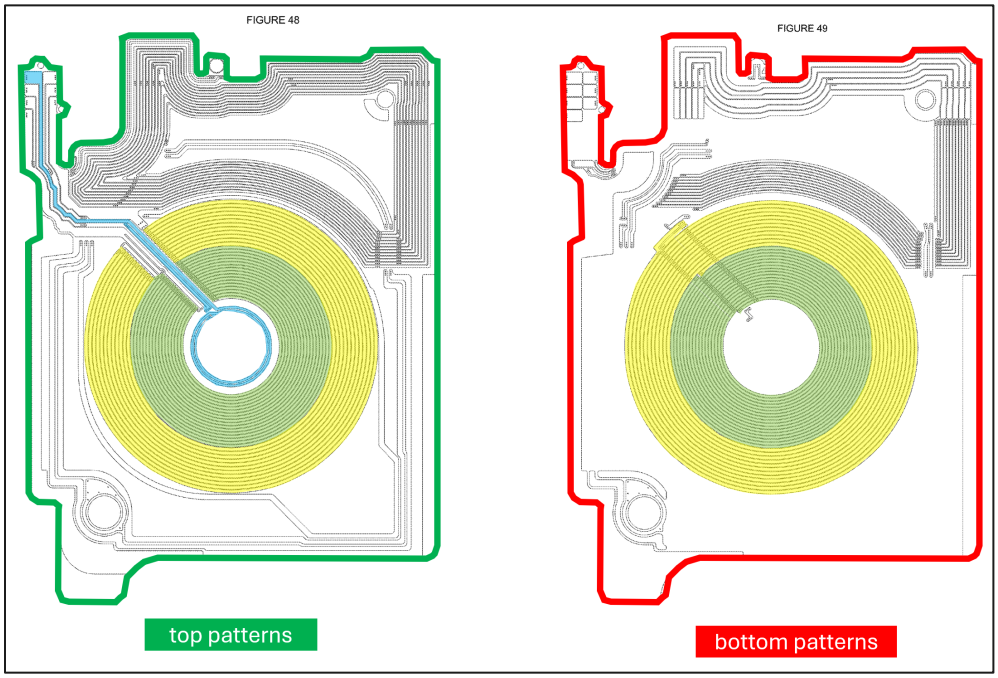
Reference Number	Claim Limitation
	and the outer coil has a second number of turns, wherein the first number of turns is greater than the second number of turns.
Claim 10	
[10]	The smartphone antenna module of claim 1, further comprising two additional extension lines formed on the second major surface and extending through both the radially-extending inner gap and the radially-extending outer gap.
Claim 11	
[11]	The smartphone antenna module of claim 10**,** wherein the second antenna pattern formed on the second major surface comprises a third antenna pattern generally surrounded by the inner antenna pattern, wherein each of the two additional extension lines is electrically connected to a terminal of the third antenna pattern.
Claim 12	
[12]	The smartphone antenna module of claim 10, wherein the second antenna pattern formed on the second major surface comprises a third antenna pattern generally surrounded by the inner antenna pattern, wherein at least one of the two additional extension lines contacts the third antenna pattern on the second major surface.
Claim 13	
[13pre]	A smartphone comprising a display module comprising a display surface;
[13a]	a rear cover comprising a rear surface facing away from the display surface;
[13b]	a battery placed between the display module and the rear cover; and
[13c]	the smartphone antenna module of claim 2 placed between the battery and the rear cover,
[13d]	wherein at least one of the inner coil and the outer coil are configured for wireless battery charging.
Claim 14	
[14]	The smartphone of claim 13, wherein the inner extension line is electrically connected to a terminal of the inner coil, wherein at least part of the concentric circular lines of the inner antenna pattern is in a C shape.
Claim 15	
[15]	The smartphone of claim 13, wherein the outer extension line is electrically connected to a terminal of the outer coil, wherein at least

Reference Number	Claim Limitation
	part of the concentric circular lines of the outer antenna pattern is in a C shape.
Claim 16	
[16]	The smartphone of claim 13, wherein the inner coil and the outer coil are electrically connected in parallel.
Claim 17	
[17]	The smartphone of claim 13, wherein at least one of the inner extension line and the outer extension line is electrically connected to the first antenna pattern formed on the first major surface through at least one via.
Claim 18	
[18]	The smartphone of claim 13, wherein the inner extension line is referred to as a first inner extension line and is electrically connected to a first terminal of the inner coil, wherein the smartphone antenna module further comprises a second inner extension line formed on the second major surface, wherein the second inner extension line is electrically connected to a second terminal of the inner coil and extends through at least part of the radially-extending outer gap.
Claim 19	
[19]	The smartphone of claim 13, wherein the inner coil includes a wire line having a width different from that of a wire line of the outer coil, wherein the inner coil has a first number of turns, and the outer coil has a second number of turns, wherein the first number of turns is greater than the second number of turns.
Claim 20	
[20]	The smartphone claim 13, further comprising two additional extension lines formed on the second major surface and extending through both the radially-extending inner gap and the radially-extending outer gap.
Claim 21	
[21]	The smartphone of claim 20, wherein the second antenna pattern formed on the second major surface comprises a third antenna pattern generally surrounded by the inner antenna pattern, wherein each of the two additional extension lines is electrically connected to a terminal of the third antenna pattern.
Claim 22	

Reference Number	Claim Limitation
[22]	The smartphone of claim 20, wherein the second antenna pattern formed on the second major surface comprises a third antenna pattern generally surrounded by the inner antenna pattern, wherein at least one of the two additional extension lines contacts the third antenna pattern on the second major surface.

I. INTRODUCTION

The '564 Patent "relates to a smartphone antenna module." Ex1001, 1:16-18. The patent specification contends space is limited for antennas, which the alleged invention purports to address by arranging "coil antenna patterns" in rings on both sides of a PCB and "electrically connect[ing]" them through vias:

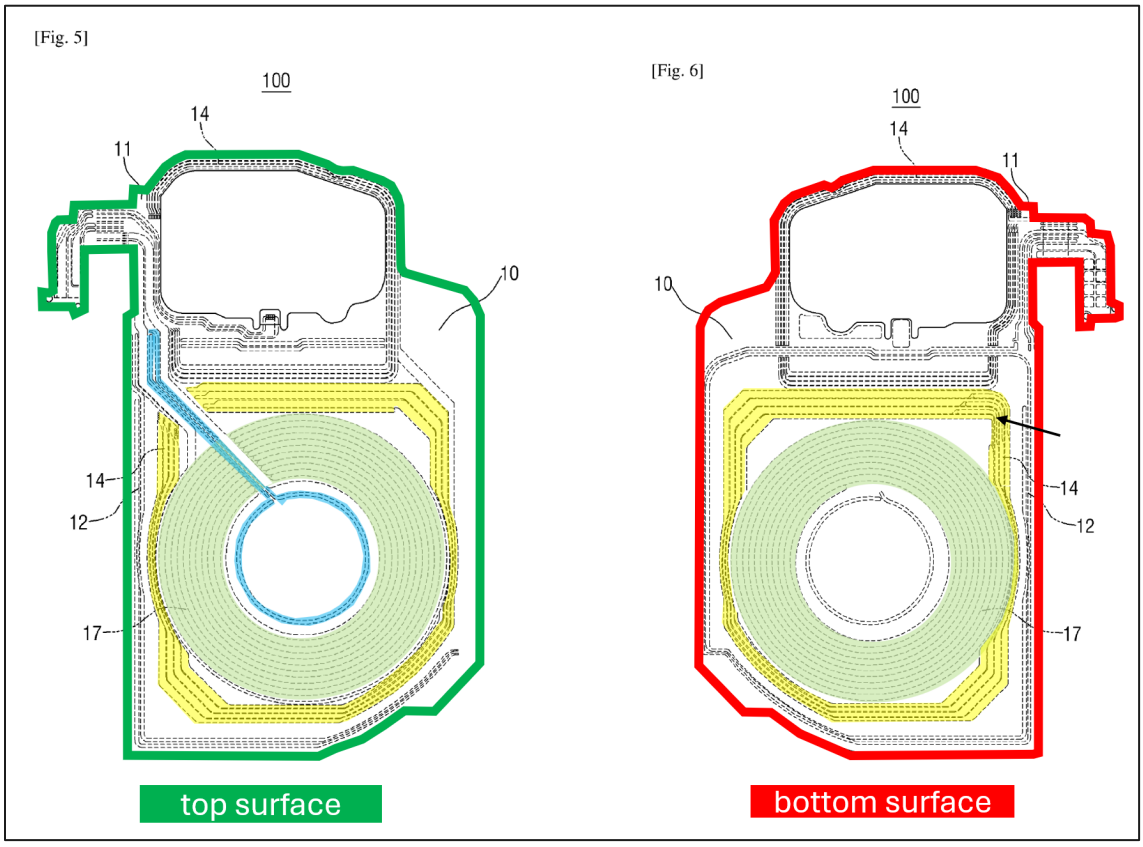


Ex1001, 1:22-41, 41:50-42:4, Figs. 48-49; Ex1002 ¶¶4.[1]

But forming wireless-communication antennas—including NFC (Near Field Communication), MST (Magnetic Secure Transmission), and WPC (Wireless Power Charging)—on both sides of a substrate was well-known, as were the generic components and layouts that the '564 Patent claims. Seong, Ahn, and 005Lee taught

[1] All annotations added.

essentially identical layouts addressing the same space-efficiency problem years earlier:



Ex1006, Figs. 5-6; Ex1002 ¶¶55-56.

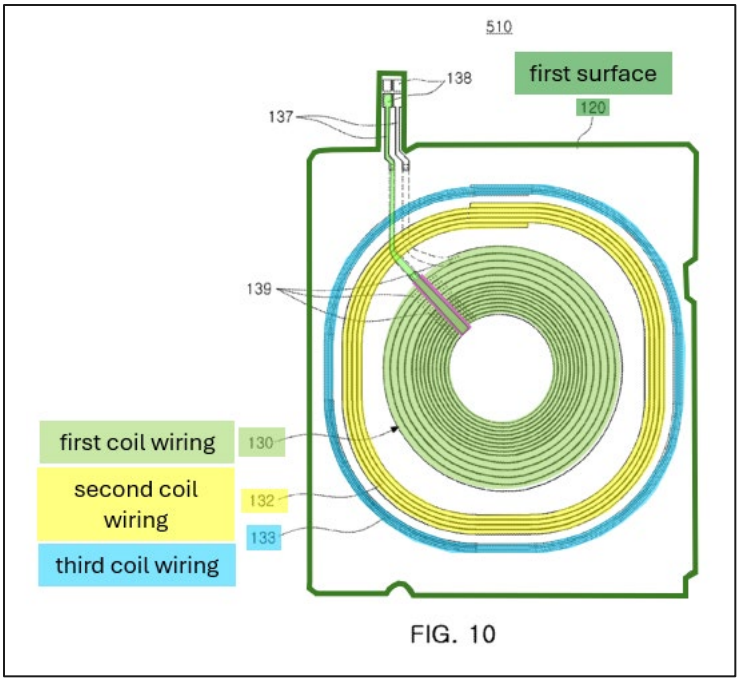


FIG. 10

Ex1007, Fig. 10; Ex1002 ¶57.

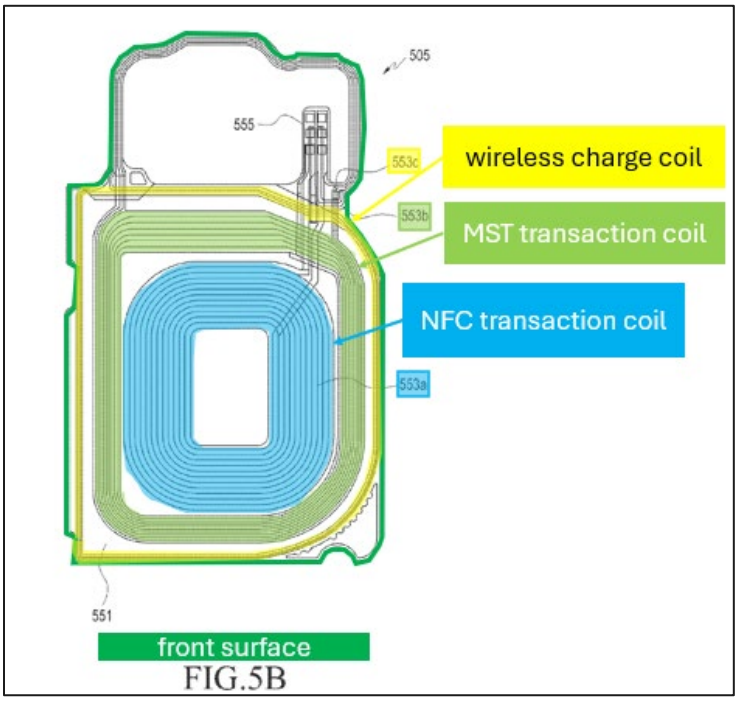


FIG.5B

Ex1008, Fig. 5B; Ex1002 ¶58.

II. STANDING (§42.104(A))

Petitioners certify the '564 Patent is available for IPR, and Petitioners are not barred or estopped from requesting IPR to challenge the claims on the grounds herein.

III. RELIEF REQUESTED (§42.104(B))

Petitioners respectfully request review and cancellation under §311 of claims 1-20 as follows.[2] This table identifies the prior art status of the references relied on herein:

Prior Art	Publication	Basis
PCT Publication 2017/175886 ("Seong")	10/12/2017	AIA 102(a)(1), 102(a)(2)
U.S. Patent Application Publication 2019/0109373 ("Ahn")	4/11/2019	
U.S. Patent 10,269,005 ("005Lee")	7/21/2016	
Korean Patent Publication 10-2017-0093670 ("Cho")	8/16/2017	

[2] Petitioners do not concede that any claims satisfy other requirements for patentability that cannot be raised in IPR, including §§101 and 112.

Prior Art	Publication	Basis
U.S. Patent Application Publication 2017/0228721 ("721Lee")	8/10/2017	
U.S. Patent Application Publication 2018/0198209 ("Kang")	7/12/2018	AIA 102(a)(1)

This table identifies the invalidity grounds relied on herein:

Ground	Claims	Basis
1	1-20	§103: Seong, Kang, Cho
2	1-20	§103: Ahn, 721Lee
3	1-20	§103: 005Lee, Seong, Ahn

IV. '564 PATENT OVERVIEW

The '564 Patent issued from Application No. 17/955,126, filed 09/28/2022, and claims priority to 11/27/2019. Ex1001, Cover.

A. Specification

The '564 Patent acknowledges that prior-art smartphones included "a circuit and antenna for enabling [NFC]," and "other wireless communication circuits and antennas," including "MST" and "wireless power." Ex1001, 1:22-33, 30:38-49. The '564 Patent contends space for antennas is limited, and purports to solve this by

arranging coils on both sides of a PCB, electrically connected by vias. Ex1001, 1:22-41, 41:50-42:4. This purported solution already existed. Ex1002 ¶¶32-58.

B. Prosecution History

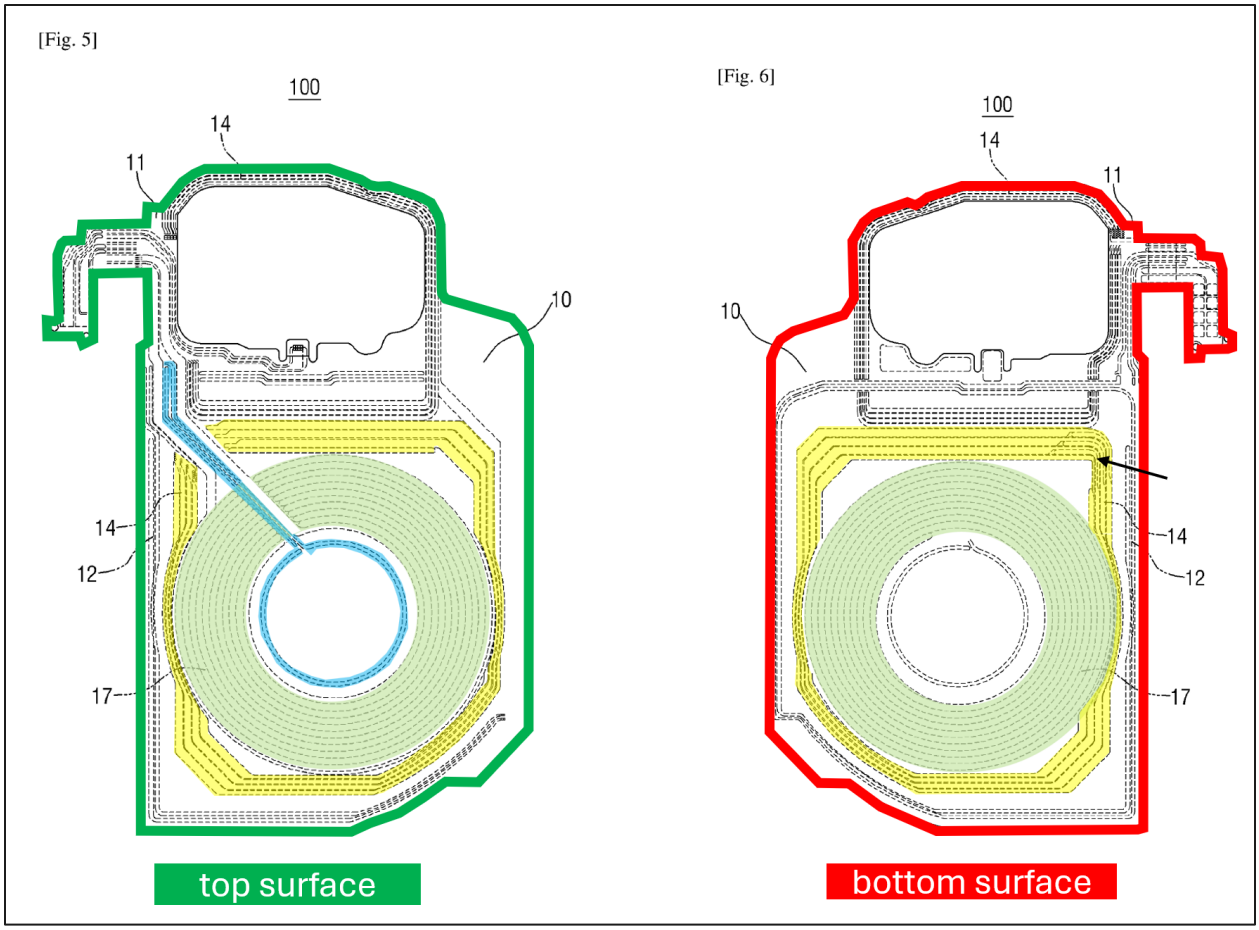
The '564 Patent issued without any Examiner rejections. During prosecution, the Applicant disclosed 70+ references, but failed to disclose material, invalidating references, including the references herein.

The Examiner concluded an "outer antenna pattern generally surround[ing] an "inner antenna pattern," both comprising "concentric circular lines" that each define a "radially-extending outer gap and [a] radially-extending inner gap" that are "connected and aligned in a direction," wherein "the outer antenna pattern … overlaps [an] outer coil formed on" the opposing surface and "is connected to the outer coil through vias" was "not found in the prior art of record." Ex1004, 222-23. These limitations were well-known, however.

V. PRIOR ART OVERVIEW

A. Seong

Seong is a PCT application teaching a "smartphone[]" "antenna structure":

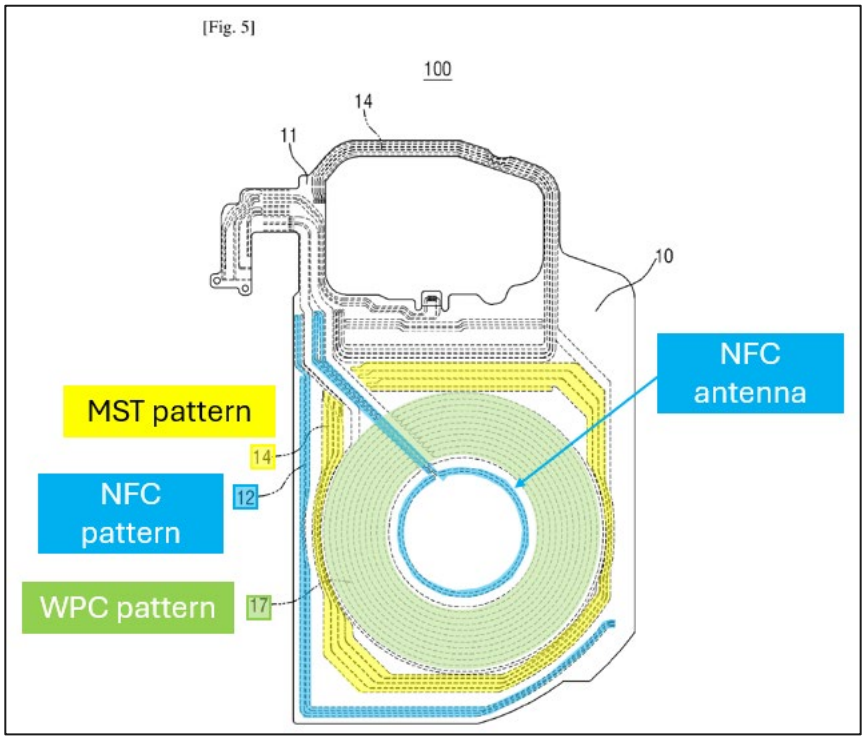


Ex1006, Abstract, Fig. 5; Ex1002 ¶63.

Seong discloses antennas formed on a substrate's top and bottom surfaces to "reduce the overall size of the antenna structure" and "efficiently use the [smartphone's] internal space." Ex1006, Abstract, ¶¶9-12, 16-17, 34-42, 63-69, 74, 80, Figs. 5-15, 17, Cls. 1, 6-7.

Seong uses multiple antenna pattern types, including NFC, MST, and WPC. Ex1006, Abstract, ¶2. Seong depicts "**WPC pattern**" and the innermost portion of "**NFC pattern**" as circular, and "**MST pattern**" as including rounded portions and

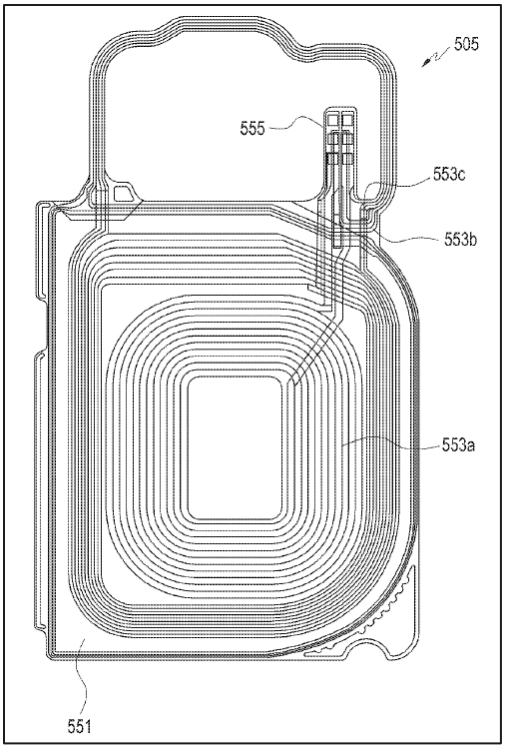
generally tracking the substrate's shape, but notes, "shape and layout arrangement of the antenna patterns may be varied":



Ex1006, Fig. 5, ¶63; Ex1002 ¶¶63-65.

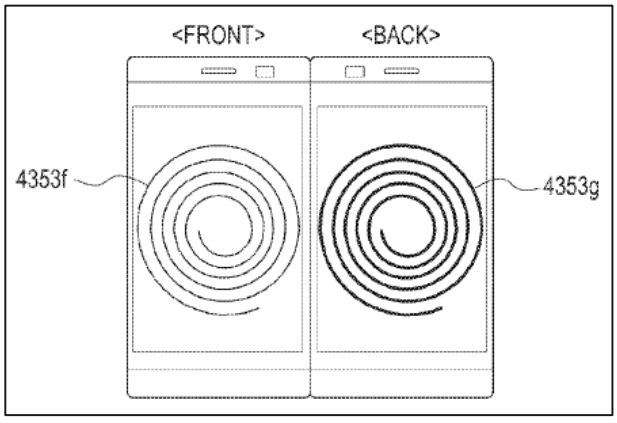
B. 005Lee

005Lee is a U.S. patent teaching a smartphone antenna module:



Ex1008, 17:4-19, Fig. 5B.

005Lee discloses antennas formed on a PCB's "front" and "back" surfaces:



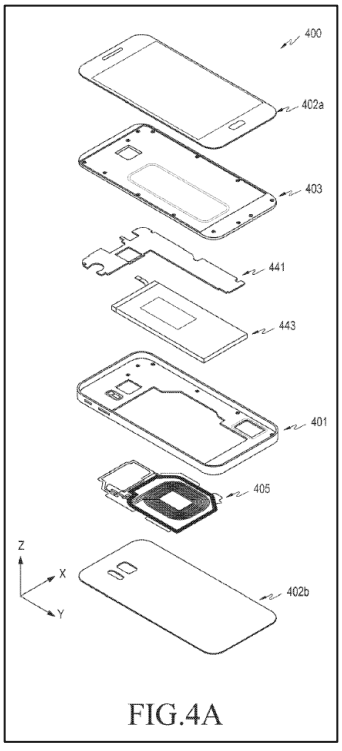


FIG.4A

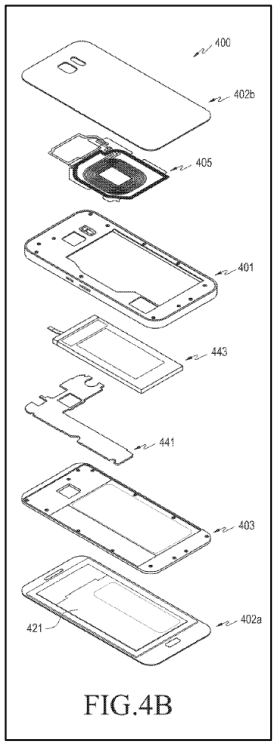


FIG.4B

Ex1008, 17:24-28, 49:55-62, Figs. 4A-4B, 43D.

005Lee's antennas may function as NFC, MST, and "**wireless charge coil[s]**," and can be configured in concentric circles:

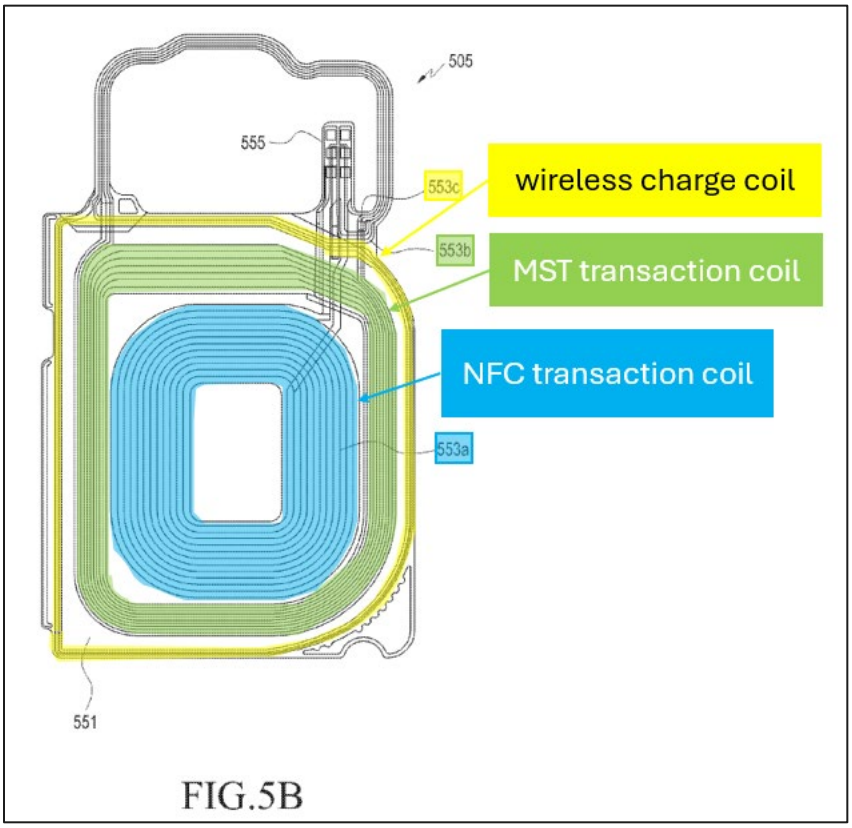
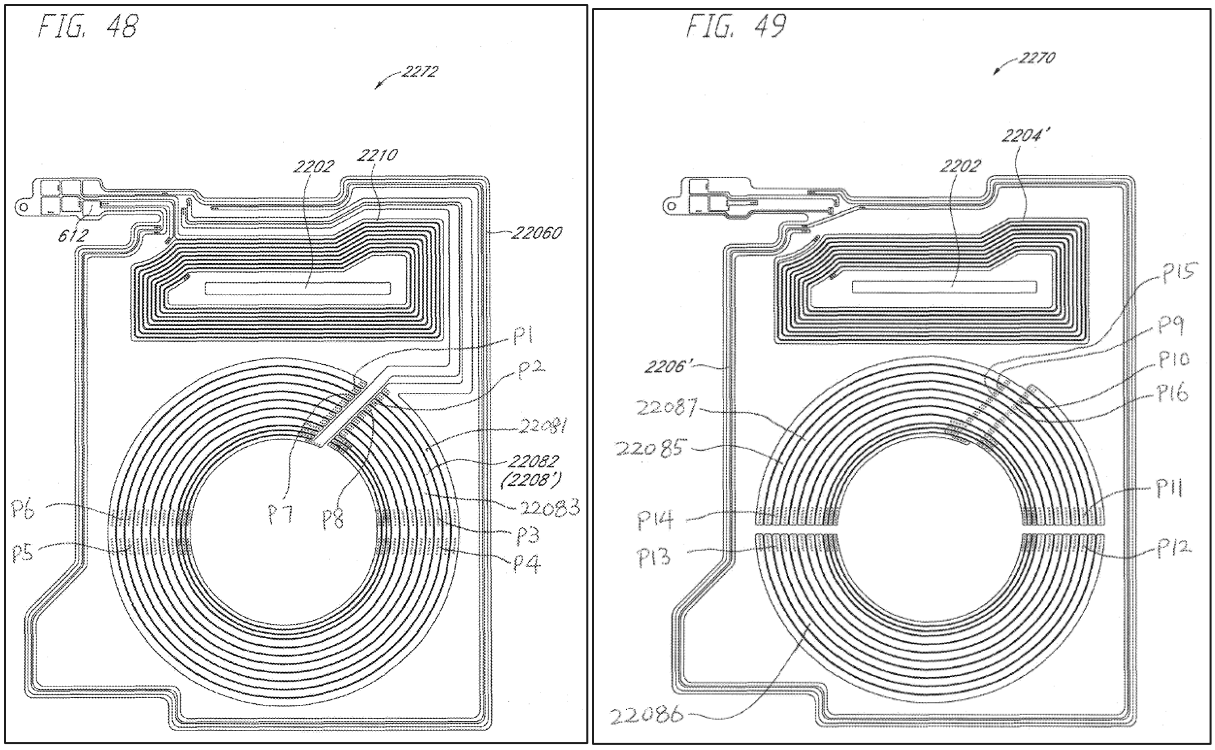


FIG.5B

Ex1008, 17:67-18:4, 19:28-35, Fig. 5B; Ex1002 ¶¶66-68.

C. Kang

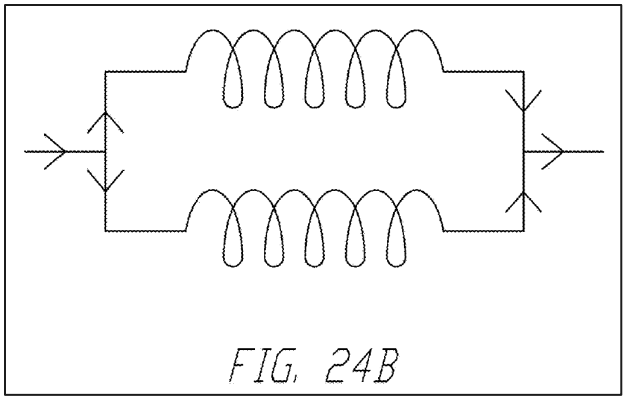
Kang is a U.S. patent publication—published more than one year before the '564 Patent's earliest effective filing date—sharing an identical specification with the '564 Patent apart from approximately one column of disclosure (second half of column 41 and first half of column 42) and a few figures (the '564 Patent adds Figures 45-55 while removing Kang Figures 15-20). Ex1012, Cover; Ex1013. Kang teaches a "smartphone" "antenna module":



Ex1012, Abstract, Figs. 48-49; Ex1002 ¶¶69-71.

Kang discloses "improved layout[s]" and "shape[s]" for three-or-more coils that may be shaped "different from that of the periphery of the PCB," including "circular-spiral shape[s]." Ex1012, ¶¶33, 179, 248-49, Figs. 43, 46, 48-49. Kang's coils can be concentric, can be formed on both opposing surfaces of the substrate, can be connected using "vias," and each can perform MST, NFC, and wireless charging. *Id.* ¶¶5-15, 76, 174-75, 216, 231, 238, 247-49, 259, 261, 263, Figs. 43, 46, 48-49, Cl. 6.

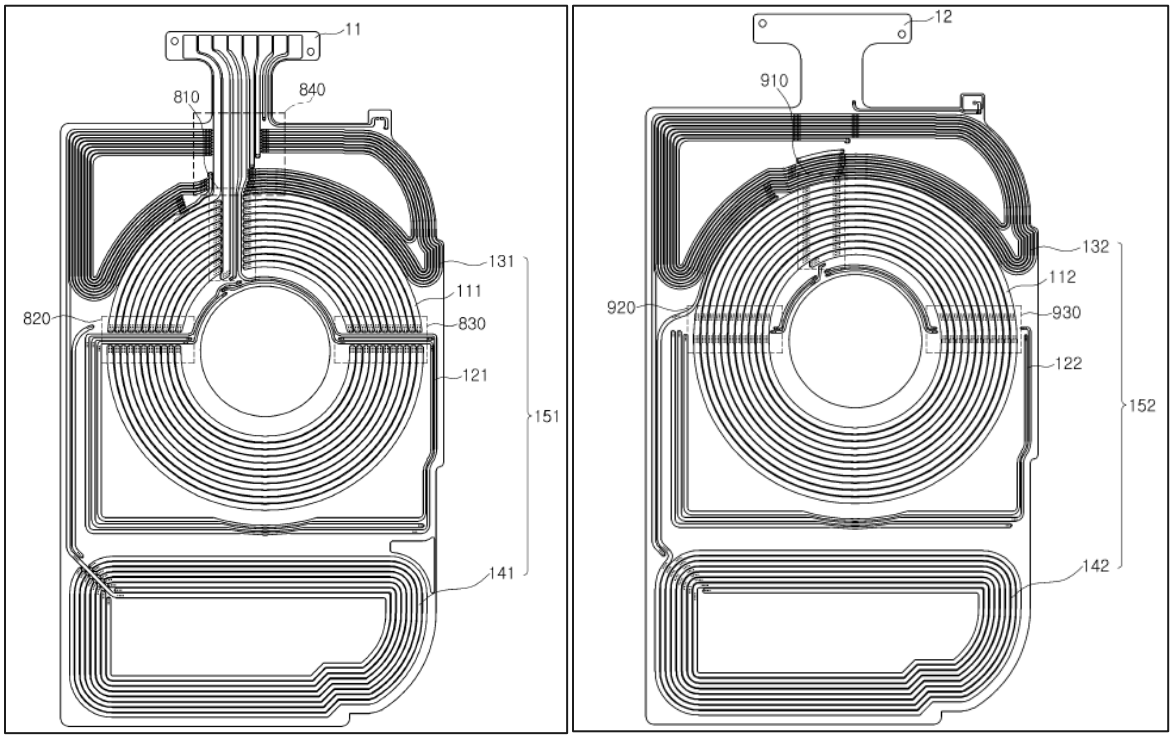
Kang's "coils may be connected in parallel":



Ex1012 ¶¶214, 217, Fig. 24B.

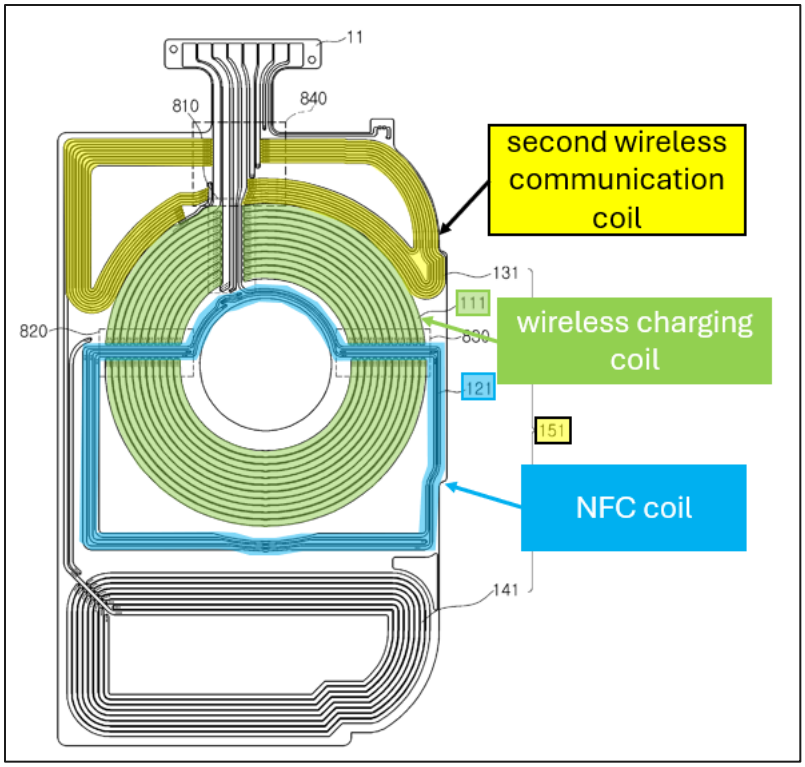
D. Cho

Cho is a Korean patent publication teaching a smartphone "coil module":



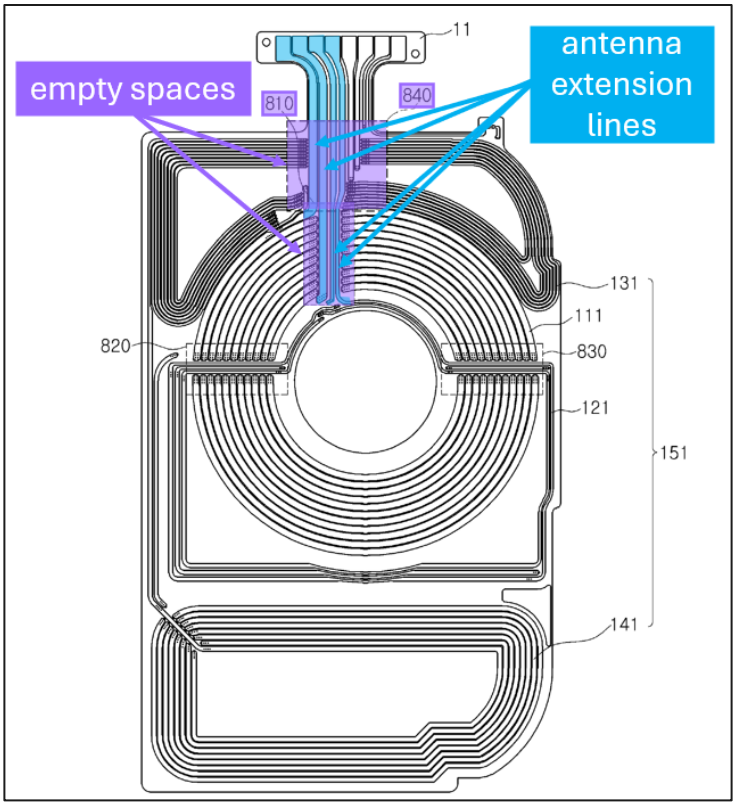
Ex1010, Figs. 8-9

Cho discloses "coils for wireless communication"—including "**NFC**," "**wireless charging**," and a "**second wireless communication**"—on "both sides of the substrate," connected through "vias":



Ex1010 ¶¶3, 4, 5, 9, 75, 79, Fig. 8, Cls. 2, 10; Ex1002 ¶¶72-73.

Cho uses space-efficient "**empty spaces**" (coil gaps) through which **antenna extension lines** run:



Ex1010, Fig. 8, ¶¶64, 68, 72; Ex1002 ¶74.

E. Ahn

Ahn is a U.S. patent publication teaching a smartphone "antenna" "coil assembly":

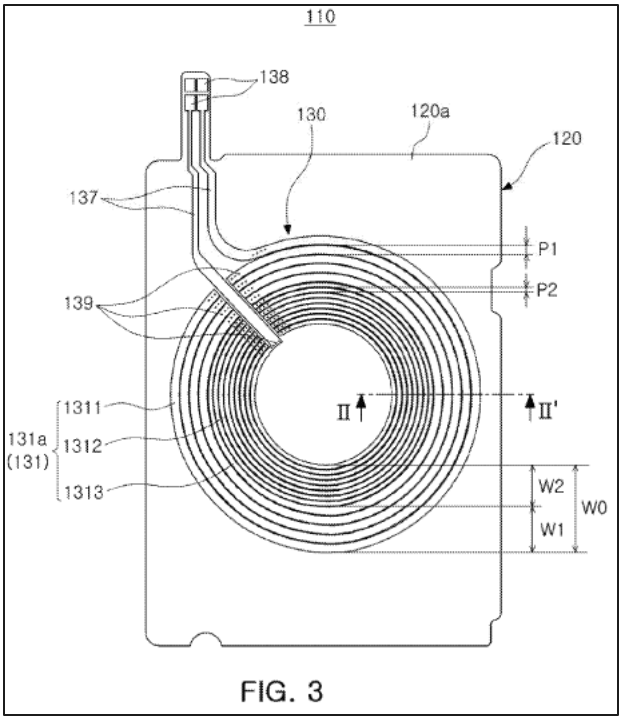


FIG. 3

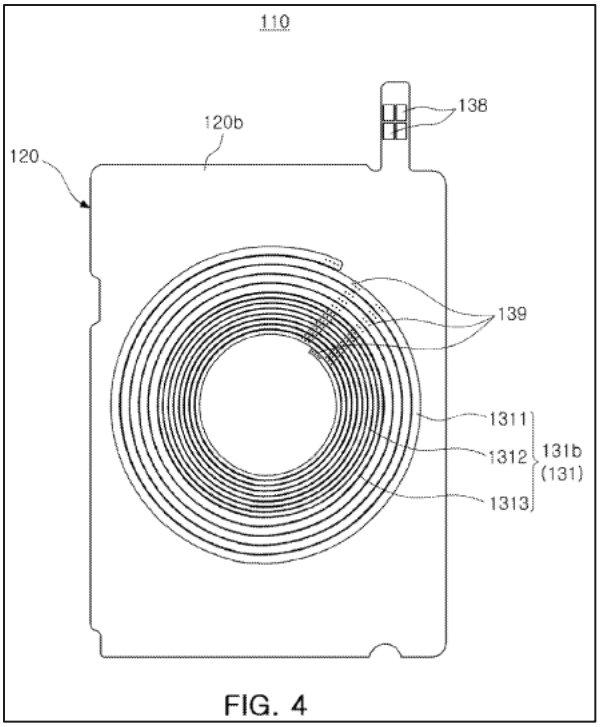


FIG. 4

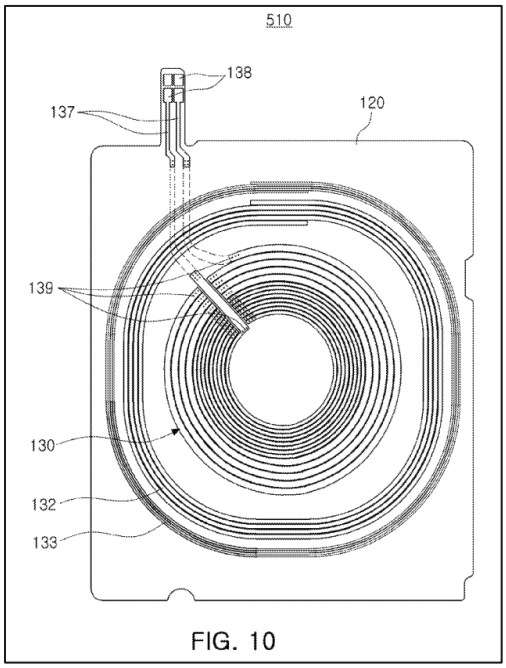


FIG. 10

Ex1007, Abstract, ¶¶23, 47-48, 125, Cl. 18, Figs. 3-4, 10.

Ahn discloses antennas formed on opposing surfaces 120a and 120b of "substrate 120." Ex1007 ¶¶4, 27-28, 65, 68, 71, 99-100, 127, Figs. 3-4, 10.

Ahn's coils perform **NFC**, **MST**, and "**wireless charging**":

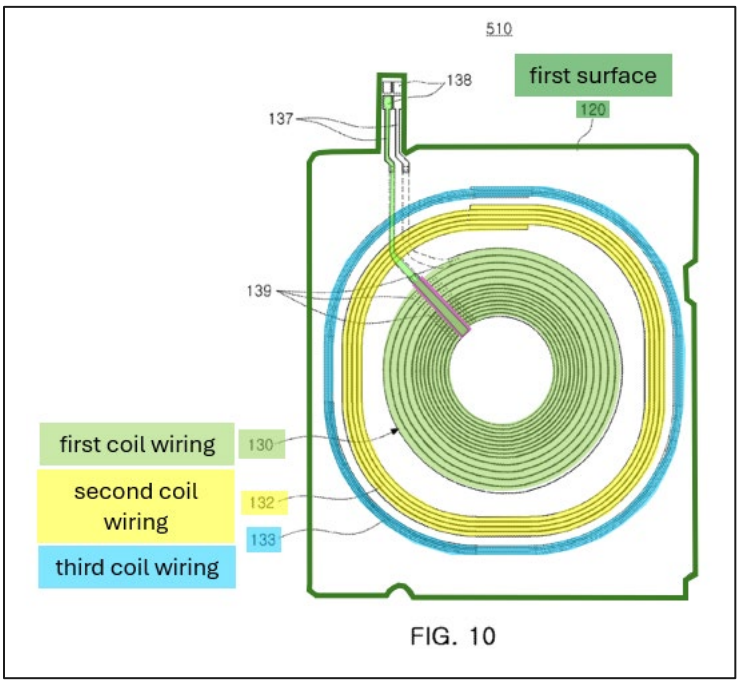


FIG. 10

Ex1007 ¶¶18, 23, 125, Fig. 10; Ex1002 ¶¶75-78.

"[B]oth ends" of each coil "need to be connected to the connection pads" using "lead wirings" extending through "disconnection [coil] region[s]" in a "diameter (radial) direction." Ex1007 ¶¶72-73, 124-25, Fig. 10.

F. 721Lee

721Lee is a U.S. patent publication teaching a smartphone antenna module:

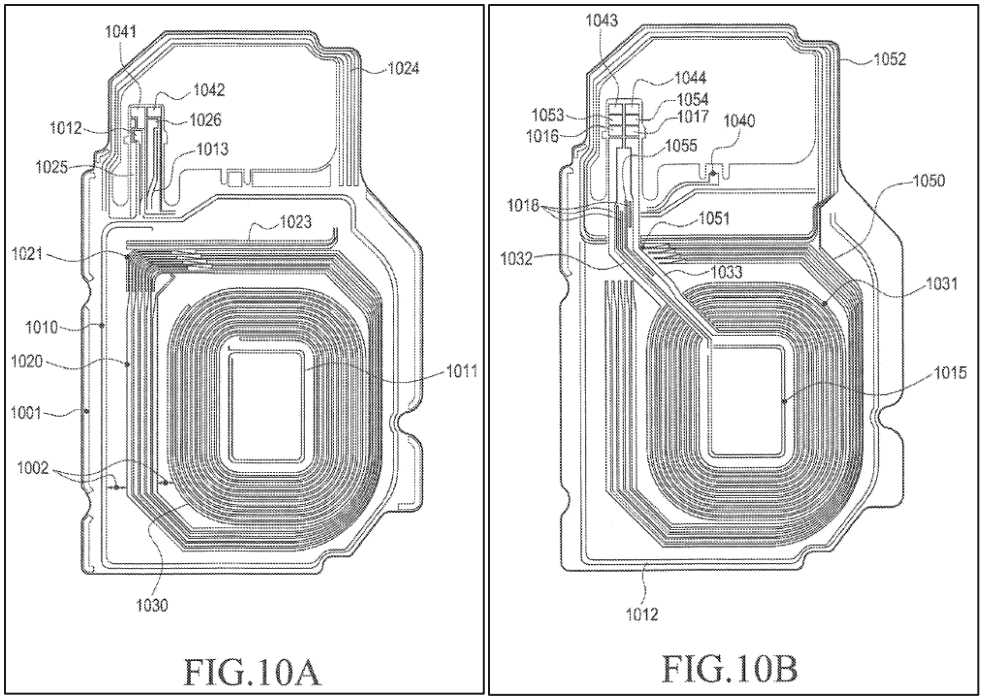


FIG.10A FIG.10B

Ex1011, Figs. 10A-10B.

721Lee discloses "overlap[ping]" coils "disposed on a first" and "a second layer." Ex1011 ¶¶12, 122, Figs. 6A-6B.

721Lee's coils perform "**MST**," "**wireless charging**," and "**NFC**":

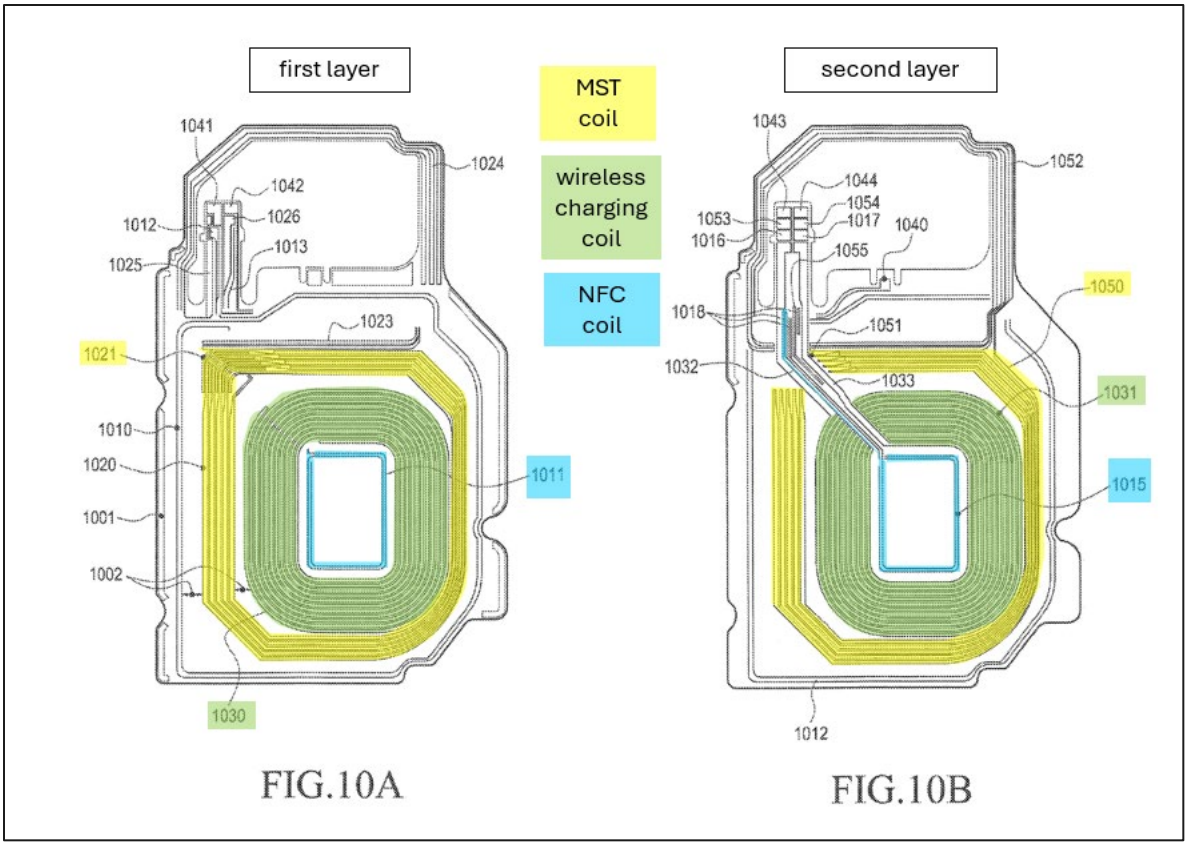


FIG.10A FIG.10B

Ex1011, Abstract, ¶¶28-29, Figs. 10A-10B; Ex1002 ¶¶79-81.

721Lee's coils "may have the **opened loop** form," having gaps allowing "connect[ion] to the input/output terminals" using extension lines:

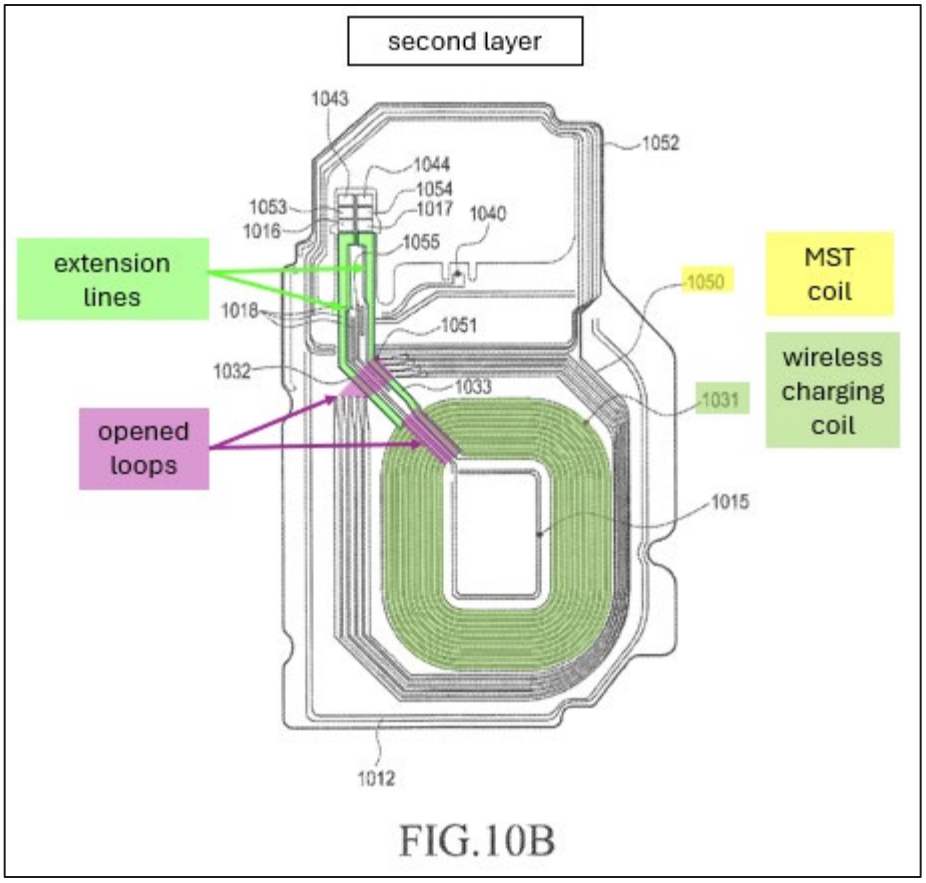


FIG.10B

Ex1011 ¶140, Fig. 10B; Ex1002 ¶82.

VI. LEVEL OF ORDINARY SKILL IN THE ART

A POSA would have had a bachelor's degree in electrical engineering or a similar field and 2-3 years of experience in antenna design, wireless charging, and/or contactless wireless communication. Additional education could offset less experience and vice versa, and a POSA could have also obtained similar knowledge and experience through other means. Ex1002 ¶¶30-31.

VII. CLAIM CONSTRUCTION

Petitioners are unaware of any "prior claim construction determination" related to the '564 Patent. 37 C.F.R. §42.100(b). Petitioners do not believe any

claim construction is necessary to resolve the parties' controversy in this Petition, and the claims should be given their plain and ordinary meaning for purposes of this IPR.[3]

VIII. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. Ground 1: Seong Renders Claims 1-22 Obvious In View Of Kang And Cho

1. Motivation To Combine Seong, Kang, And Cho

These references overcome limited space in smartphones with space-efficient WPC, NFC, and MST antennas, optimizing shape and layout, placing coils on both sides of a substrate. Section V. A POSA reading Seong would have been motivated to incorporate Kang's and Cho's teachings. Ex1002 ¶¶88-95. All three references teach antenna patterns on both sides of a substrate in a smartphone, including WPC, NFC, and MST antennas. Ex1006, Abstract, Figs. 5-6, ¶¶63-64; Ex1012 ¶¶262-263, Figs. 46, 48-49, Cl. 6; Ex1010 ¶¶63-69, Figs. 8-9; Ex1002 ¶88. If Seong is found to not expressly teach a claimed limitation, as discussed below, it would have been obvious to a POSA to adopt well-known, predictable, and finite approaches taught by Kang and Cho to Seong's substrate to achieve wireless communication functions in a space efficient module. Ex1002 ¶88.

[3] Petitioners reserve all rights to raise claim construction and other arguments in litigation.

First, Seong's antenna patterns on its substrate's top and bottom surfaces are connected through vias. Ex1006 ¶¶4, 33-34, 77, Figs. 5-6; Ex1002 ¶89. Further, a POSA would have found connections by vias obvious in view of Kang and Cho. Ex1012 ¶263, Cl. 6; Ex1010 Cl. 2, 10; ¶¶66-67, 73; Ex1002 ¶89. Via-connected coils can have increased surface area and improved communication performance in a space-efficient manner. Ex1002 ¶89.

A POSA would have reasonably expected success. Ex1002 ¶90. Vias were common and would have been obvious to try as there were a finite number of predicable solutions for connecting antenna patterns on different surfaces. *Id.*

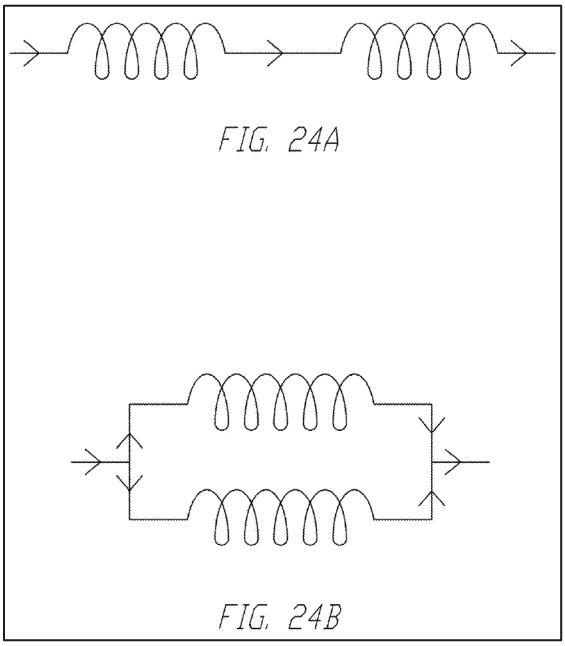
Second, a POSA would have been motivated to use concentric, circular-shaped coils for Seong's WPC and MST patterns, as Kang teaches, and to connect and align their radially extending gaps, as Kang and Cho teach. Ex1002 ¶91. A POSA reading Seong's teaching that coil "shape and layout" "may be varied," Ex1006 ¶63, and reviewing Seong's depiction of WPC pattern 17 as circular, *id.*, Figs. 5-6, would have understood MST patterns with concentric circles were common and space-efficient. Ex1002 ¶91. Further, a POSA would have been motivated to look for references teaching layouts furthering Seong's space-efficiency goal, including Kang and Cho. Ex1012 ¶¶3, 179, Figs. 46, 48-49; Ex1010 ¶¶5, 9; Ex1002 ¶91. Kang furthers that goal with concentric coils shaped "different from that of the periphery of the PCB," including "circular-spiral shape[s]." Ex1012

¶¶248-49, Figs. 43, 46, 48-49. Kang and Cho also further Seong's space-efficiency goal with connected and aligned inner and outer gaps, which, similar to Seong's disclosure, let extension lines through. Ex1012 Figs. 48-49; Ex1010 Fig. 8, ¶¶64, 68, 72; Ex1002 ¶91.

A POSA would have reasonably expected success. Ex1002 ¶92. There were a finite number of predictable coil shapes and arrangements, and concentric circles were common and yielded predictable results. Ex1002 ¶92. Seong teaches circular coils, including WPC antenna 17, and teaches other shapes could be used. Ex1006 ¶63, Figs. 5-6. Kang teaches using "different" coil shapes, including concentric circles. Ex1012 ¶¶33, 179, 248-49, Fig. 43, 46, 48-49. It was well-known that coils "can be wound in a variety of shapes," including "circular." Ex1010 ¶¶37, 57, Cls. 6, 14; Ex1002 ¶92.

Third, a POSA would have been motivated to electrically connect Seong's WPC and MST patterns in parallel. Ex1002 ¶93. A POSA would have understood parallel connections may be more secure, and thus preferable for high-security, close-distance transactions, such as NFC payment transactions. *Id.* Seong does not explicitly disclose how its WPC and MST patterns are electrically connected. A POSA would have been motivated to look to references teaching how to electrically connect inner and outer coils. *Id.* Kang teaches such coils can be electrically

connected for improved performance flexibility and in one of two ways—"in series or in parallel":



Ex1012 ¶¶150, 214, 217, 237, Figs. 24A, 24B; Ex1002 ¶93.

Electrically connecting Seong's WPC and MST patterns in parallel was a simple design choice and would have been obvious to try. Ex1002 ¶94.

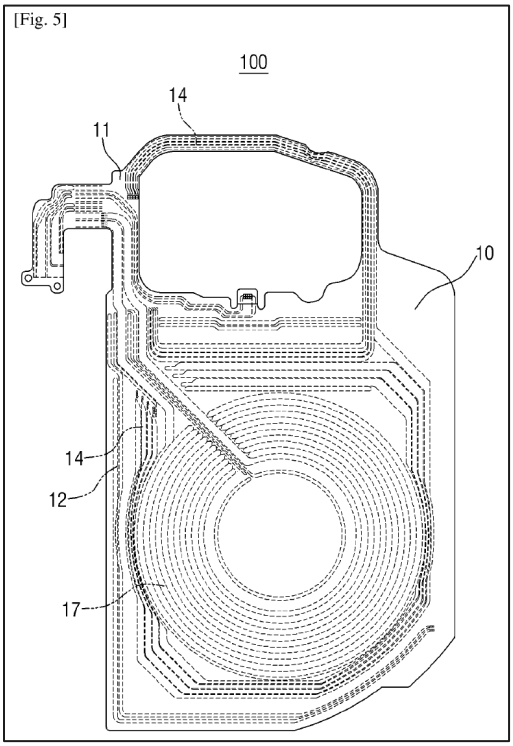
A POSA would have reasonably expected success. Ex1002 ¶95. Parallel electrical connection was well-known, straightforward, and achieved predictable results. *Id.*

2. [1]

a. [1pre][4]

To the extent the preamble is limiting, Seong teaches it. Ex1002 ¶¶96-98.

Seong teaches a "smartphone[]" "antenna structure [(100)]":



Ex1006 ¶¶2-3, 51-53, Fig. 5.

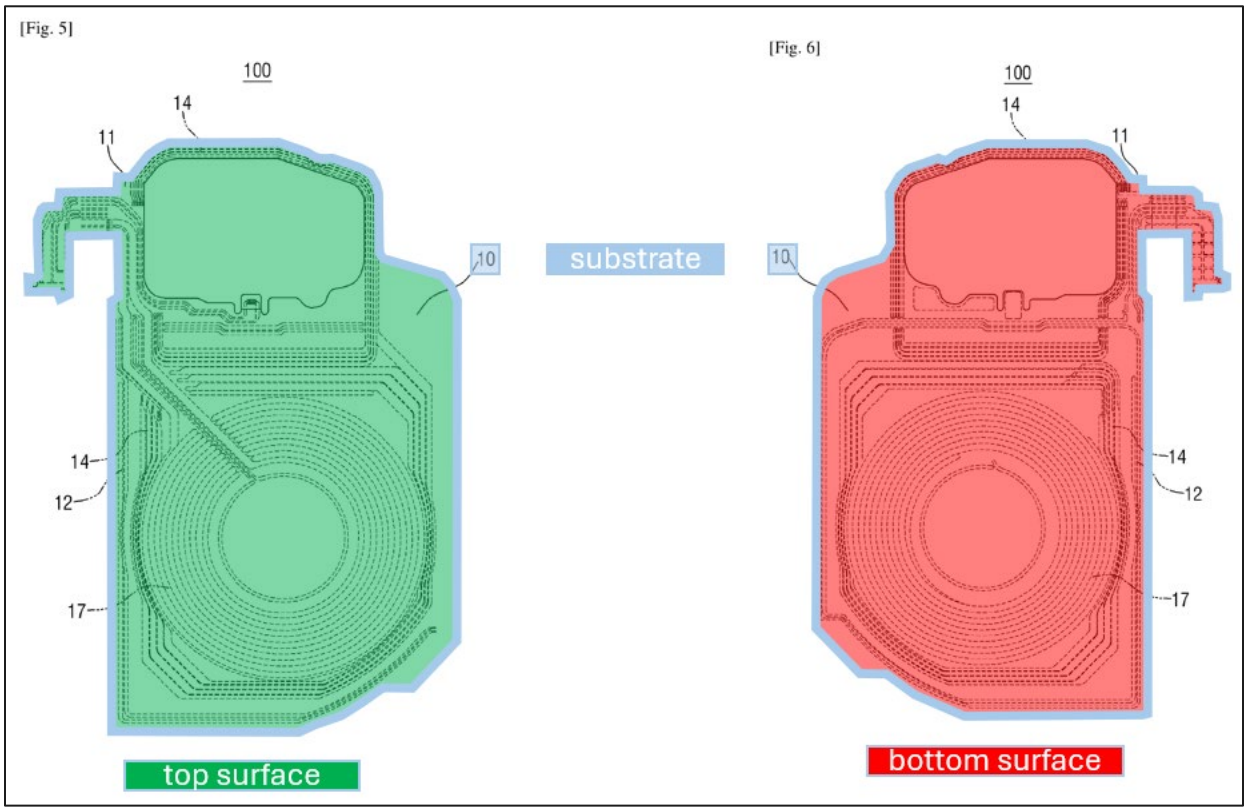
This is a smartphone antenna module including because it comprises multiple antennas. Ex1002 ¶98.

b. [1a]

Seong teaches this limitation. Ex1002 ¶¶99-100.

[4] *See* LIST OF CHALLENGED CLAIMS.

Seong teaches "antenna structure [(100)]" "includes a substrate [(10)] having" a "**bottom surface**" (first major surface) and a "**top surface**" (second major surface) on which "NFC pattern, MST pattern, [and/or] WPC pattern may be formed." Ex1006 Abstract, ¶16. The "**top surface**" faces away from the "**bottom surface**":



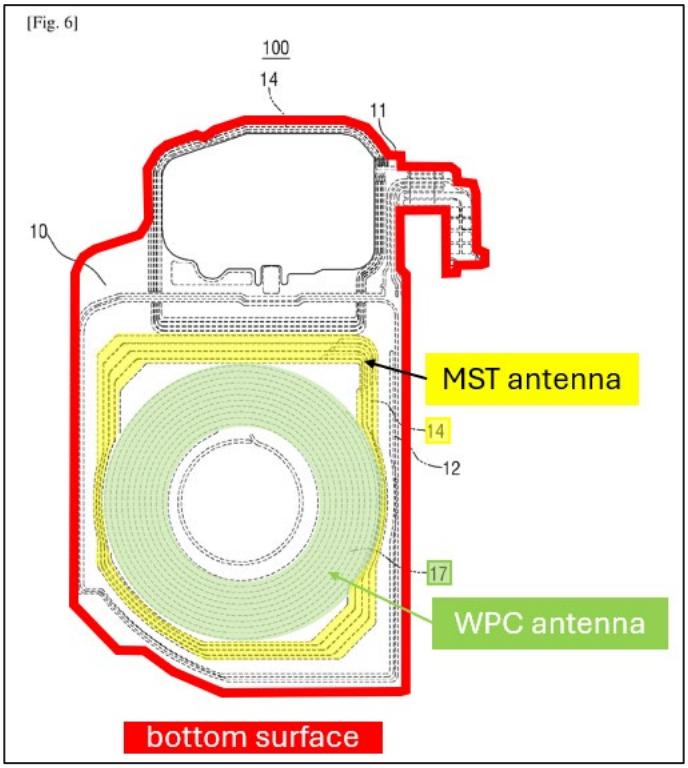
Ex1006, Figs. 5 ("antenna patterns formed on the top surface of the substrate"), 6 ("antenna patterns formed on the bottom surface of the substrate"), ¶¶33-34; *id.*, Figs. 7-13; Ex1002 ¶100.

c. [1b]

Seong teaches this limitation. Ex1002 ¶¶101-104.

Seong teaches "a composite antenna structure in which an NFC pattern, an MST pattern, and a WPC pattern are simultaneously formed on a single substrate" (first antenna pattern). Ex1006 ¶¶1, 5, 9-10, 12, 34, Abstract, Fig. 6; Ex1002 ¶102.

Seong's first antenna pattern is on the "**bottom surface**" (first major surface) and comprises "**WPC antenna**" (inner coil) and "**MST antenna**" (outer coil) surrounding "**WPC antenna**":



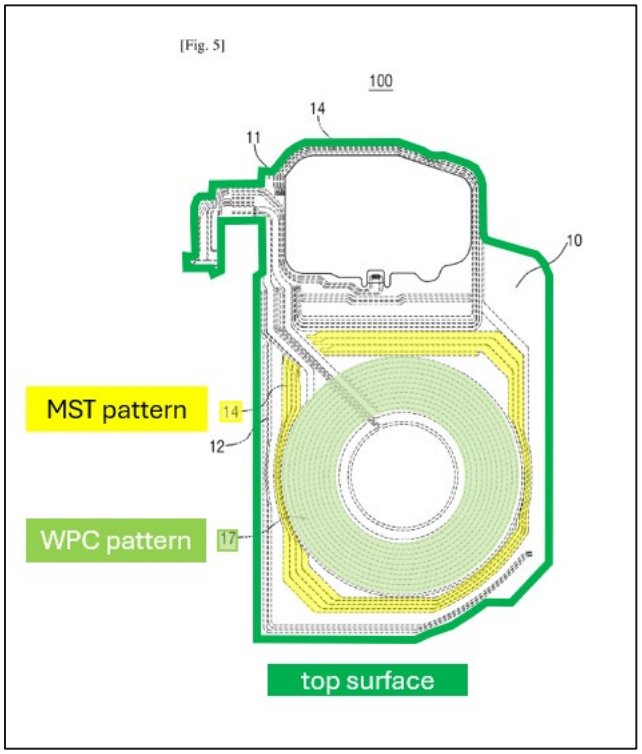
Ex1006, Fig. 6; Ex1002 ¶103.

Seong's MST, NFC, and WPC "antennas" comprise coils, including because Seong depicts coils in Figs. 5-6, 11-13, and 15. Ex1006, Abstract; Ex1002 ¶104. The '564 Patent similarly describes "MST antenna" and "NFC antenna" as "coil antennas." Ex1001, 16:24-27, 30:42-45.

d. [1c]

Seong teaches this limitation. Ex1002 ¶¶105-06.

Seong teaches a second antenna pattern on the "**top surface**" (second major surface) comprising "**WPC pattern**" (inner antenna pattern) and "**MST pattern**" (outer antenna pattern):

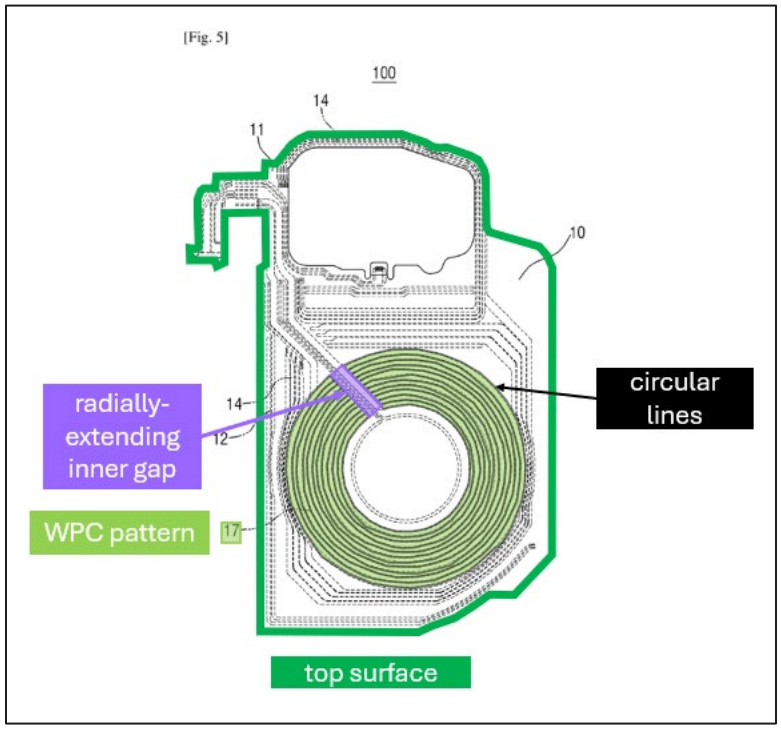


Ex1006, Figs. 5; Ex1002 ¶106.

e. [1d]

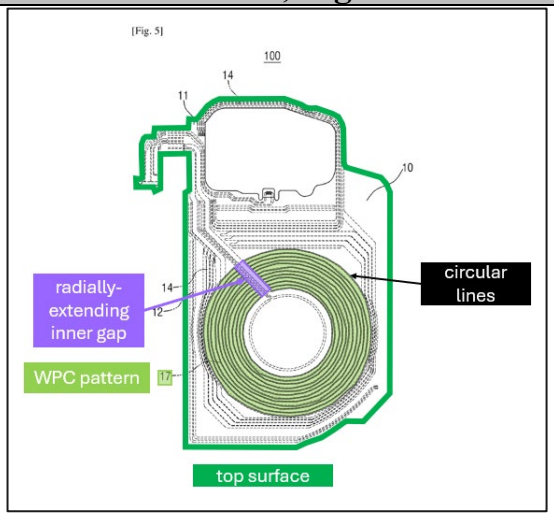
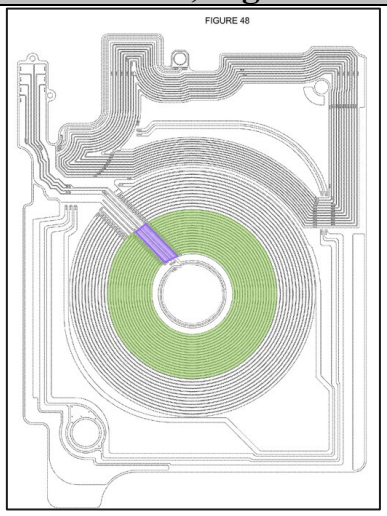
Seong teaches this limitation, or alternatively, the Seong-Kang-Cho combination renders it obvious. Ex1002 ¶¶107-115.

Seong's "**WPC pattern**" comprises a plurality of concentric **circular lines** defining a **radially-extending inner gap** into which the plurality of concentric **circular lines** of "**WPC pattern**" does not extend:

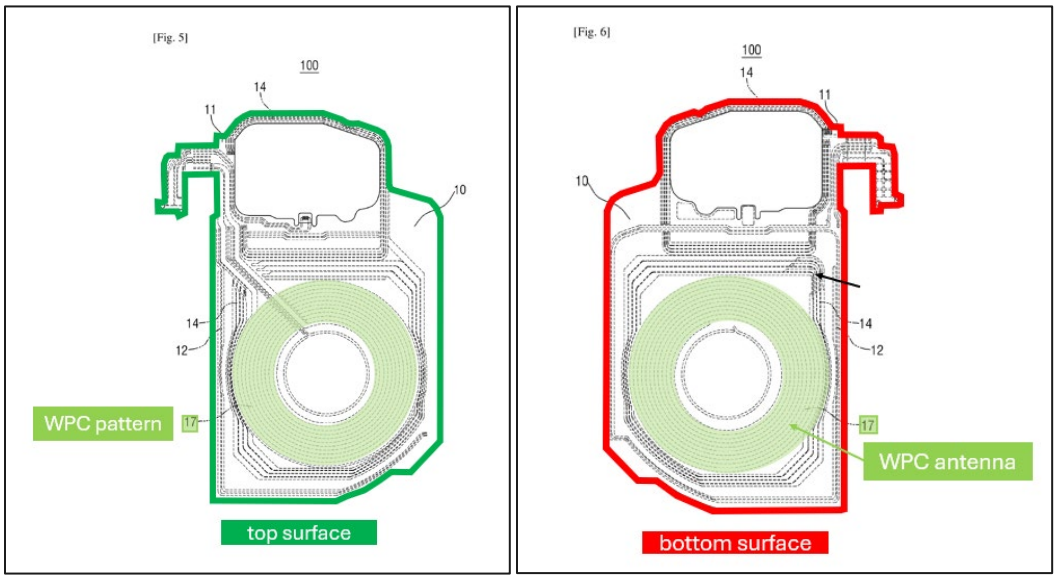


Ex1006, Fig. 5; Ex1002 ¶108.

This is at least as much disclosure as the '564 Patent:

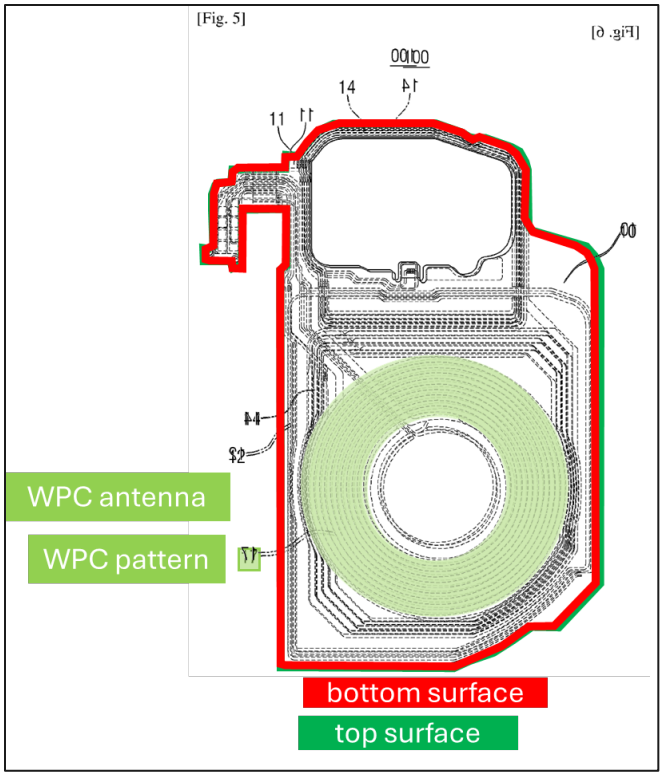
Ex1006, Fig. 5	Ex1001, Fig. 48
	

Further, at least part of the concentric **circular lines** of Seong's "**WPC pattern**" on the "**top surface**" (inner antenna pattern) overlaps "**WPC antenna**" on the "**bottom surface**" (inner coil):



Ex1006, Figs. 5, 6; Ex1002 ¶¶110.

This can be seen by overlaying Seong Figures 5-6:



Ex1006, Figs. 5-6 (inverted and combined); Ex1002 ¶111.

Further, Seong teaches and the Seong-Kang-Cho combination renders obvious, "**WPC pattern**" on the "**top surface**" is connected to "**WPC antenna**" on the "**bottom surface**" through vias. Ex1002 ¶112. Seong's coils formed on opposing surfaces of the substrate "are connected to respective terminals" to "be electrically connected to internal [smartphone] components." Ex1006 ¶¶4, 33-34, 77, Figs. 5-6. Seong depicts coils from the same antenna pattern (NFC, WPC, MST) formed on the top and bottom surfaces of the substrate. Ex1006, Figs. 5-8, ¶¶ 63, 65, 68. A POSA would have understood these coils are interconnected through the PCB using vias. Ex1002 ¶112.

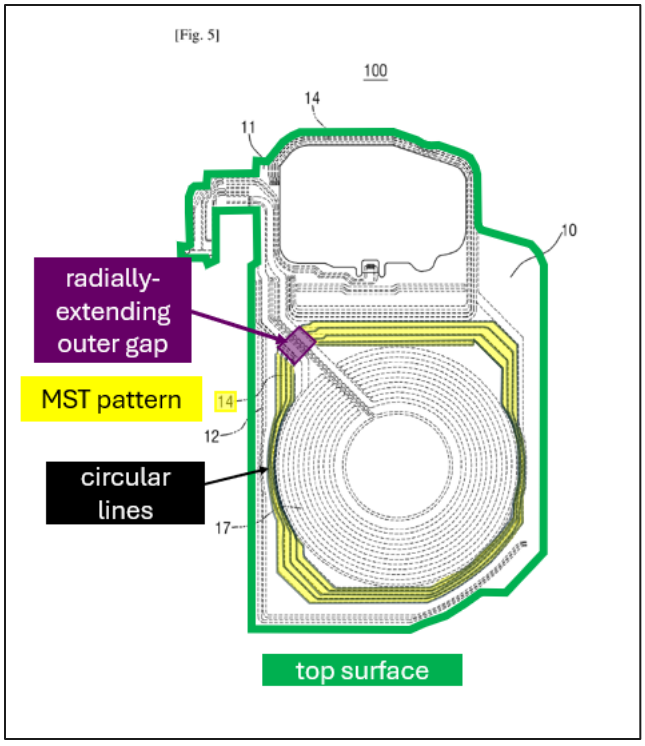
If PO incorrectly argues Seong does not teach this limitation, it would have been obvious in view of Kang and Cho. Section VIII.A.1; Ex1002 ¶¶113-114. Kang teaches electrically antenna patterns on different surfaces to each other through a plurality of "vias." Ex1012 ¶¶76, 231, 247-49, 261, 263, Cl. 6.

Cho also teaches electrically connecting antenna patterns on different surfaces to each other through a "plurality of vias." Ex1010 Cls. 2, 10, ¶¶66-67, 73.

f. [1e]

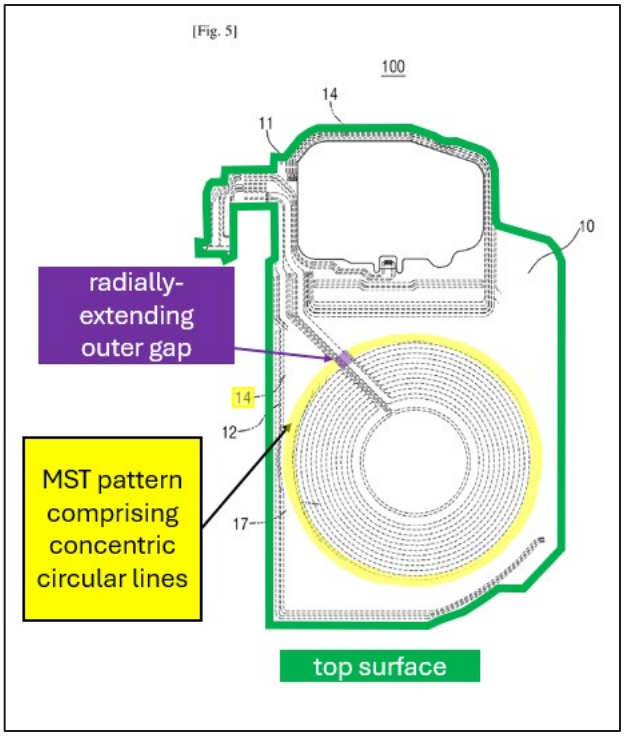
Seong teaches this limitation, or alternatively, the Seong-Kang-Cho combination renders it obvious. Ex1002 ¶¶115-124.

Seong's "**MST pattern**" (outer antenna pattern) comprises a plurality of **concentric circular lines** defining a **radially-extending outer gap** into which the plurality of concentric **circular lines** of "**MST pattern**" does not extend:



Ex1006, Fig. 5; Ex1002 ¶116.

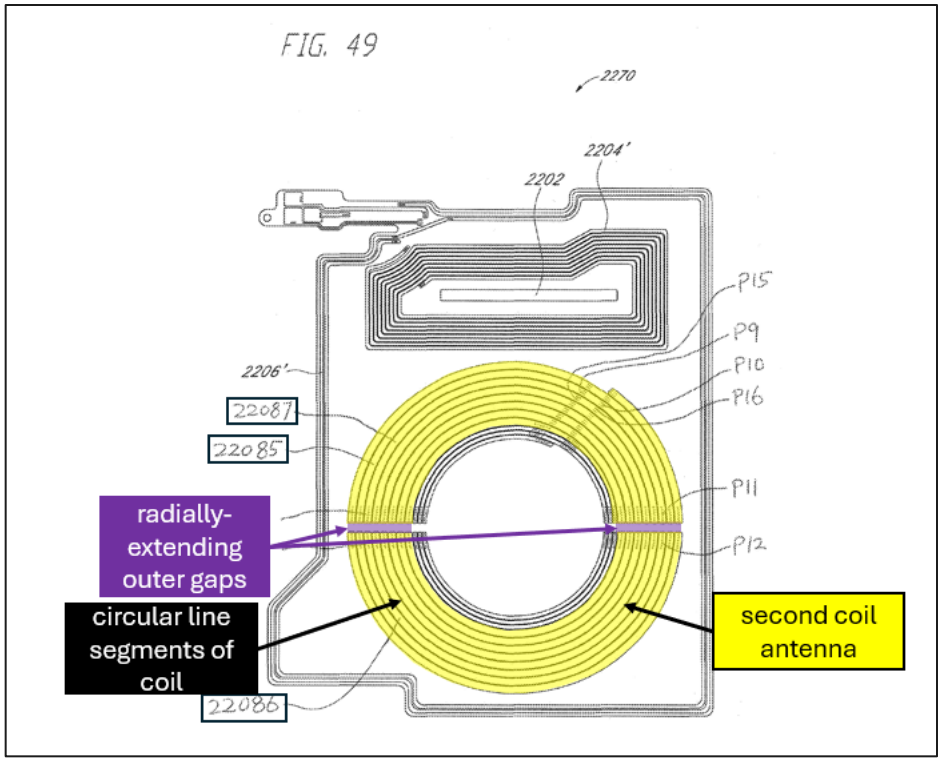
If PO argues Seong's "**MST pattern**" does not comprise circular lines, Seong renders this limitation obvious. Ex1002 ¶117. Seong's "**WPC pattern**" and "NFC pattern" are "circular" and Figures 5-6's antenna patterns' shapes, including "**MST pattern**," "may be varied as needed." Ex1006 ¶¶63, 66, 75. A POSA would have found it obvious to use a circular shape for Seong's "**MST pattern**," as shown in modified Figure 5 below. Section VIII.A.1.



Ex1006, Fig. 5 (modified based on Ex1006 ¶63 and Ex1012 ¶¶33, 179, 216, 238, 248-49, Figs. 43, 46, 48-49); Ex1002 ¶117.

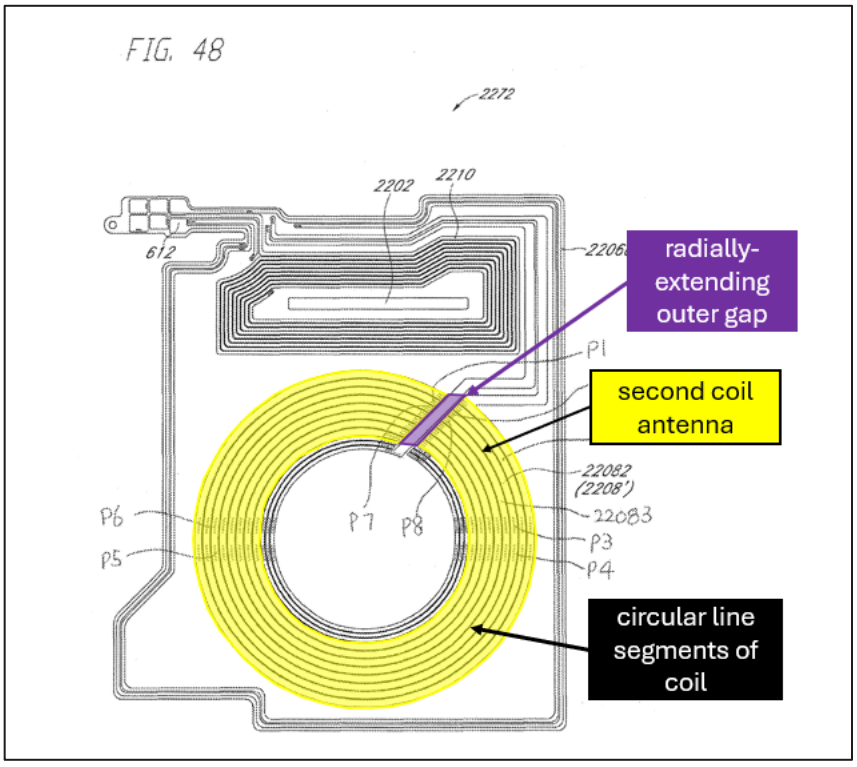
In addition, this limitation would have been obvious in view of Kang and Cho. Section VIII.A.1; Ex1002 ¶¶118-124.

Kang teaches multiple ways of comprising an outer antenna pattern out of a plurality of concentric circular lines defining a radially-extending outer gap. Kang Figure 49 teaches "**second coil antenna**" comprising a plurality of concentric circular "**line segments of coil**" defining a **radially-extending outer gap** on the "**second coil antenna**":



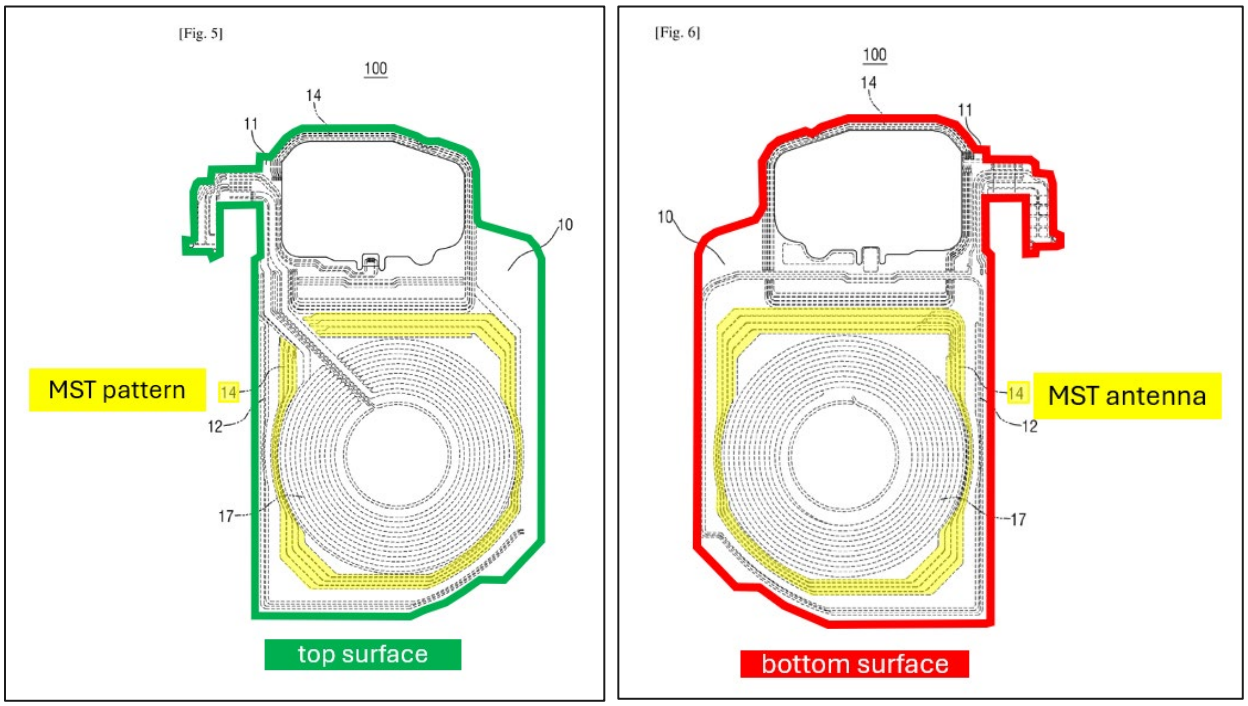
Ex1012 ¶¶26, 262, Fig. 49; Ex1002 ¶119.

Kang Figure 48 teaches this too:



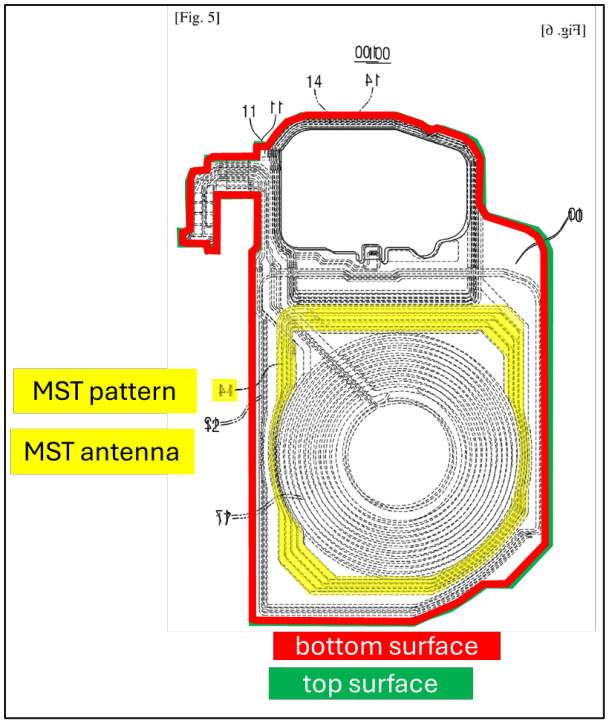
Ex1012 ¶262, Fig. 48; Ex1002 ¶120.

Further, at least part of the concentric **circular lines** of "**MST pattern**" on the "**top surface**" (outer antenna pattern) in Seong overlaps "**MST antenna**" on the "**bottom surface**" (outer coil):



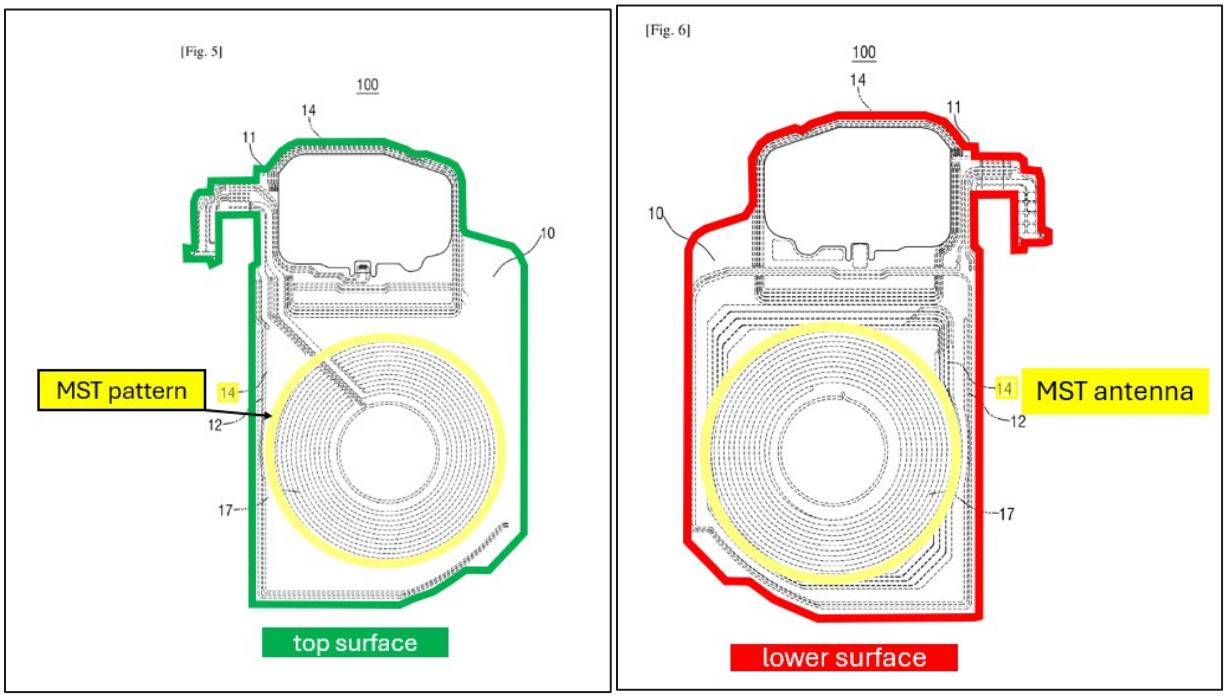
Ex1006, Figs. 5, 6; Ex1002 ¶121.

This can be seen by overlaying Seong Figures 5-6:



Ex1006, Figs. 5-6 (inverted and combined); Ex1002 ¶122.

This limitation is also met when Seongs' "**MST pattern**" and "**MST antenna**" are formed with concentric circular lines as shown below:



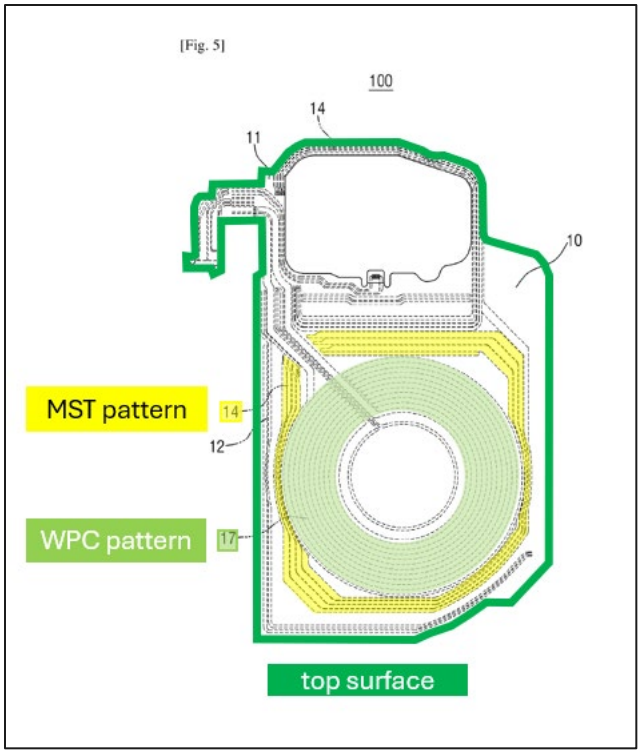
Ex1006, Fig. 5 (modified based on Ex1006 ¶63 and Ex1012 ¶¶33, 179, 216, 238, 248-49, Figs. 43, 46, 48-49); Ex1002 ¶123.

Further, Seong teaches, and the Seong-Kang-Cho combination renders obvious, "**MST pattern**" on the "**top surface** is connected to "**MST antenna**" on the "**bottom surface**" through vias. Ex1002 ¶124. Ground 1 Limitation [1d]. A POSA would have also found it obvious to apply these teachings of electrically connecting antenna patterns, including on different surfaces, using vias to Seong's outer coil and antenna pattern. Section VIII.A.1; Ex1002 ¶124.

g. [1f]

Seong teaches this limitation. Ex1002 ¶¶125-127.

At least part of the concentric **circular lines** of Seong's "**MST pattern antenna**" (outer antenna pattern) generally surround at least part of the concentric **circular lines** of "**WPC pattern**" (inner antenna pattern):



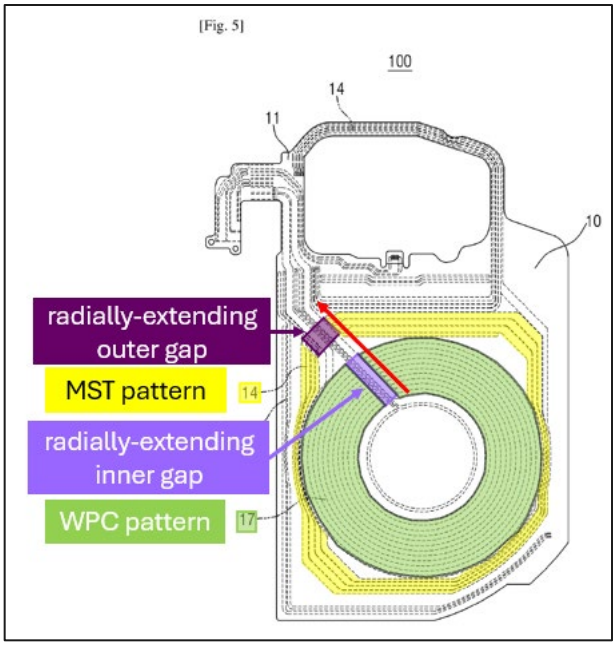
Ex1006, Fig. 5; Ex1002 ¶126.

Further, Seong teaches, and the Seong-Kang-Cho combination renders obvious, "**MST pattern**" comprising a plurality of concentric **circular lines**. Ground 1 Limitation [1e]; Ex1002 ¶127.

h. [1g]

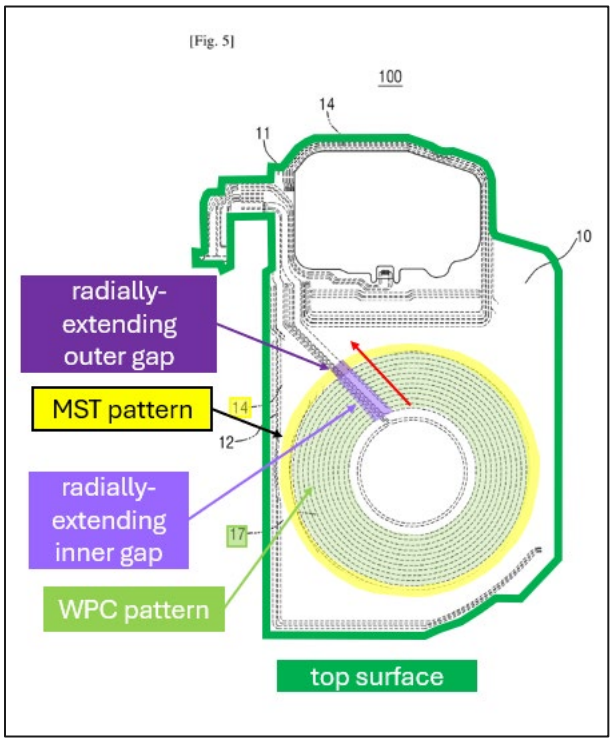
Seong teaches this limitation, or alternatively, the Seong-Kang-Cho combination renders it obvious. Ex1002 ¶¶128-134.

Seong's **radially-extending outer gap** and **radially-extending inner gap** are connected and aligned in a **direction**:



Ex1006, Fig. 5; Ex1002 ¶129.

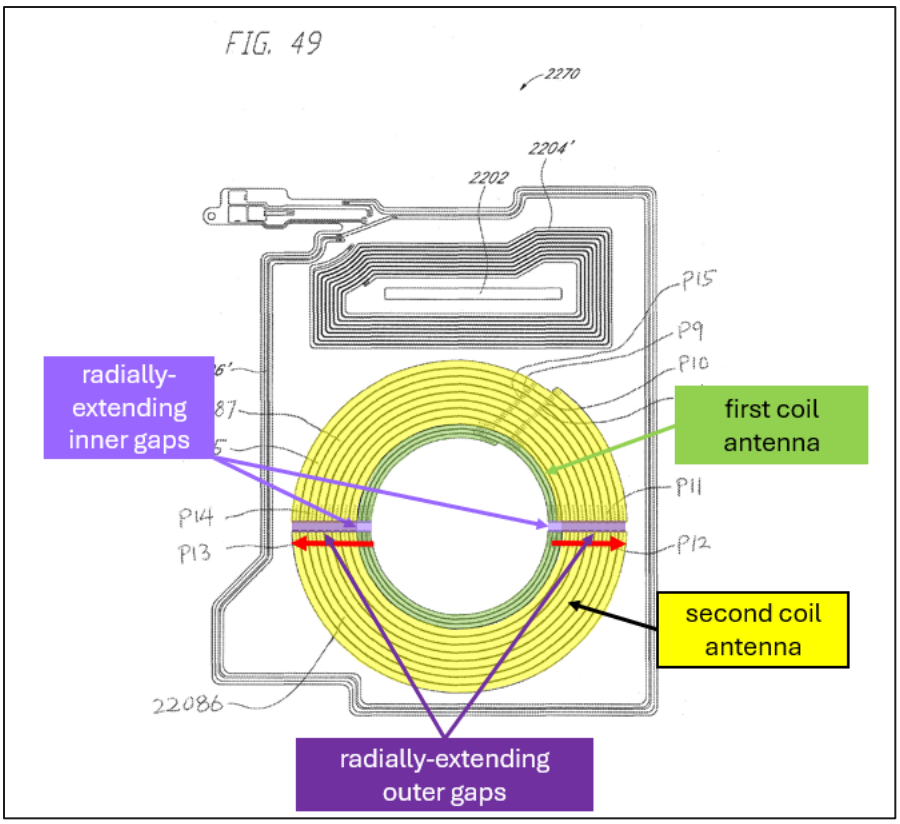
In addition, this limitation is met when "**MST pattern 14**" on Seong's "**top surface**" is circular:



Ex1006, Fig. 5 (modified, Ground 1 Limitation [1e]); Ex1002 ¶130.

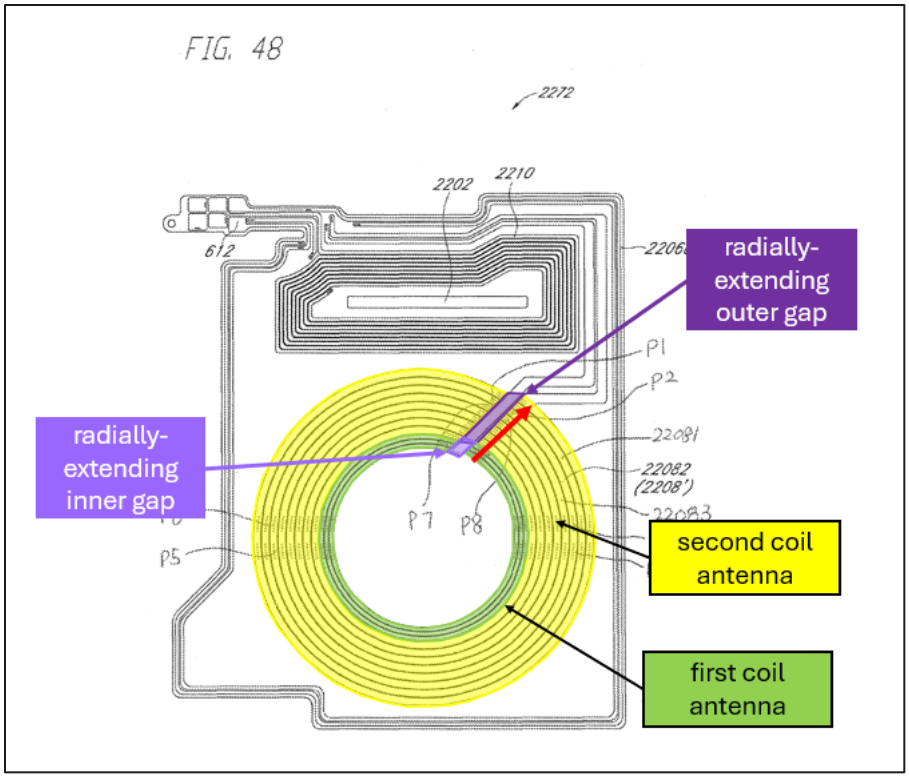
Moreover, this arrangement would have been obvious in view of Kang and Cho. Section VIII.A.1; Ex1002 ¶¶131-134.

Kang teaches multiple ways of connecting and aligning radially-extending inner and outer gaps in a direction. Kang Figure 49 teaches the **radially-extending outer gap** on Kang's "**second coil antenna**" and the **radially-extending inner gap** on Kang's "**first coil antenna**" are connected and aligned in a **direction**:



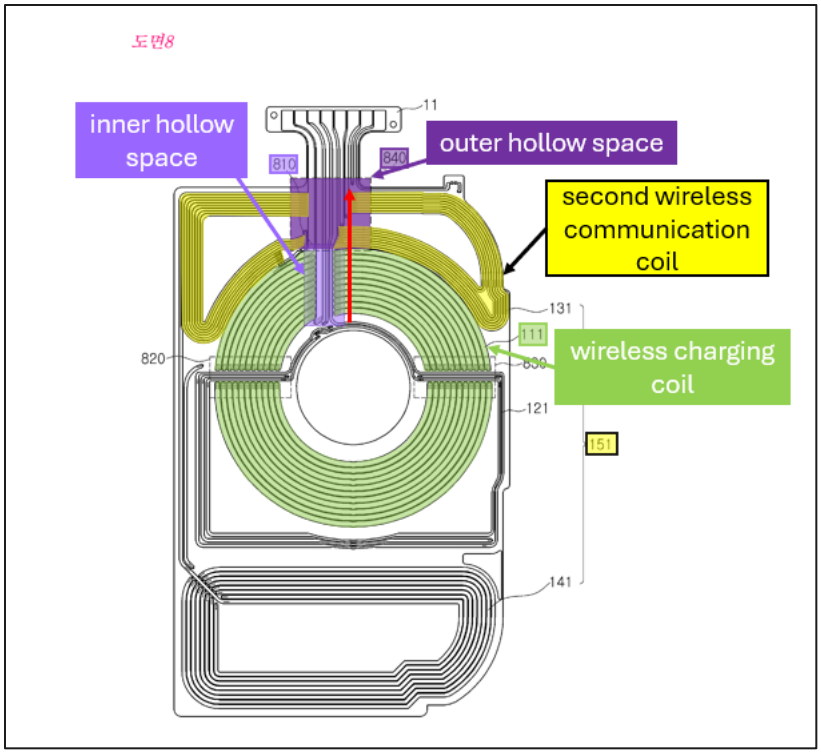
Ex1012, Fig. 49; Ex1002 ¶132.

Kang Figure 48 teaches this too:



Ex1012, Fig. 48; Ex1002 ¶133.

If PO incorrectly argues Kang does not teach radially-extending inner and outer gaps that are connected and aligned in a radial direction as described above, this would have been obvious in view of Cho. Section VIII.A.1; Ex1002 ¶134. Cho teaches radially-extending **outer** "**hollow space 840**" in "**second wireless communication coil 151**" is connected and aligned in a **direction** with **inner** "**hollow space 810**" in "**wireless charging coil 111**":



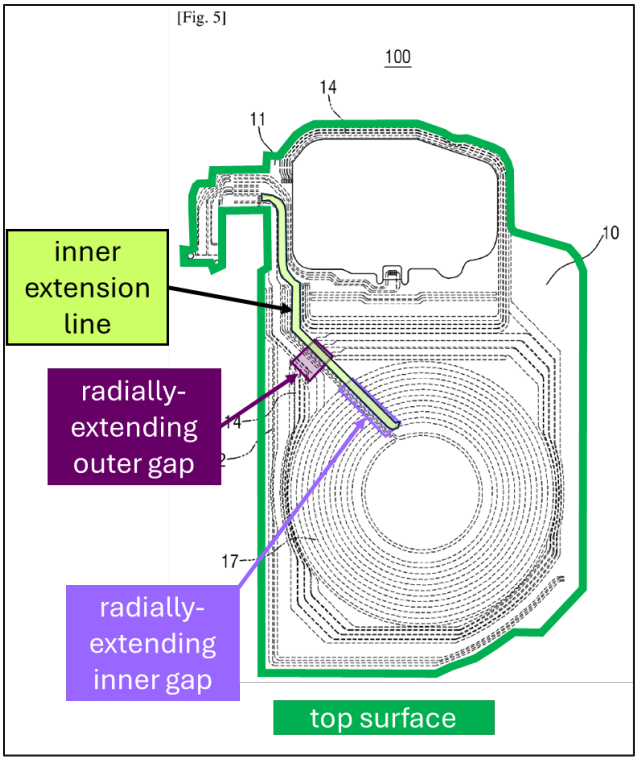
Ex1010 ¶68, Fig. 8; Ex1002 ¶134.

3. [2]

a. [2pre]

The Seong-Kang-Cho combination renders claim 1 obvious, and further, Seong teaches the remaining limitations of this claim. Ex1002 ¶¶135-136.

Seong teaches an **inner extension line** formed on the "**top surface**" (second major surface) and extending through the **radially-extending outer gap** and at least part of the **radially-extending inner gap**:

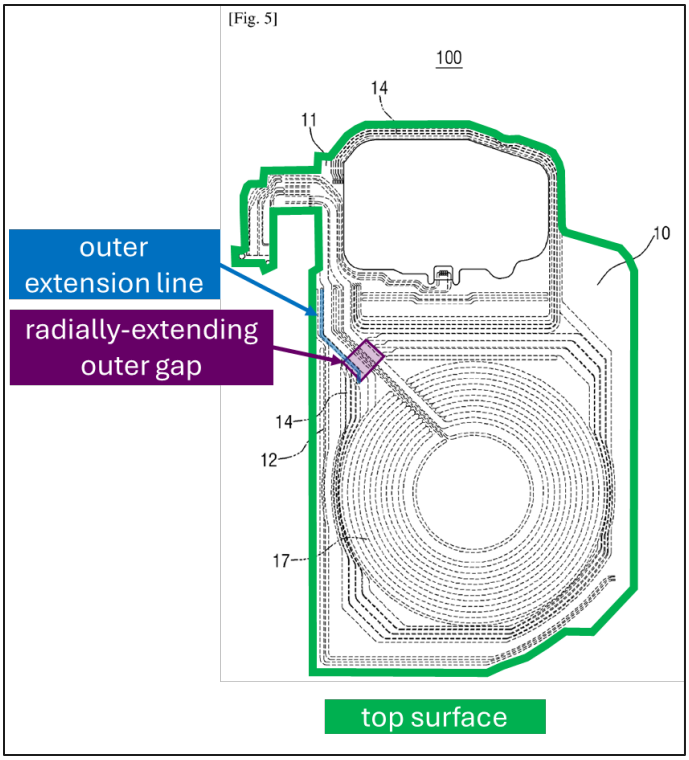


Ex1006, Fig. 5; *id.*, Figs. 11, 12, 15, ¶77; Ex1002 ¶136.

b. [2a]

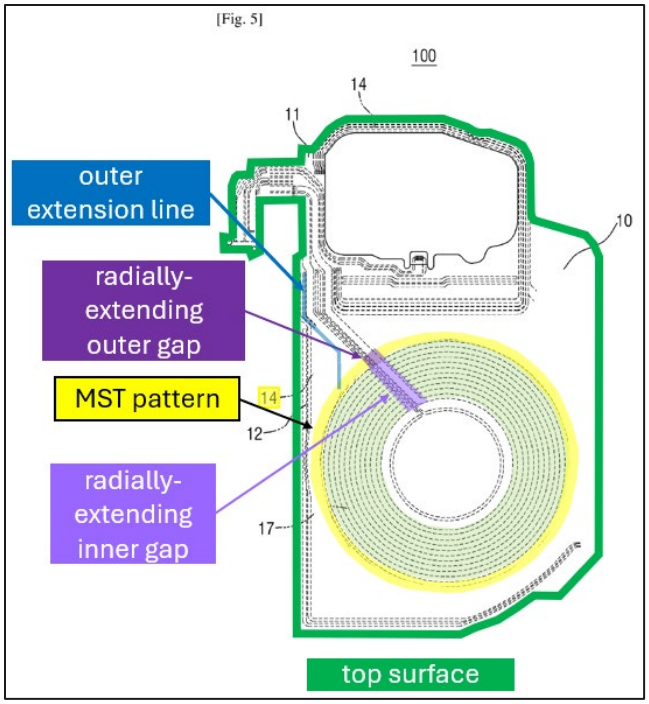
Seong teaches this limitation. Ex1002 ¶¶137-139.

Seong teaches an **outer extension line** formed on "**top surface**" (second major surface) and extending through at least part of the **radially-extending outer gap**:



Ex1006, Fig. 5; *id.*, Figs. 9, 15, ¶77; Ex1002 ¶138.

This limitation is further met when "**MST pattern 14**" on Seong's "**top surface**" is circular:

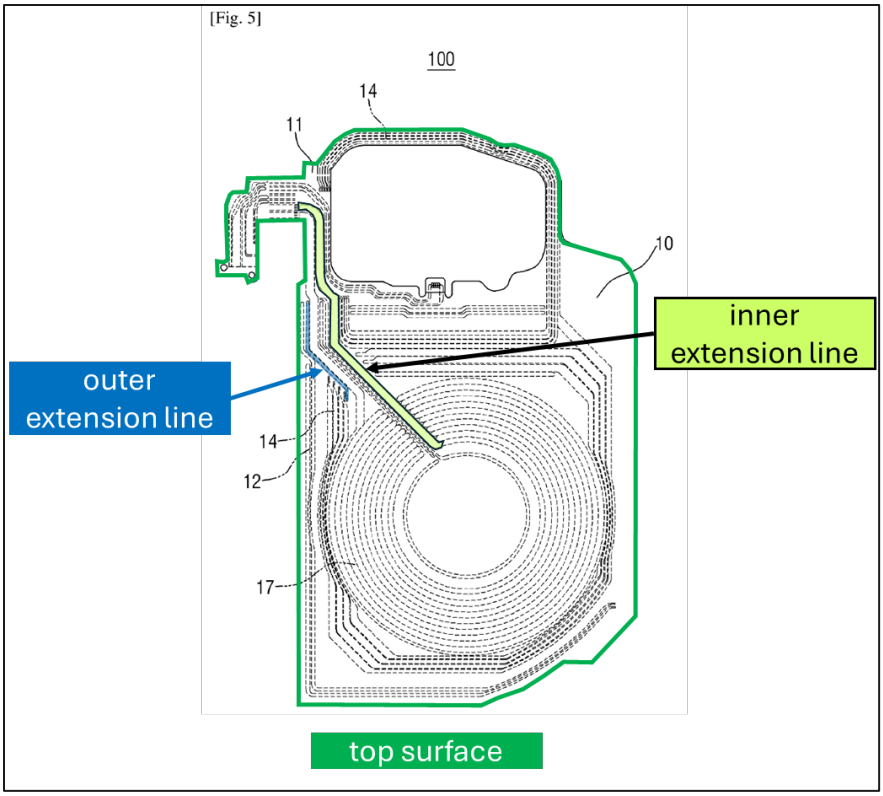


Ex1006, Fig. 5 (modified, Ground 1 Limitation [1e]/[1g]); Ex1002 ¶139.

4. [3]

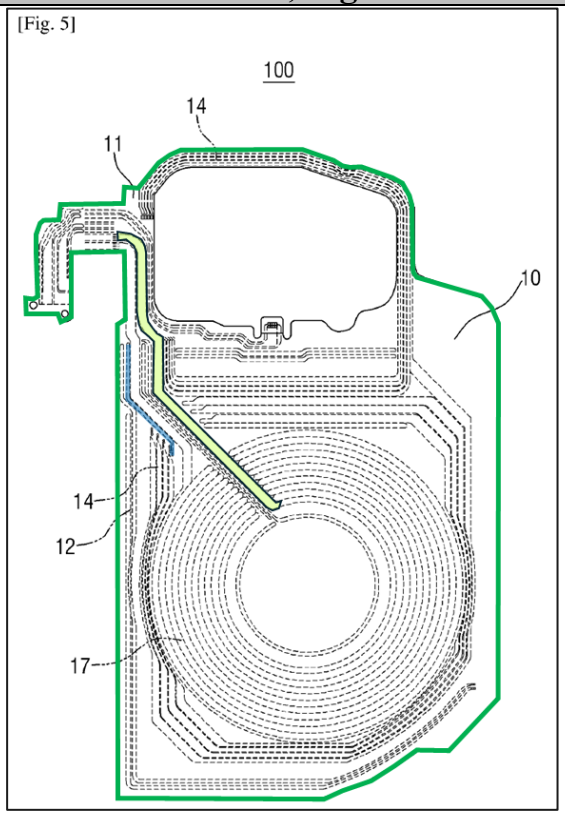
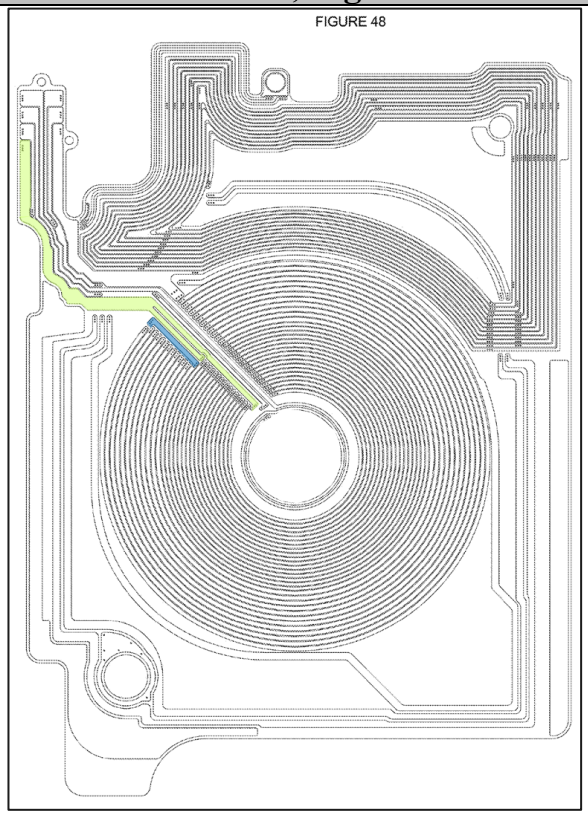
The Seong-Kang-Cho combination renders claim 2 obvious, and further, Seong teaches the remaining limitations of this claim. Ex1002 ¶¶140-145.

Seong's **inner extension line** and **outer extension line** extend generally in parallel:

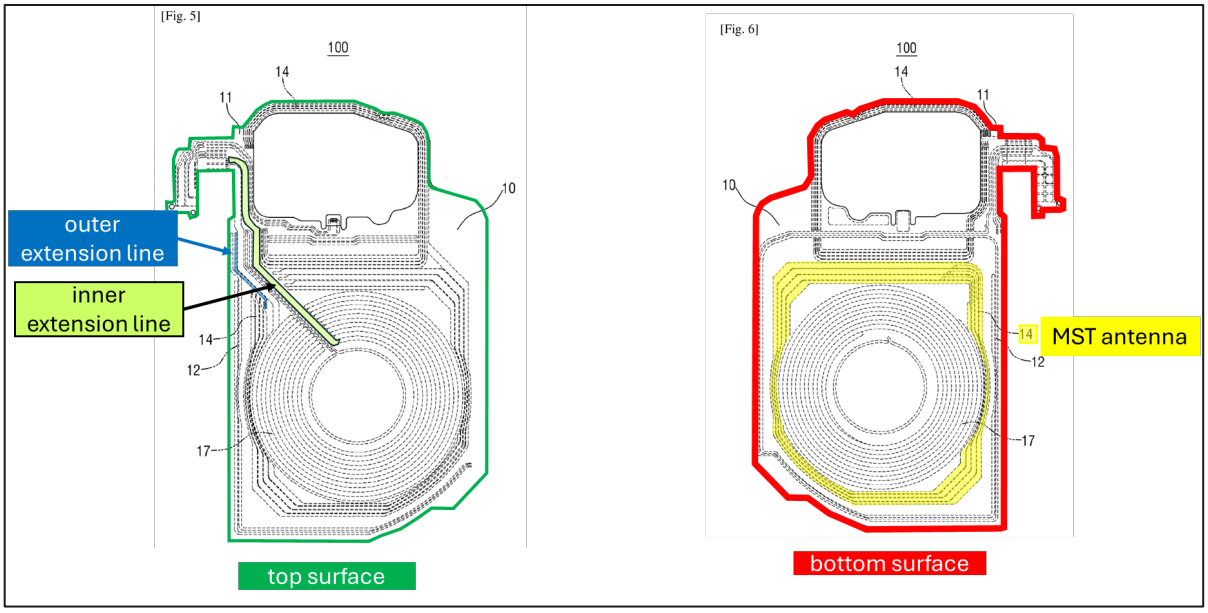


Ex1006, Fig. 5, ¶77; Ex1002 ¶141.

This is at least as much disclosure as the '564 Patent:

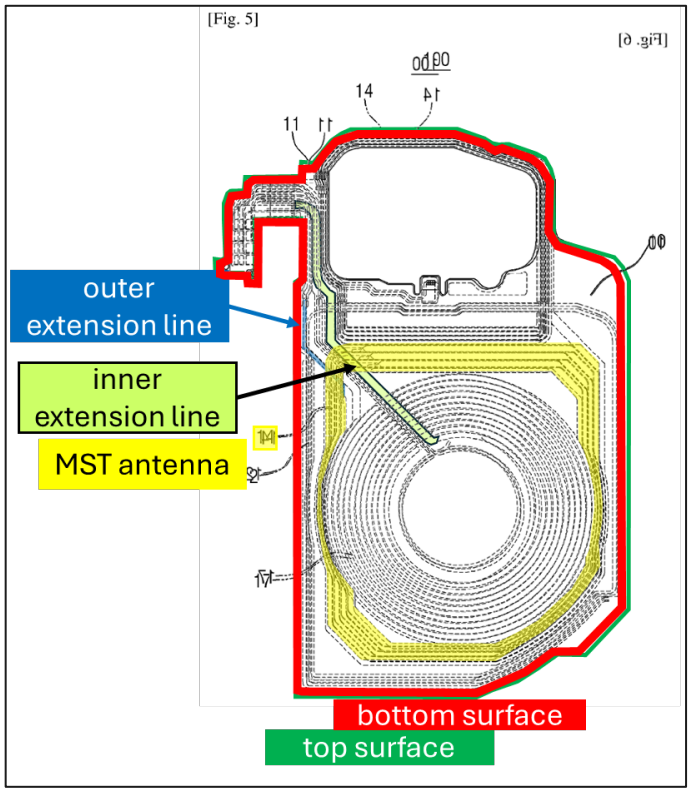
Ex1006, Fig. 5	Ex1001, Fig. 48
	

Further, in Seong, each of the **inner extension line** and **outer extension line** on the "**top surface**" (second major surface) comprises a portion that overlaps "**MST antenna**" formed on the "**bottom surface**" (first major surface):



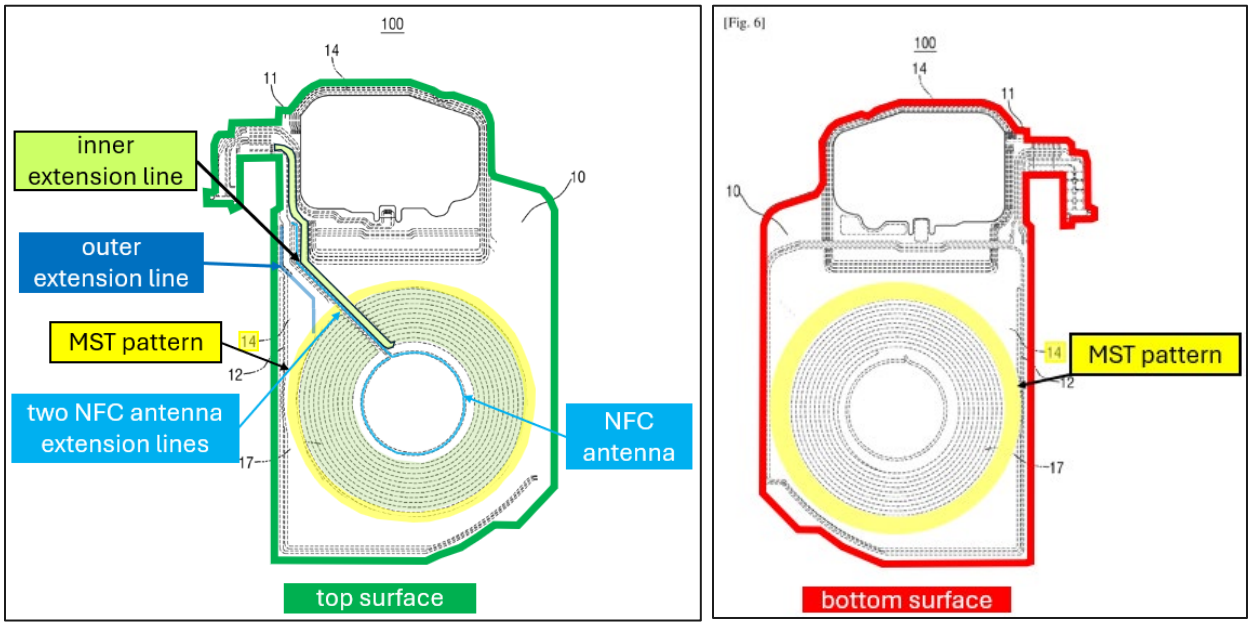
Ex1006, Figs. 5, 6, ¶77; Ex1002 ¶143.

This can be seen by overlaying Seong Figures 5-6:



Ex1006, Figs. 5-6 (inverted and combined), ¶77; Ex1002 ¶144.

This limitation is further met when "**MST pattern 14**" on Seong's "**top surface**" is circular:

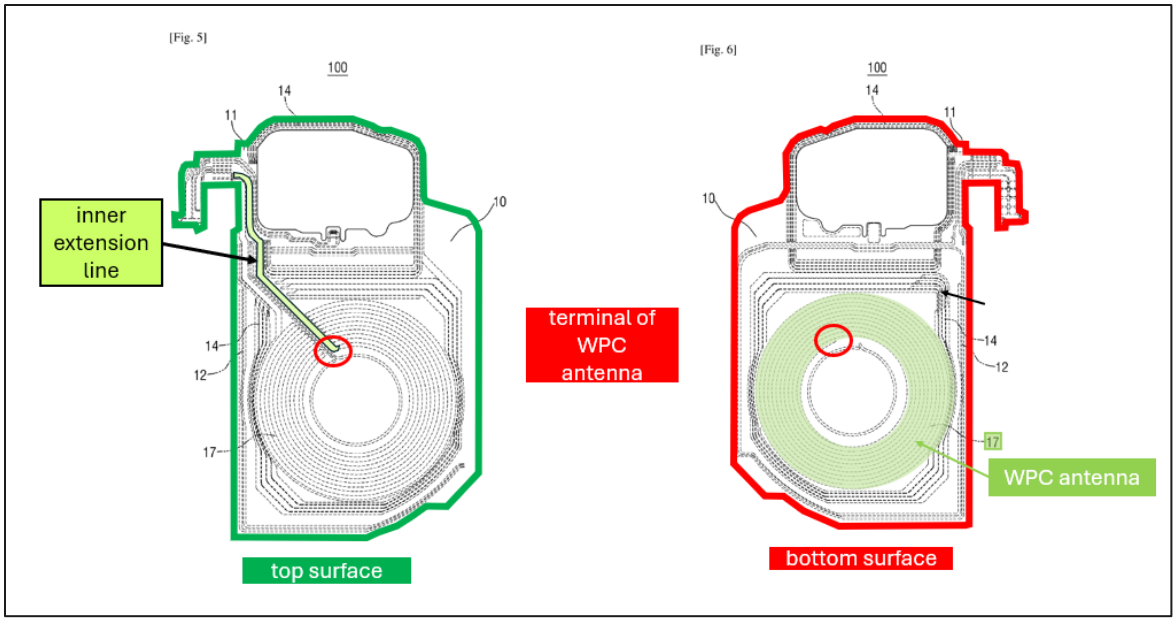


Ex1006, Figs. 5-6 (modified, Ground 1 Limitation [1e]/[1g]); Ex1002 ¶145.

5. [4]/[14]

The Seong-Kang-Cho combination renders claims 2 and 13 obvious and Seong further teaches, and the combination renders obvious the remaining limitations of these claims. Ex1002 ¶¶146-149.

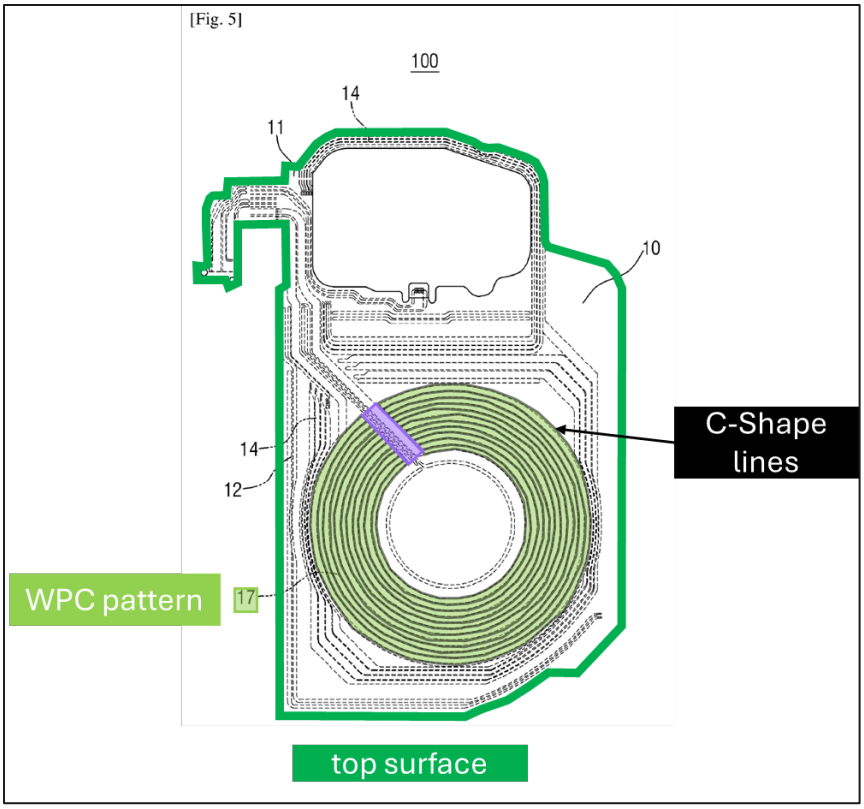
Seong's **inner extension line** is electrically connected to **a terminal** of "**WPC antenna**" by a via:



Ex1006, Figs. 5-6; *id.*, Figs. 11, 12, 15, ¶77 (Seong's coils, including WPC, are connected to "their respective terminals"); Ex1002 ¶147.

As Seong Figure 5 depicts, Seong's **inner extension line** accomplishes this. Ex1002 ¶148. Seong teaches and the Seong-Kang-Cho combination renders obvious, "**WPC pattern**" on the "**top surface** is connected to the "**WPC antenna**" on the "**bottom surface**" through vias. Ground 1 Limitation [1d]. A POSA would have understood the **inner extension line** electrically connects to a "**WPC antenna**" terminal through vias too. Ex1006 ¶¶4, 33-34, 77, Figs. 5-6; Ex1002 ¶148.

Further, at least part of the concentric circular lines of Seong's "**WPC pattern**" (inner antenna pattern) is in a C-shape:

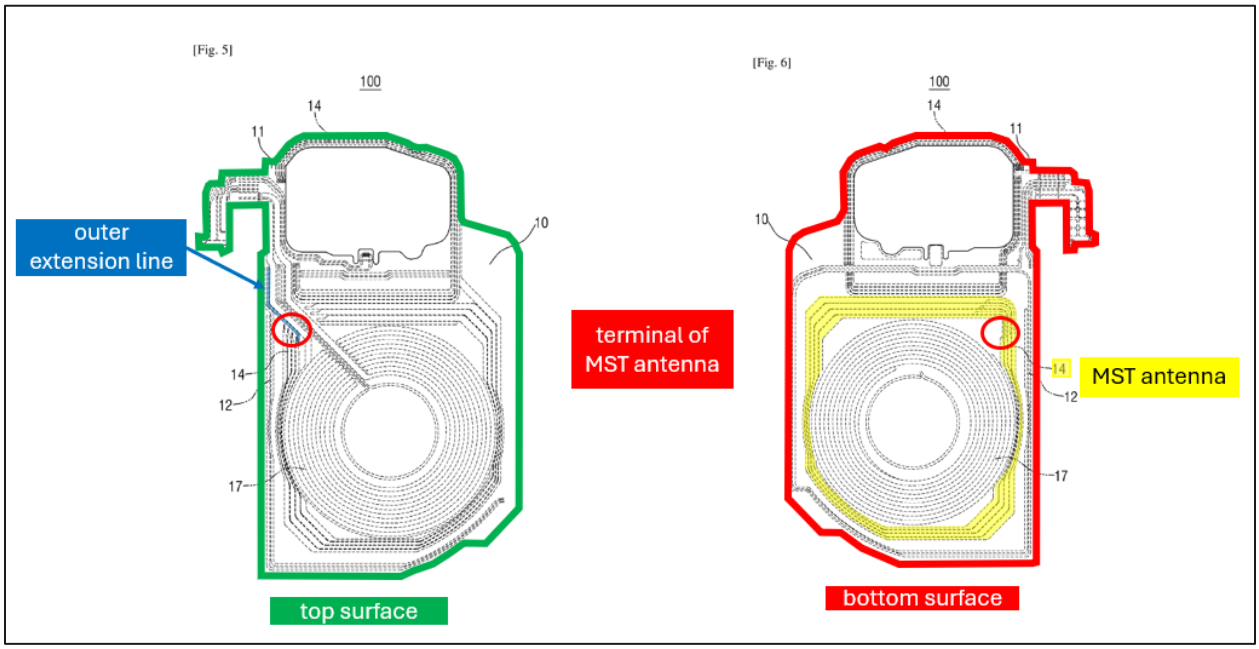


Ex1006, Figs. 5; Ground 1 Limitation [1d]; Ex1002 ¶149.

6. [5]/[15]

The Seong-Kang-Cho combination renders claims 2 and 13 obvious and Seong further teaches, or alternatively, the combination renders obvious, the remaining limitations of these claims. Ex1002 ¶¶150-153.

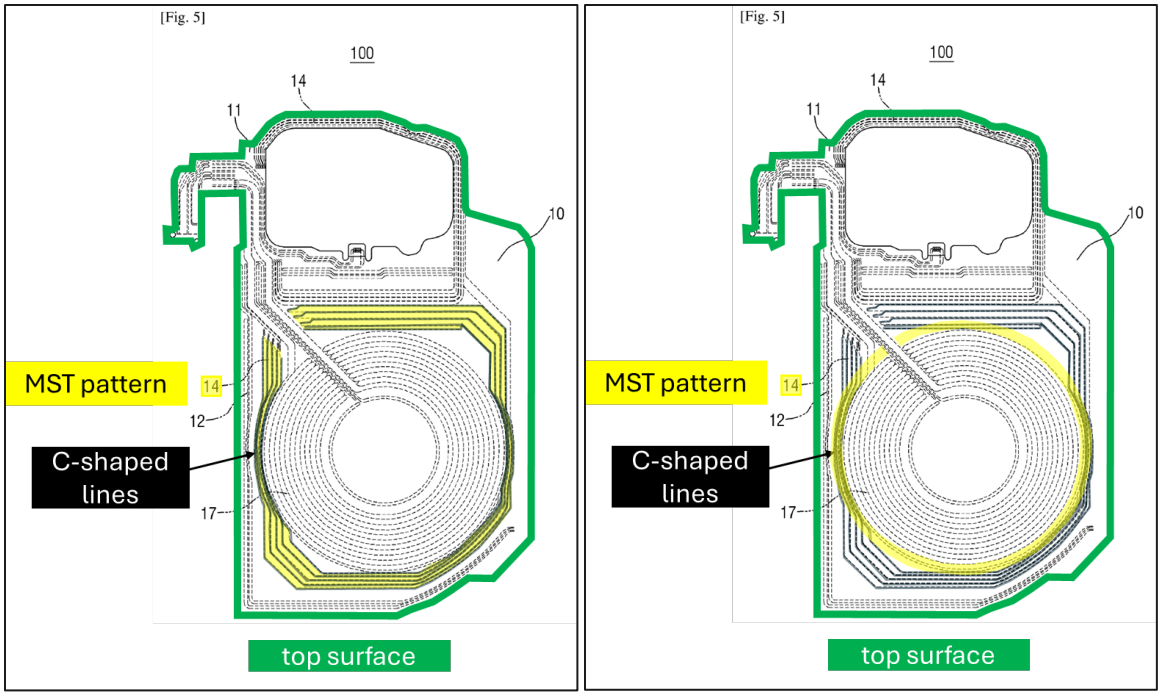
Seong's **outer extension line** is electrically connected to a "**MST antenna**" **terminal**:



Ex1006, Fig. 5-6; *id.*, Figs. 9, 15, ¶77; Ex1002 ¶151.

As Figure 5 depicts, Seong's **outer extension line** accomplishes this. Ex1002 ¶152. Seong teaches, or the Seong-Kang-Cho combination renders obvious, "**MST pattern**" on the "**top surface** is connected to the "**MST antenna**" on the "**bottom surface**" through vias. Ground 1 Limitation [1e]. A POSA would have understood the **outer extension line** electrically connects to a "**MST antenna**" terminal through vias too. Ex1006 ¶¶4, 33-34, 77, Figs. 5-6; Ex1002 ¶152.

Further, at least part of the concentric circular lines of Seong's "**MST pattern**" (outer antenna pattern) is in a C-shape:



Ex1006, Figs. 5 (figure on right modified based on Ex1006 ¶63 and Ex1012 ¶¶33, 179, 216, 238, 248-49, Figs. 43, 46, 48-49); Ground 1 Limitation [1e]; Ex1002 ¶153.

7. [6]/[17]

The Seong-Kang-Cho combination renders claims 2 and 13 obvious, and Seong further teaches, or alternatively, the combination renders obvious, the additional limitations of these claims. Ex1002 ¶¶154-156.

Seong teaches, and the Seong-Kang-Cho combination renders obvious, at least one of the **inner extension line** and **outer extension line** extension lines is electrically connected to the first antenna pattern on the "**bottom surface**" through at least one via. *Id.* Seong teaches, and the Seong-Kang-Cho combination renders obvious, the **inner extension line** and **outer extension line** are electrically connected to "**WPC antenna**" (inner coil) and "**MST antenna**" (outer coil),

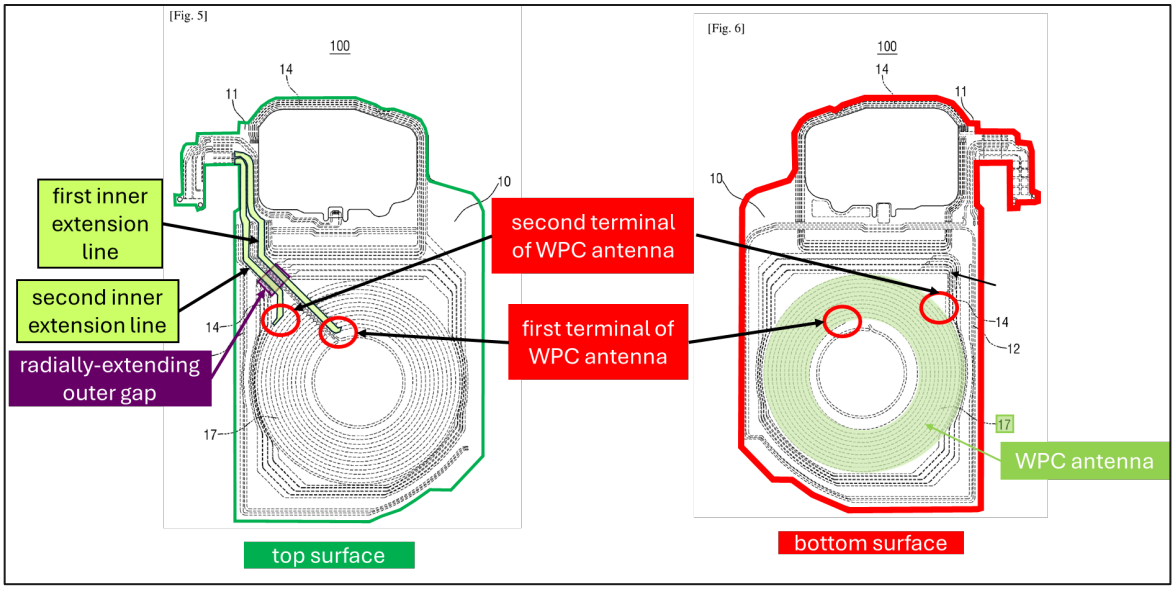
respectively, through vias. Ground 1 Limitations [4]/[14]/[5]/[15]; Section VIII.A.1; Ex1002 ¶¶155 And Seong's "**WPC antenna**" and "**MST antenna**" comprise the first antenna pattern on "**bottom surface**" (first major surface). Ground 1 Limitations [1b]; Section VIII.A.1; Ex1002 ¶156.

8. [7]/[18]

The Seong-Kang-Cho combination renders claims 2 and 13 obvious and Seong further teaches, or alternatively, the combination renders obvious, the remaining limitations of this claim. Ex1002 ¶¶157-159.

Seong's smartphone antenna module comprises a **first inner extension line** electrically connected to a **first terminal** of "**WPC antenna**" through vias. Ground 1 Limitations [4]/[14].

Further, Seong teaches and the combination renders obvious, that Seong's smartphone antenna module comprises a **second inner extension line** on the "**top surface**" (second major surface) electrically connected to a **second terminal** of "**WPC antenna**" through vias, and the **second inner extension line** extends through at least part of the **radially-extending outer gap**:



Ex1006, Figs. 5-6, ¶77; Ex1002 ¶159; Ground 1 Limitations [1e]/[4]/[14].

9. [8]/[16]

The Seong-Kang-Cho combination renders claims 1 and 13 obvious and further renders these claims obvious. Ex1002 ¶¶160-162.

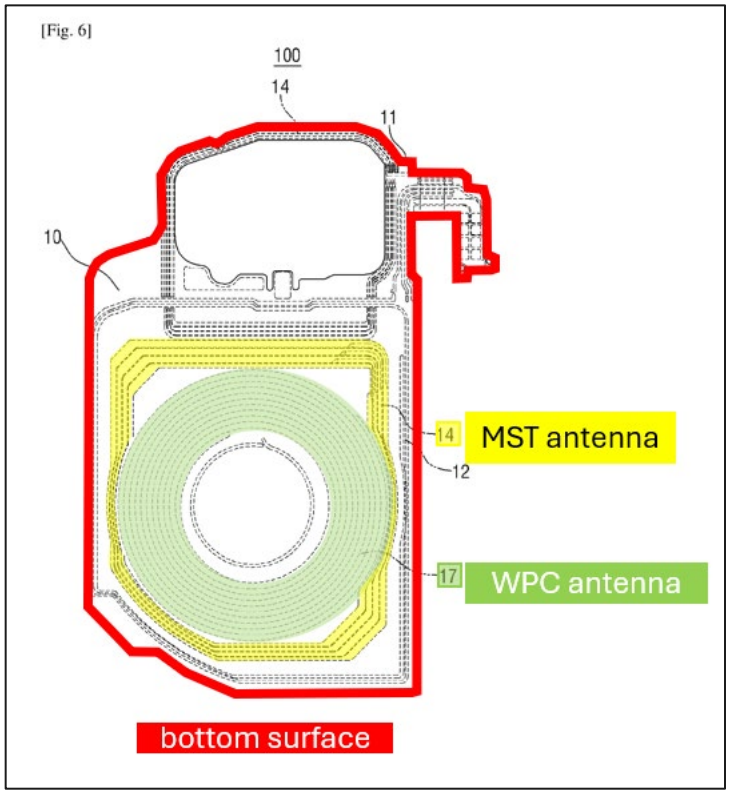
Seong's "**MST antenna**" and "**WPC antenna**" "are connected to respective terminals … 16, and 18." Ex1006 ¶77.

Seong does not, however, expressly state how the MST and WPC patterns are electrically connected. Kang teaches electrically connecting inner and outer coils in parallel. Ex1012 ¶¶150, 214, 217, 237, Figs. 24A-24B. It would have been obvious to electrically connect Seong's WPC and MST patterns in parallel in view of Kang. Section VIII.A.1.

10. [9]/[19]

The Seong-Kang-Cho combination renders claims 1 and 13 obvious and Seong further teaches the additional limitations of this claim. Ex1002 ¶¶163-167.

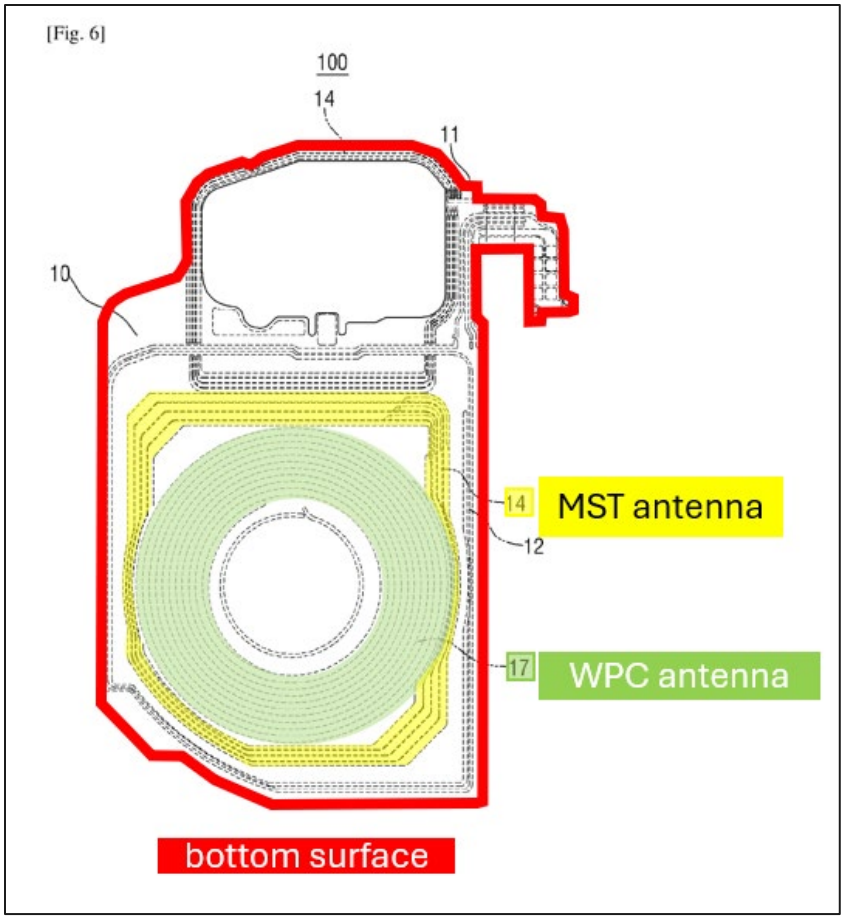
Seong's "**WPC antenna**" includes a wire line having a width different from that of a wire line of the "**MST antenna**":



Ex1006, Fig. 6; Ex1002 ¶164.

Seong's coil's wire lines' widths may vary, as Seong Figure 6 depicts. Ex1006 ¶63.

Further, Seong's "**WPC antenna**" (inner coil) has a first number of turns, and "**MST antenna**" (outer coil) has a second number of turns, wherein the first number of turns is greater than the second number of turns:



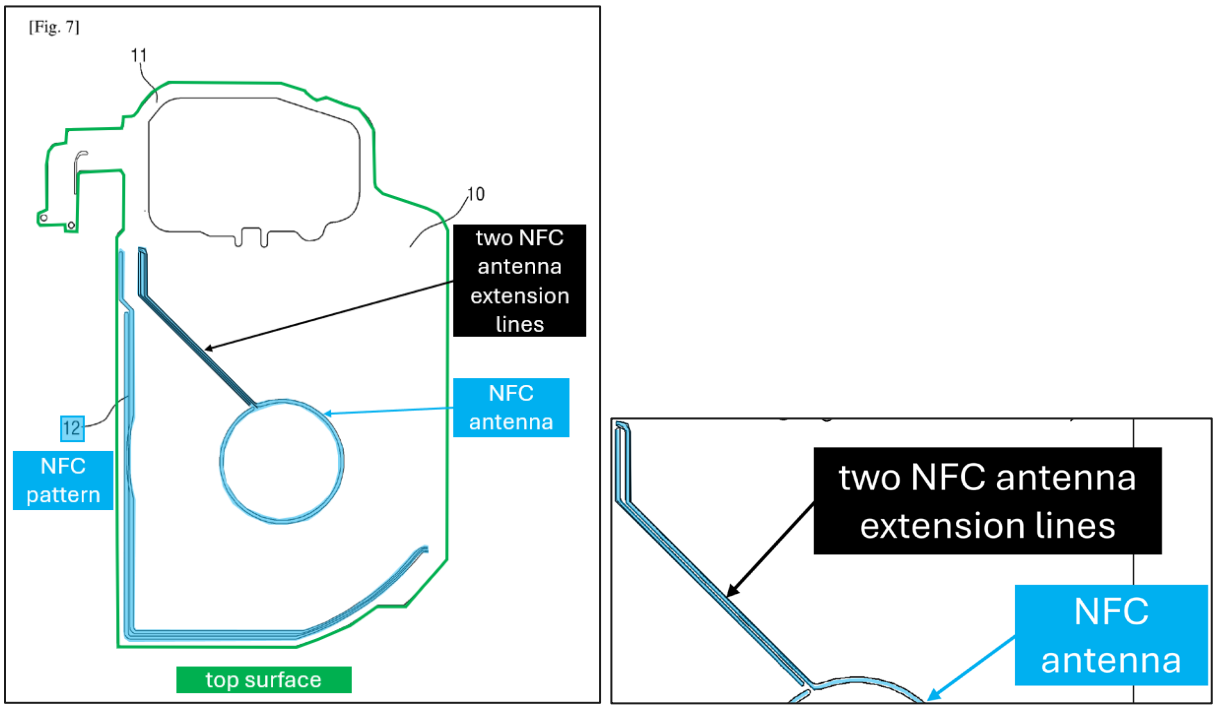
Ex1006, Fig. 6; Ex1002 ¶166.

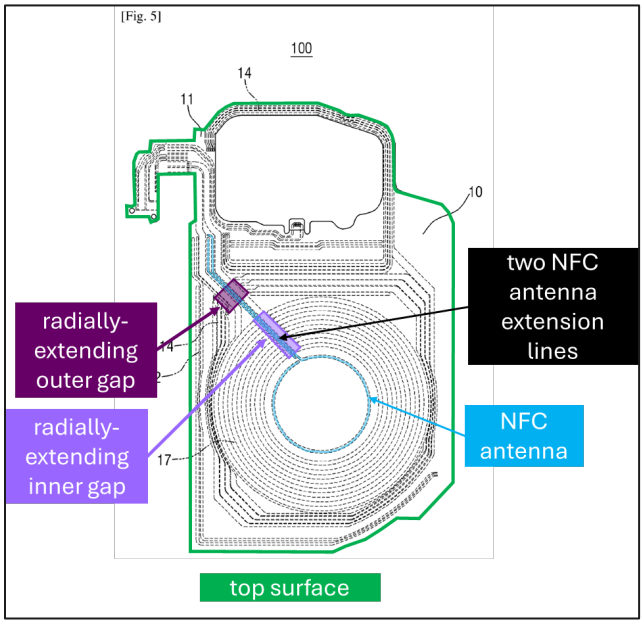
As shown above, Seong depicts "**WPC antenna**" having approximately 11 turns, and "**MST antenna**" having approximately 4 turns. Ex1002 ¶167. Further, Seong teaches "shape and layout arrangement of the antenna patterns may be varied," including the number of coil turns. Ex1006 ¶63.

11. [10]/[20]

The Seong-Kang-Cho combination renders claims 1 and 13 obvious, and Seong further teaches the additional limitations of this claim. Ex1002 ¶¶168-171.

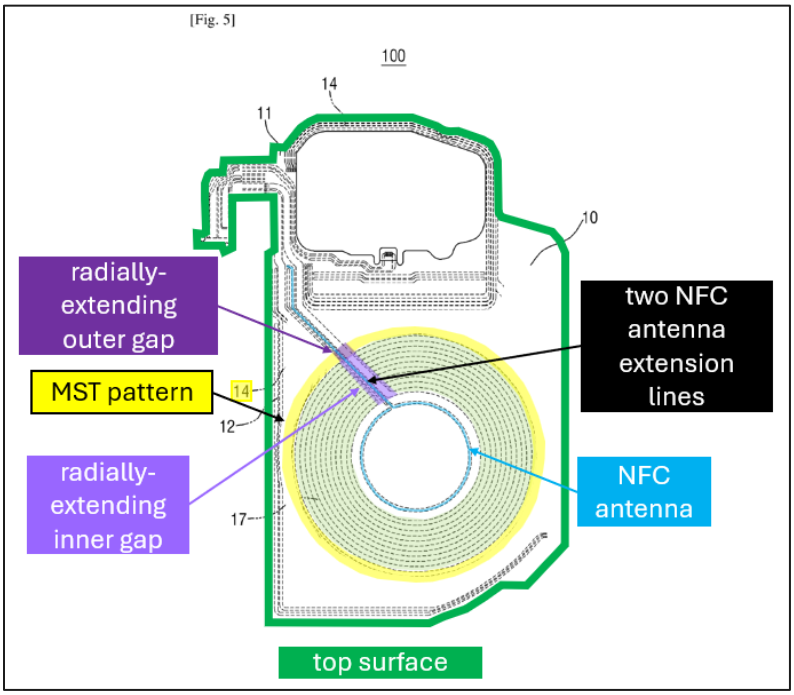
Seong teaches "**an NFC antenna**" and depicts two "**NFC antenna**" extension lines (two additional extension lines) formed on the "**top surface**" and extending through both the **radially-extending inner gap** and the **radially-extending outer gap**:





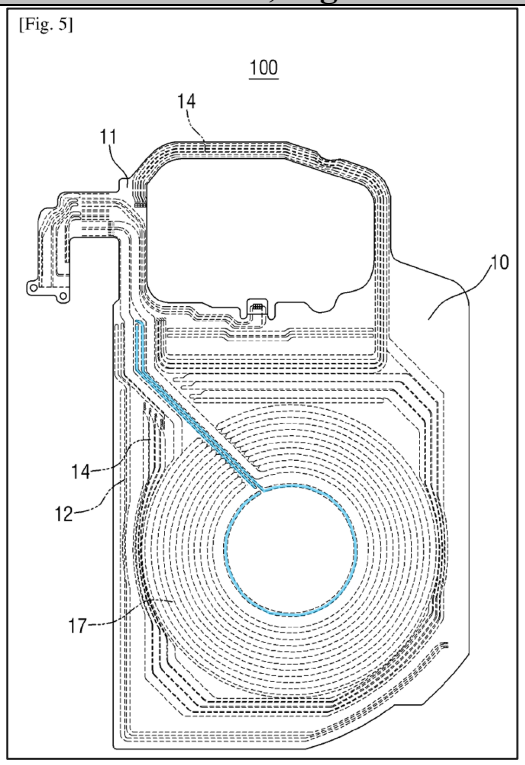
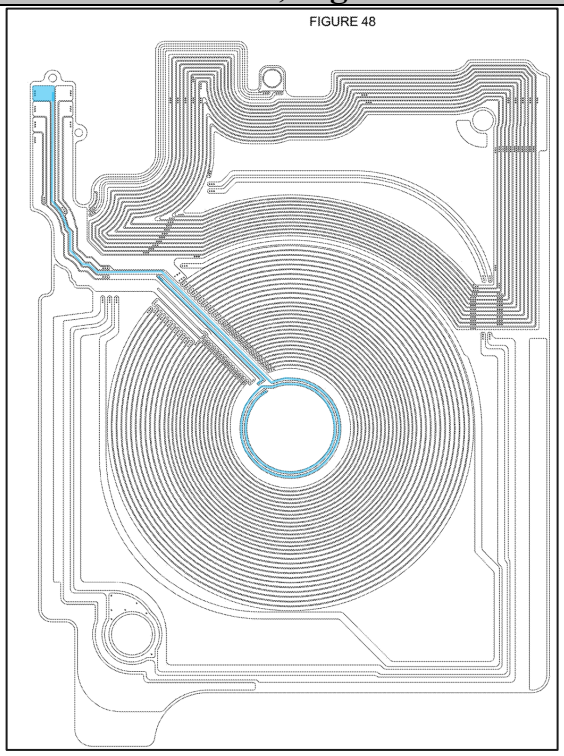
Ex1006, Figs. 5, 7, ¶¶77, 93, Cl. 13; Ex1002 ¶169.

This limitation is further met when "**MST pattern 14**" on Seong's "**top surface**" is circular:



Ex1006, Fig. 5 (modified, Ground 1 Limitation [1e]/[1g]); Ex1002 ¶170.

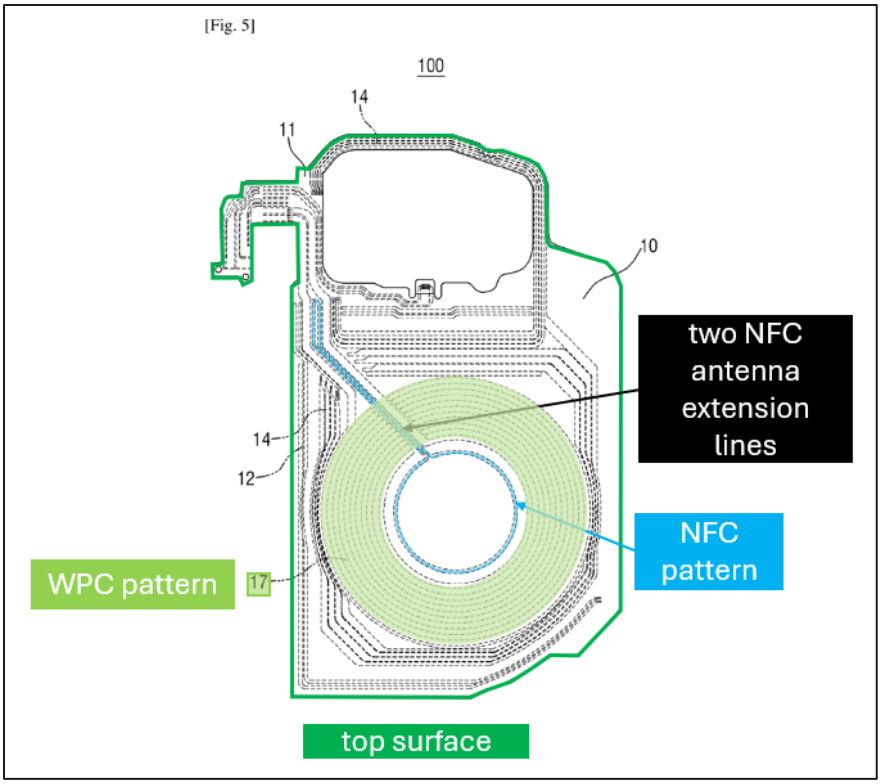
Seong's depicted **NFC antenna** and **NFC antenna extension lines** are essentially identical to those in the '564 Patent:

Ex1006, Fig. 5	Ex1001, Fig. 48
	

12. [11]/[21]

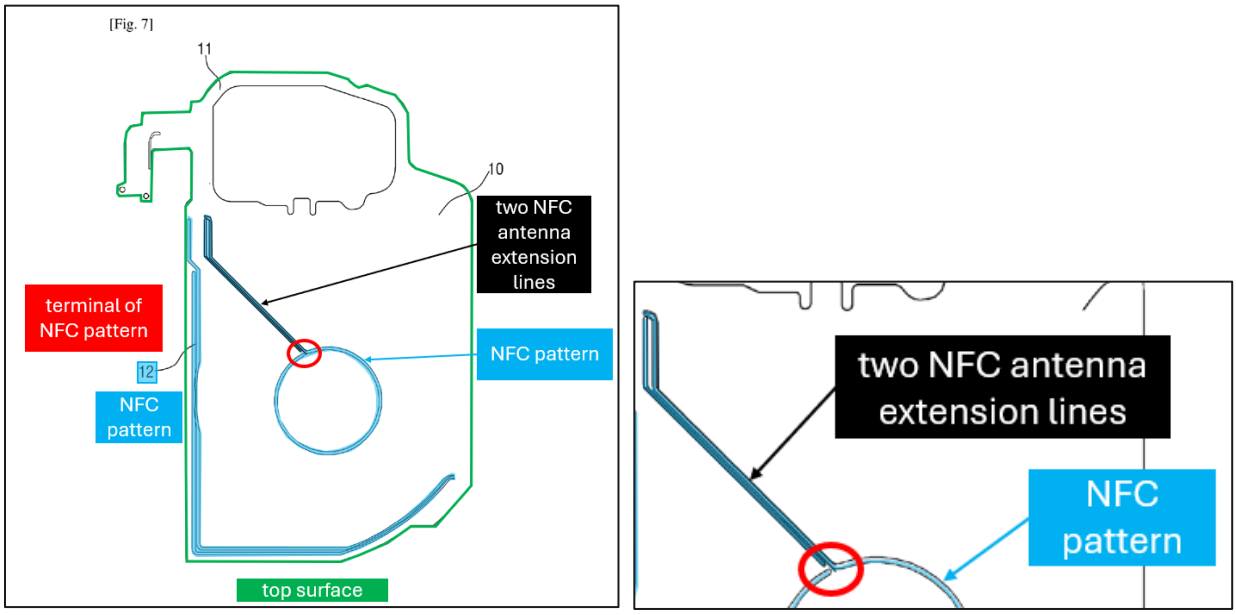
The Seong-Kang-Cho combination renders claims 10 and 20 obvious and Seong further teaches the additional limitations of these claims. Ex1002 ¶¶172-174.

Seong's "**WPC pattern**" (second antenna pattern) on the "**top surface**" (second major surface) comprises "**NFC pattern**" (third antenna pattern) that is generally surrounded by "**WPC pattern**":



Ex1006, Figs. 5, ¶¶77, 93, Cl. 13; Ground 1 Limitations [10]/[20]; Ex1002 ¶173.

Further, Seong teaches each of the two "**NFC antenna**" extension lines is electrically connected to a **terminal** of "**NFC pattern**":



Ex1006, Fig. 7, ¶¶77 (Seong's coils, including NFC, are connected to "their respective terminals"), 93, Cl. 13; Ex1002 ¶174.

13. [12]/[22]

The Seong-Kang-Cho combination renders claims 10 and 20 obvious and Seong further teaches, or alternatively the combination renders obvious, the additional limitations of these claims. Ex1002 ¶¶175-176.

For the same reasons as Ground 1 Limitations [10]/[20]/[11]/[21], Seong's "**WPC pattern**" (second antenna pattern) on the "**top surface**" (second major surface) comprises "**NFC antenna**" generally surrounded by "**WPC antenna**," wherein at least one of the two "**NFC antenna**" extension lines contacts "**NFC antenna**" on the "**top surface**." Ex1002 ¶176.

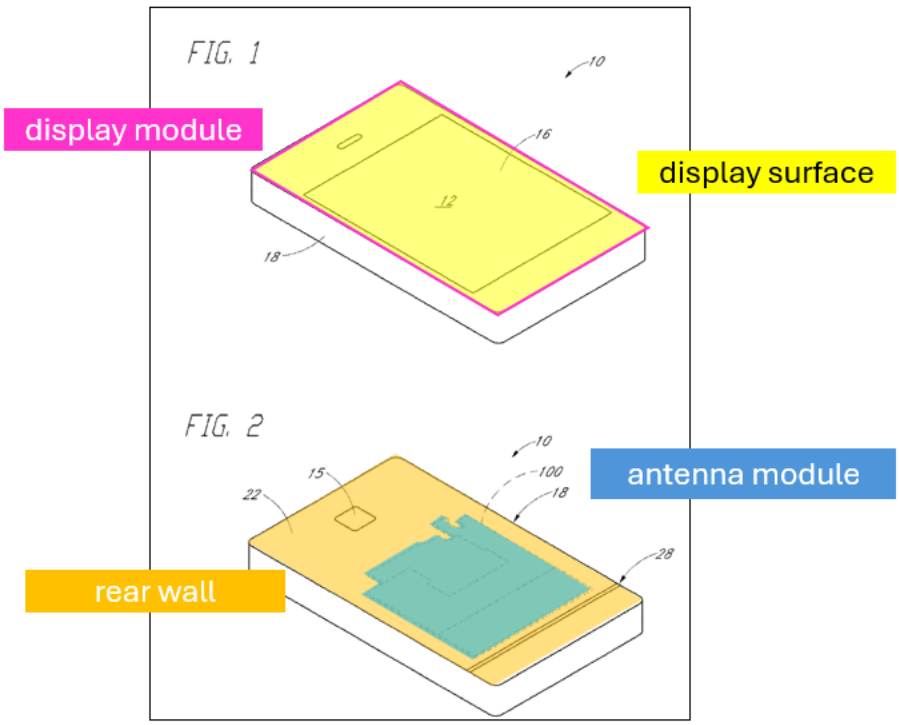
14. [13pre]/[13a]/[13b]/[13c]/[13d]

The Seong-Kang-Cho combination renders claim 2 obvious and further renders this claim obvious. Ex1002 ¶¶177-182.

Seong teaches a "smartphone[]" comprising a "battery" and an "antenna structure" "provid[ing] … wireless charging." Ex1006, Abstract, ¶¶3, 5, 12, 28, 53, 64, 75, 77, 80, Abstract. Seong's outer coil is configured for wireless battery charging and a POSA would have understood Seong's "smartphone[]" includes a display module comprising a display surface, a rear cover comprising a rear surface facing away from the display surface, a battery placed between the display module

and the rear cover, and an antenna module placed between the battery and the rear cover, because it is the most logical and common-sense arrangement; a battery between the antenna module and the rear cover would interfere with or block the wireless-charging signal. *Id* ¶¶75, 77, 80; Ex1002 ¶178.

In addition, this limitation would have been obvious in view of Kang. Ex1002 ¶¶179-182. Kang teaches configuring the inner and outer coils for wireless battery charging: "the third coil antenna is … configured for wireless charging of the smartphone." Ex1012 ¶79. Kang also teaches "[t]he second coil antenna may function as another antenna, for example, a wireless power charging antenna." *Id.* ¶¶202, 217, 239, 296 ("two coils among the multiple [can be] electrically connected in the same antenna module"). Further, Kang teaches "**display module**" comprising "**display surface**," "**rear wall**" facing away from the "**display surface**," "battery" placed between the "**display module**" and the "**rear wall**," and "**antenna module**" placed between the "battery" and the "**rear wall**":



Ex1012, ¶¶22, 178, 179, Figs. 1, 2; Ex1002 ¶179.

A POSA would have understood Kang locates its "**antenna module**" between the "battery" and the "**rear wall**" because placing the "**antenna module**" next to the "**rear wall**" is the most logical and common-sense arrangement; a battery between the antenna module and the rear cover would interfere with or block the wireless-charging signal. Ex1002 ¶180. Further, Kang's Figure 2 illustrates the "**antenna module**" flush with the "**rear wall**," leaving no space for other components, including the "battery." Ex1002 ¶180.

A POSA would have been motivated to incorporate Kang's teachings of locating the wireless-charging antenna module between the smartphone's battery

and rear cover and that the inner and outer coils can be configured for wireless battery charging with Seong to improve Seong's antenna module's performance and flexibility. Ex1002 ¶181. This would have been a simple design choice of where to locate the antenna module (including the claimed location, which would have given the wireless-charging antenna module a higher likelihood of success as compared with locating the battery between the rear cover and the antenna module) and what functionality to use for which of Seong's coils. Ex1002 ¶181.

A POSA would have reasonably expected success. Ex1002 ¶182. Seong uses its antenna module for wireless charging and teaches "shape and arrangement of the antenna patterns may vary." Ex1006 ¶63. Kang teaches "[e]ach coil can be used" for MST, NFC and wireless charging and "two coils among the multiple [can be] electrically connected in the same antenna module." Ex1012 ¶¶216-17, 238-39, 296.

B. Ground 2: Ahn Renders Claims 1-22 Obvious In View Of 721Lee

1. Motivation To Combine Ahn And 721Lee

Ahn and 721Lee overcome limited space in smartphones with space-efficient WPC, NFC, and MST antennas, optimizing shape and layout, placing coils on both sides of a substrate. Section V. A POSA reading Ahn would have been motivated to incorporate 721Lee's teachings. Ex1002 ¶¶183-187. Both references teach antenna patterns on both sides of a substrate in a smartphone, including WPC, NFC, and MST antennas. Ex1007, ¶¶113, 120, Figs. 3–4, 6–9; Ex1011, Figs. 10A–B;

Ex1002 ¶183. If Ahn is found to not expressly teach a claimed limitation, as discussed below, it would have been obvious to a POSA to adopt well-known, predictable, and finite approaches taught by 721Lee to Ahn to achieve wireless-communication functions in a space-efficient module. Ex1002 ¶183.

Ahn teaches running extension lines through disconnected coil regions to connect second and third coil wirings to connection pads. Ex1007 ¶¶73, 124, Figs. 3-4, 10. Further, a POSA would have found this arrangement obvious in view of 721Lee. Ex1002 ¶184.

Lead wirings must "traverse" coil wirings without contacting them, and running lead wirings through disconnected coil regions was a well-known solution. Ex1002 ¶185. Reading Ahn, a POSA would have been motivated to look to references including 721Lee furthering the same space-efficient goal for antenna modules. Ex1007, Figs. 3-4, 10; Ex1011, Figs.10B, 14C; Ex1002 ¶185. Ahn and 721Lee teach similar ways of achieving that goal—coils on both sides of a substrate, those coils surrounding each other, and extension lines running to those coils through radially-extending gaps. Ex1007, ¶¶72-73, 124, Figs. 4, 10; Ex1011, ¶140, Figs. 10B, 14C; Ex1002 ¶185. Further, 721Lee teaches inner and outer gaps ("interval[s]" of inner and outer coils, which "have the opened loop form") and explains gaps beneficially allow concentric coils to "be connected to input/output terminals" using extension lines:

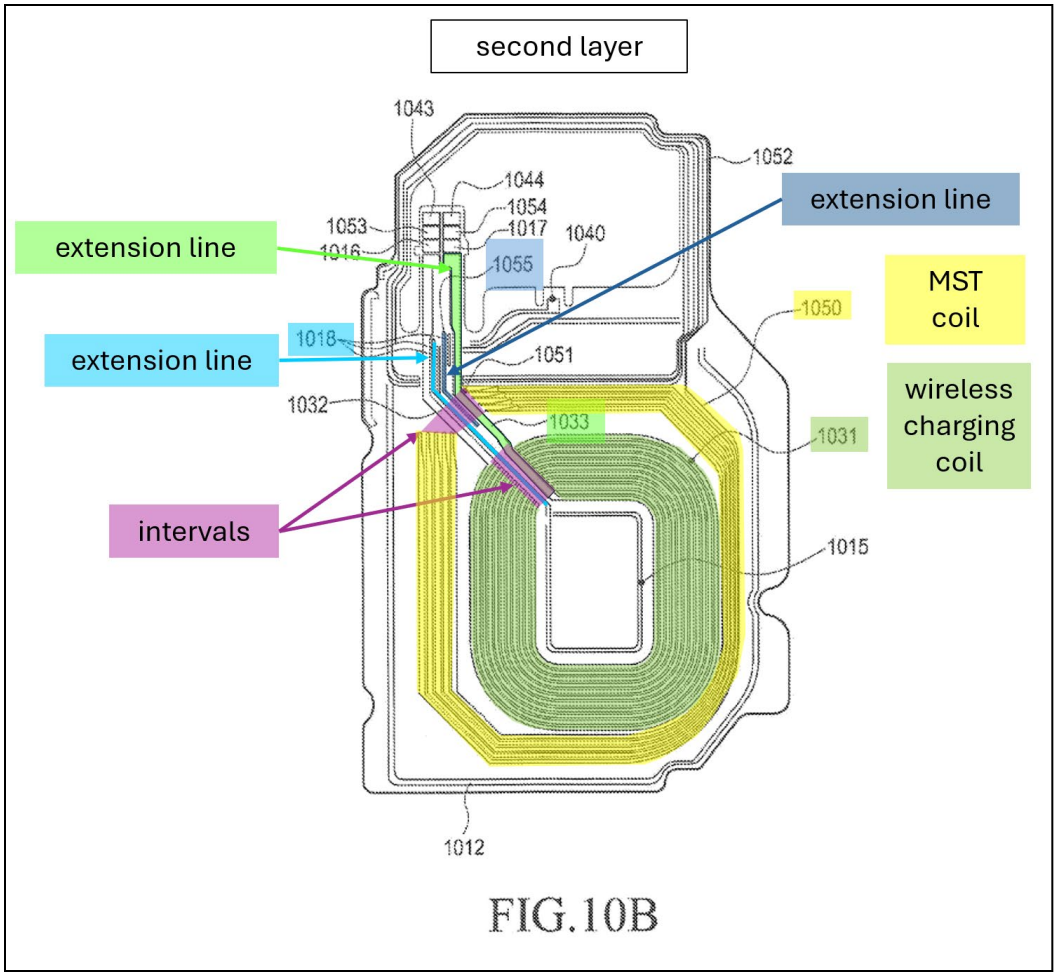


FIG.10B

Ex1011 ¶140, Fig. 10B; Ex1002 ¶185.

A POSA would have been motivated to incorporate 721Lee's gaps teachings with Ahn to achieve this benefit and further optimize space-efficiency by running extension lines to concentric coils through gaps. Ex1002 ¶186. Running extension lines through outer coils was known to improve space efficiency by up to 70% (Ex1014 ¶31), including by letting the coils be arranged in a space-efficient, concentric manner, as 721Lee teaches. Ex1011, ¶140, Figs. 10B, 14C; Ex1002 ¶186.

A POSA would have reasonably expected success. Ex1002 ¶187. Ahn uses an extension line traversing a radially-extending inner gap to connect the inner

antenna coil to the external connection pad and explains the second and third coils also need to connect to the connection pad. Ex1007, ¶¶77, 124. Further, Ahn teaches various antenna shapes and layouts are possible. Ex1007, ¶¶111, 126. Running other extension lines through antenna coil gaps would have been a straightforward implementation of a known antenna-pattern layout to achieve predictable results of a space-efficient operable antenna. Ex1002 ¶187.

2. [1]

a. [1pre]

To the extent the preamble is limiting, Ahn teaches it. Ex1002 ¶¶188-190.

Ahn teaches a smartphone "antenna" "coil assembly":

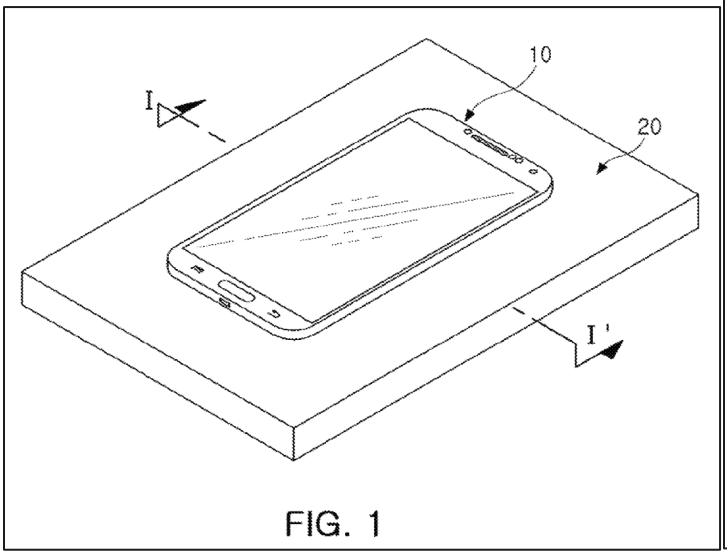


FIG. 1

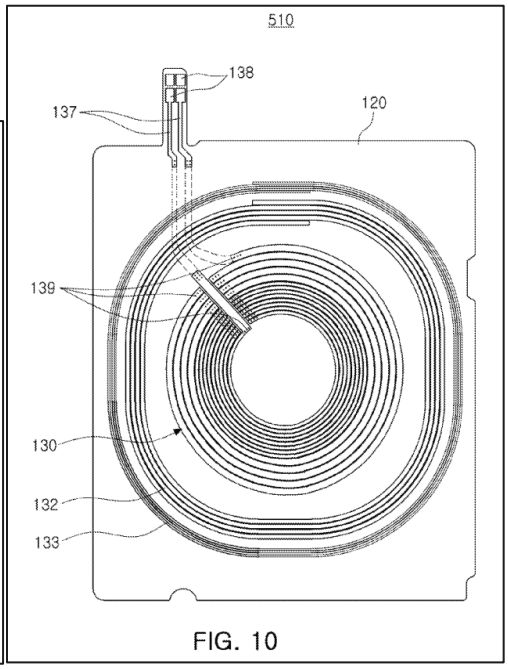


FIG. 10

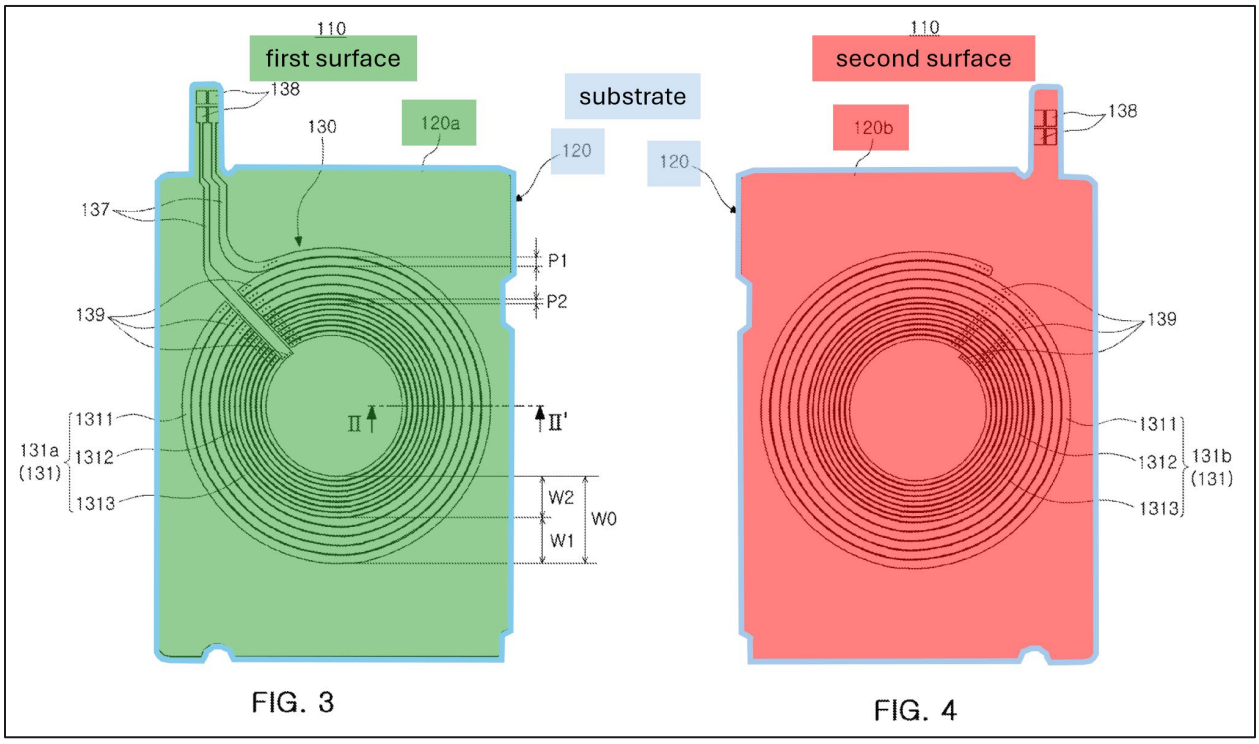
Ex1007, Abstract, ¶¶23, 47-48, 125, Cl. 18, Figs. 1, 10.

This is a smartphone antenna module at least because it comprises multiple antennas. Ex1002 ¶190.

b. [1a]

Ahn teaches this limitation. Ex1002 ¶¶191-194.

In Ahn, "**substrate 120**" has "**second surface 120b**" (first major surface) and "**first surface 120a**" (second major surface). Ex1007 ¶71, Figs. 3-4. Ahn's "**first surface 120a**" and "**second surface 120b**" face away from each other—they are "opposite surfaces of the substrate":



Ex1007 ¶¶27-28, 71, Figs. 3-4; Ex1002 ¶192.

Ahn Figure 10 also depicts the "**first surface**" of "**substrate 120**":

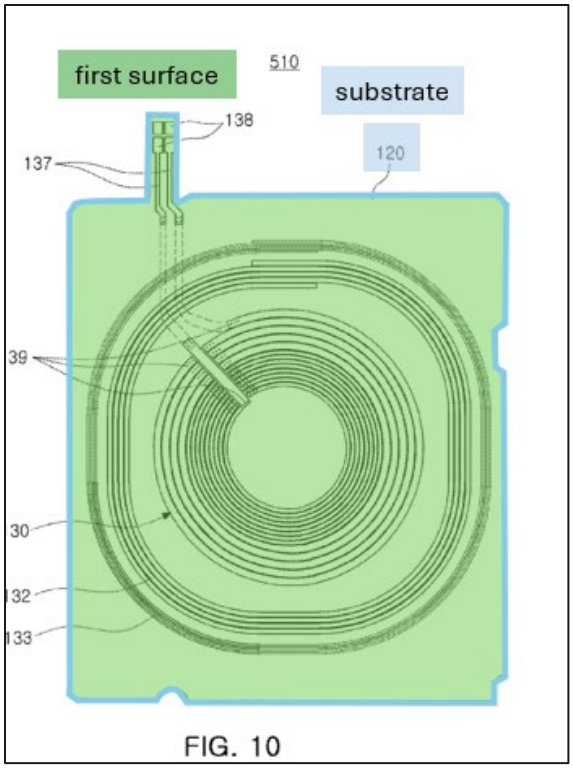


FIG. 10

Ex1007, Fig. 10; Ex1002 ¶193.

Figure 10's "**substrate 120**" has opposing surfaces. Ex1002 ¶194. Ahn describes "**substrate 120**," which Ahn depicts in Figure 10, as having a "**first surface 120a**" and a "**second surface 120b**." Ex1007, ¶¶27-28, 71, 107, 113, 120.

c. [1b]

Ahn teaches this limitation. Ex1002 ¶¶195-197.

Ahn teaches "second spiral wiring 131b" (first antenna pattern) on the "**second surface**" (first major surface) comprising "**second section 1312**" (inner coil) and "**first section 1311**" (outer coil), which surrounds "**second section 1312**" (inner coil):

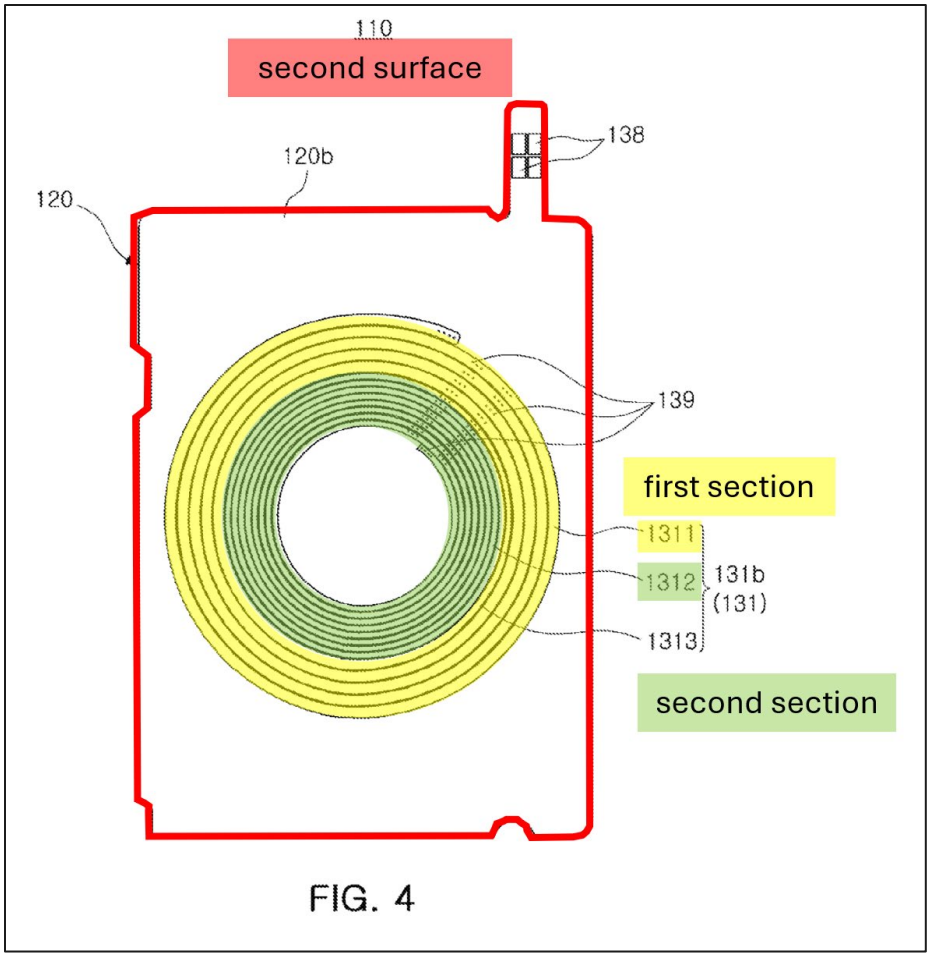


FIG. 4

Ex1007 ¶¶71, 76-77, Fig. 4; Ex1002 ¶196.

"[S]econd spiral wiring 131b" comprises coils. Ex1002 ¶197. Ahn describes "second spiral wiring 131b" as a "coil shape" and as a subset of "coil assembly 110." Ex1007 ¶¶68-69. Ahn's coil wirings may be used as antennas. Ex1007 ¶125.

d. [1c]

Ahn teaches this limitation or alternatively, the Ahn-721Lee combination renders it obvious. Ex1002 ¶¶198-203.

Ahn teaches "coil assembly 510" (second antenna pattern) on the "**first surface**" (second major surface) comprising "**first coil wiring 130**" (inner antenna pattern) and "**second coil wiring 132**" (outer antenna pattern):

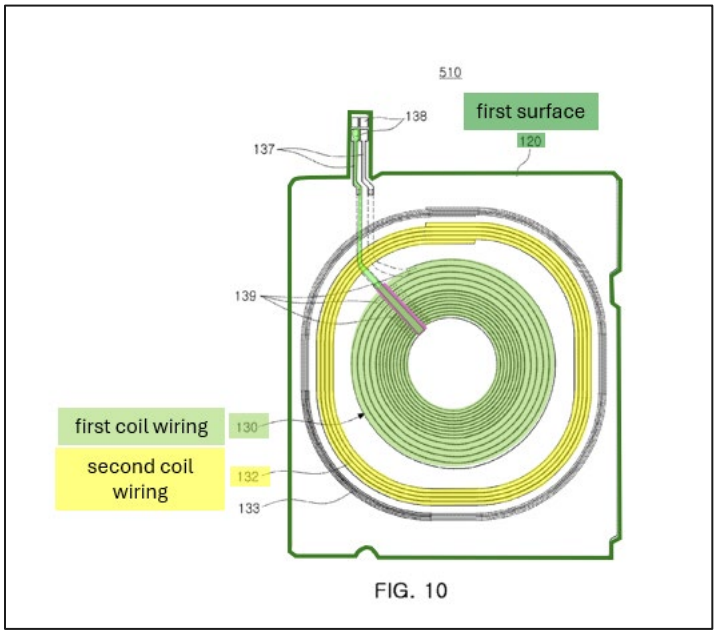


FIG. 10

Ex1007 ¶¶71, 123, 125-26, Fig. 10; Ex1002 ¶199.

Ahn teaches antenna patterns from Figures 4 and 10 may be disposed on opposing surfaces of "**substrate 120**." Ex1007, ¶¶122-23 (antenna patterns for Figure 10's "**substrate 120**" "may have the same structure described … [for] FIG. 3," i.e., coils on opposing surfaces, as Figures 3-4 depict), Figs. 3-4; Ex1002 ¶200.

In addition, a POSA would have found using Figure 4's coil patterns on the back surface of Figure 10's "**substrate 120**" obvious. Ex1002 ¶201. Ahn teaches combining "coil wiring … structure[s]" of Figures 10 and 3. Ex1007, ¶¶122-23. Ahn illustrates Figure 10 with "**interlayer connection conductors 139**," which

electrically connect coils on opposing surfaces of "**substrate 120**." Ex1007, ¶74, Fig. 10. A POSA would have been motivated to look at other Ahn embodiments, including Figures 3-4, illustrating coil patterns on both surfaces. Ex1007, Figs. 3-4, ¶¶113, 120 (describing same for Figs. 8-9), Figs. 6-9; Ex1002 ¶201. Because Ahn teaches Figures 3 and 10 may have "the same structure," a POSA would have tried combining the embodiments of Figures 4 (Figure 3's opposing side) and 10. Ex1002 ¶201. "[F]eatures of the examples described [in the specification] may be combined in various ways." Ex1007 ¶45. A POSA would have reasonably expected success combining Ahn Figures 10 and 4 because it would have been a straightforward application of known coil structures taught by Ahn and because Ahn teaches that its "components" can be "combined in a different manner," "replaced," or "supplemented." Ex1007 ¶129; Ex1002 ¶201.

In addition, forming the antenna patterns from Figures 4 and 10 on opposing surfaces of "**substrate 120**" would have been obvious in view of 721Lee. Ex1002 ¶202. 721Lee teaches antenna patterns on multiple surfaces, each comprising an **inner ring portion** and an **outer ring portion**:

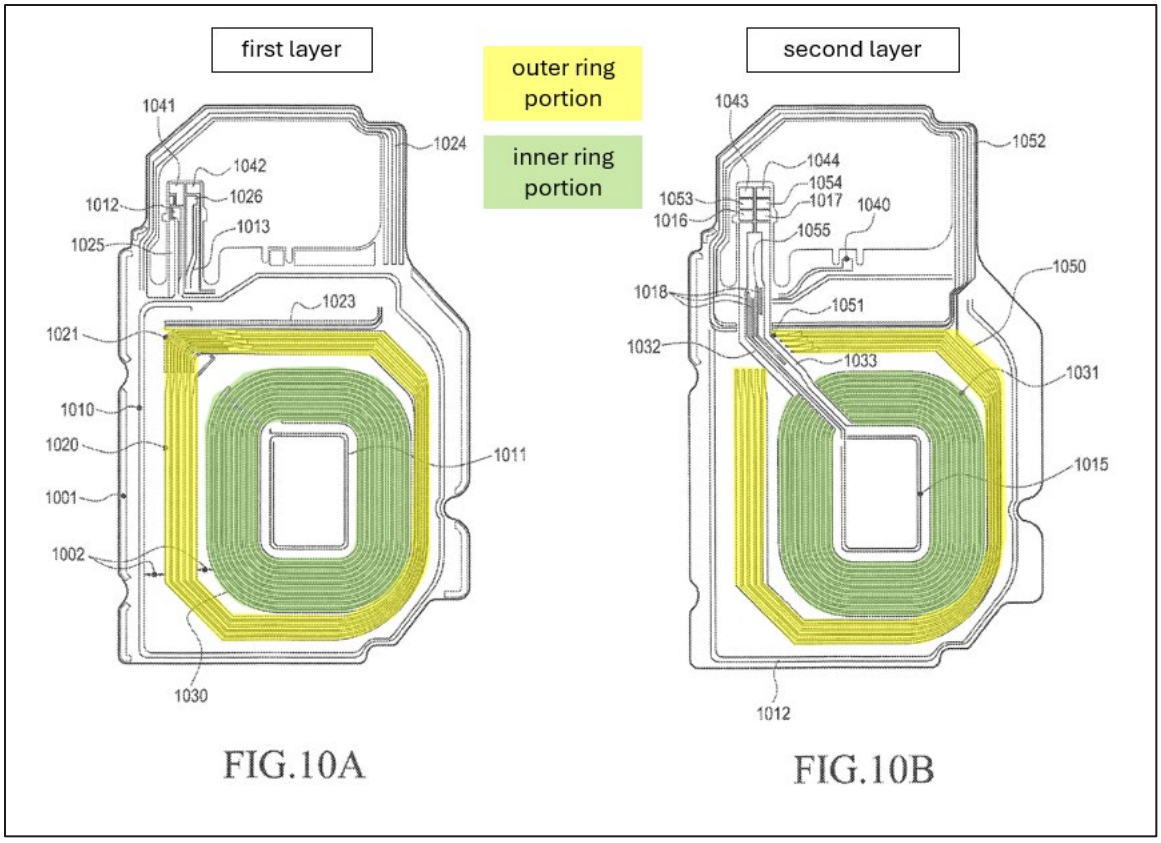


FIG.10A FIG.10B

721Lee, Figs. 10A-B; Ex1002 ¶202.

A POSA would have been motivated to incorporate 721Lee's teaching of antenna patterns on multiple surfaces with Ahn because Ahn already teaches this with several embodiments. Ahn, ¶¶113, 120, Figs. 3-4, 6-9; Ex1002 ¶203. Further, combining Ahn's Figures 4 and 10 on opposing surfaces of "**substrate 120**" would have been obvious to try in view of 721Lee, and a POSA would reasonably expect success based on the similarities between the antenna patterns of Ahn's Figures 4 and 10, and 721Lee's Figures 10A-B. Section VII.A.1; Ex1002 ¶203.

e. [1d]

Ahn teaches this limitation. Ex1002 ¶¶204-209.

Ahn's "**first coil wiring 130**" (inner antenna pattern) comprises a plurality of **concentric circular lines** defining a "**partially disconnected**" portion (radially-extending inner gap) into which the plurality of **concentric circular lines** of "**first coil wiring 130**" does not extend:

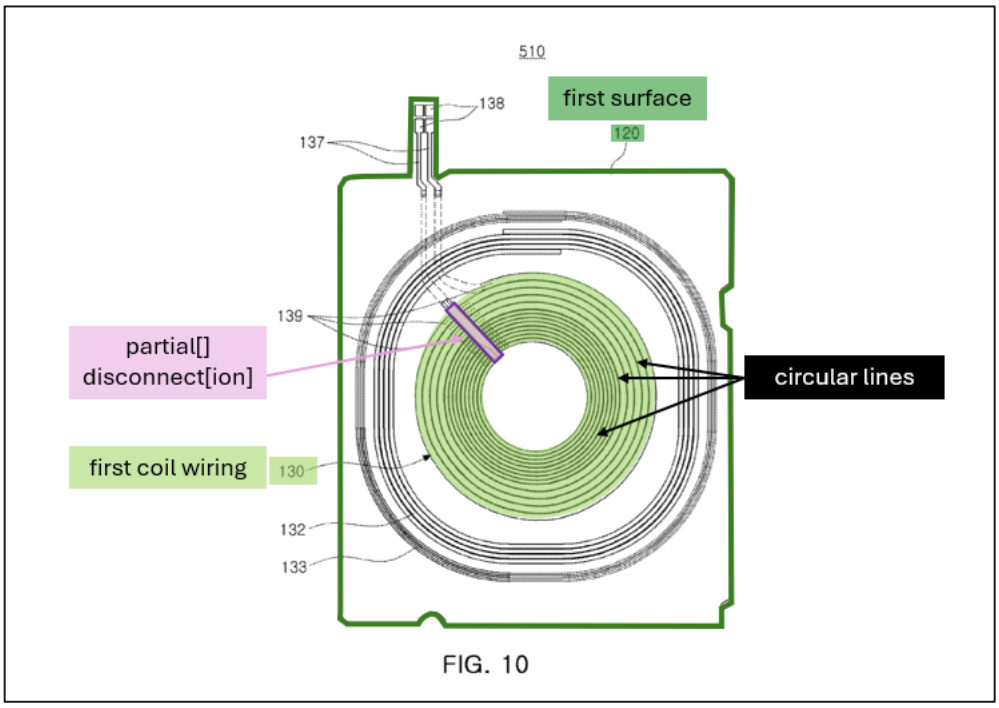
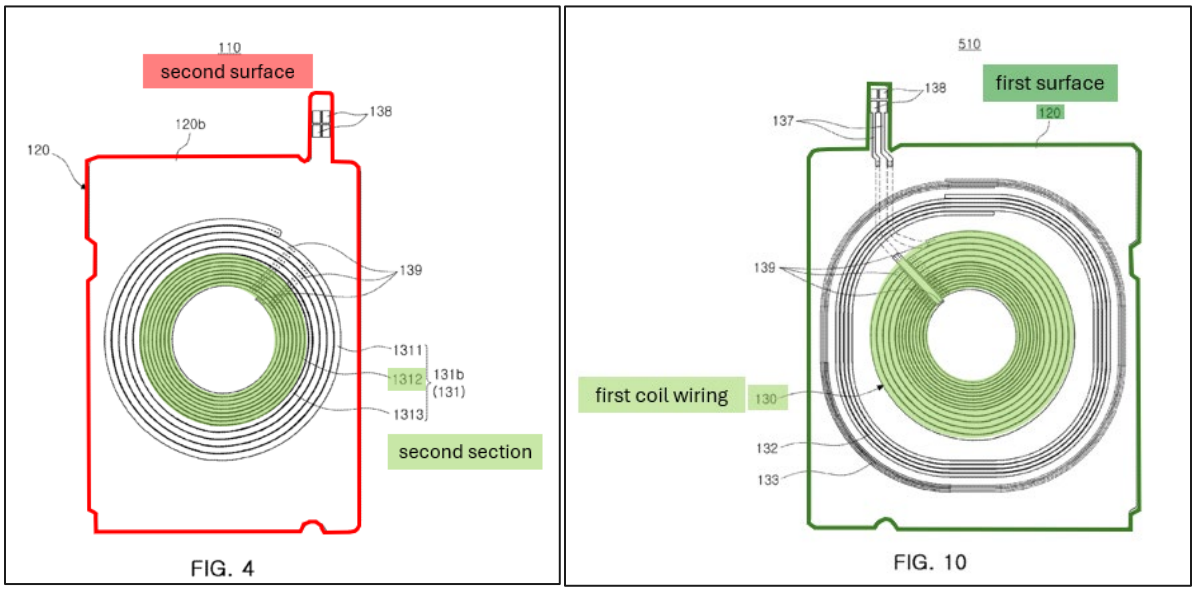


FIG. 10

Ex1007 ¶72, Fig. 10; Ex1002 ¶205.

Ahn teaches an inner gap is formed when the spiral wiring of "**first coil wiring 130**" is "**partially disconnected**." Ex1007 ¶¶72-73, 124-125, Fig. 10. The inner gap's purpose is so "lead wirings 137 may be disposed … through the disconnected region" in a "diameter (radial) direction," thereby connecting both ends of "**first coil wiring 130**" to "connection pads 138." Ex1007 ¶73; Ex1002 ¶206.

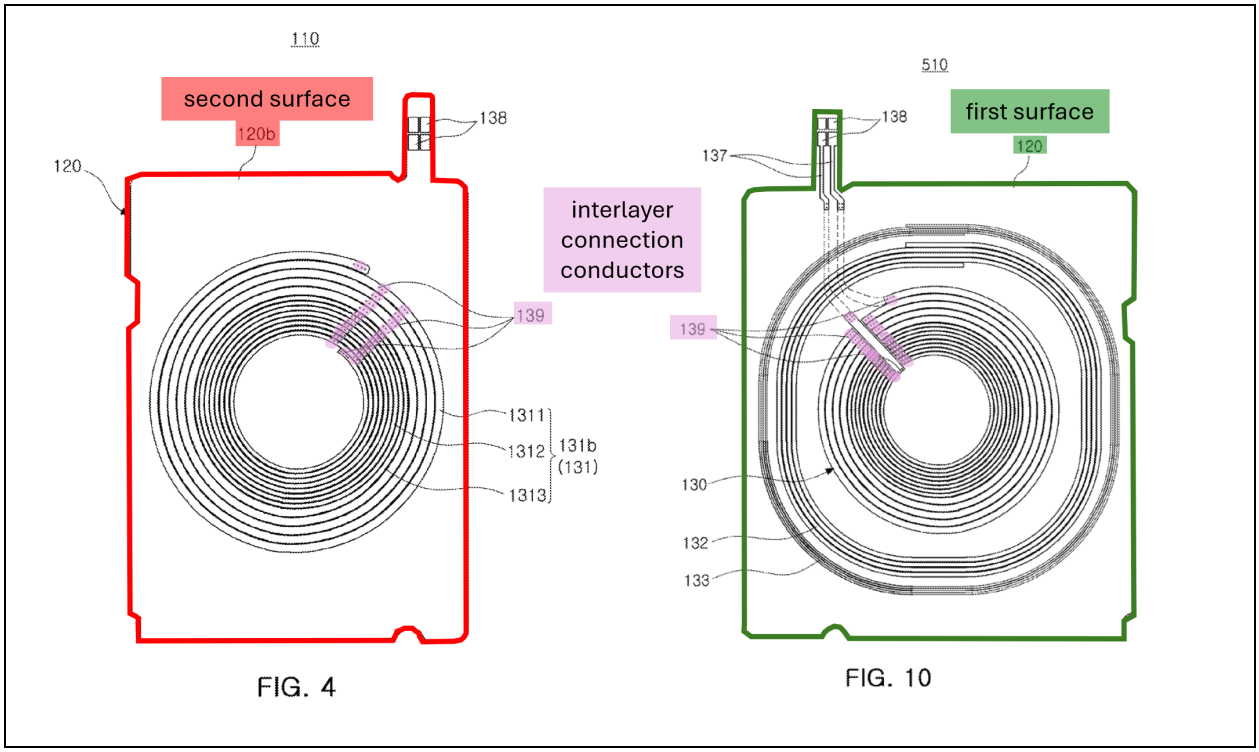
At least part of the concentric **circular lines** of "**first coil wiring 130**" on Ahn's "**first surface 120**" (inner antenna pattern) overlaps the "**second section 1312**" formed on "**second surface**" (inner coil), as can be seen by comparing Ahn's first and second surfaces:



Ex1007, Figs. 4, 10; Ex1002 ¶207.

Ahn teaches and renders obvious forming the antenna patterns from Figures 4 and 10 on opposing surfaces of "**substrate 120**." Ground 2 Limitation [1c].

Ahn teaches "**first coil wiring 130**" on "**first surface 120**" (inner antenna pattern) is connected to "**second section 1312**" on "**second surface**" (inner coil) through "**interlayer connection conductors 139**" (plurality of vias):



Ex1007 ¶¶13, 71, 74, 108, 113, 120, Figs. 4, 10, Cl. 8; Ground 2 Limitation [1c]; Ex1002 ¶209.

f. [1e]

The Ahn-721Lee combination renders this limitation obvious. Ex1002 ¶¶210-220.

Ahn teaches "both ends of the **second wiring coil 132** … ***need*** to be connected to the **connection pads 138**, which is ***omitted in FIG. 10 for convenience***":

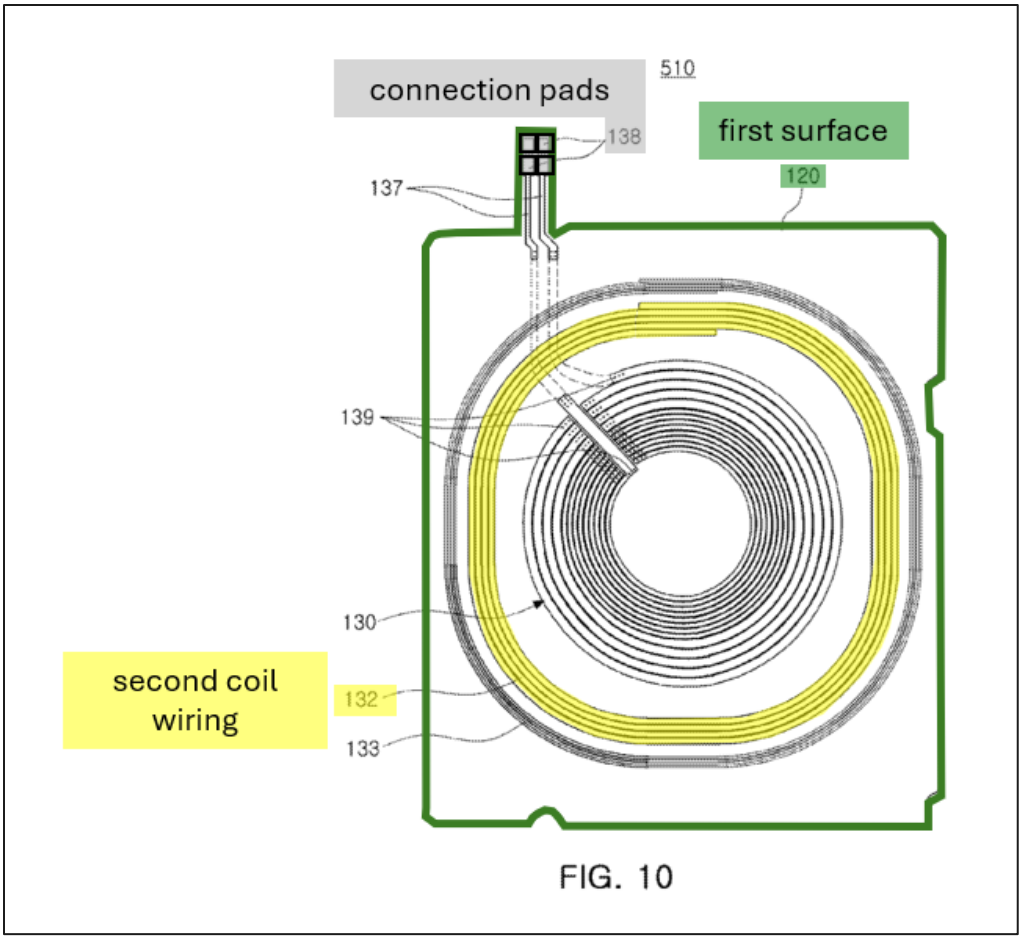


FIG. 10

Ex1007 ¶124, Fig. 10; Ex1002 ¶211.

A POSA reading Ahn would have understood, as explained for Ground 2 Limitation [1d] regarding Ahn's "**partial[] disconnect[ion]**" of "**first coil wiring 130**," which lets both ends of "**first coil wiring 130**" be connected to connection pads 138 (Ex1007 ¶¶72-73, Fig. 10), Ahn renders obvious using a **partial disconnection** of "**second coil wiring 132**" (radially-extending outer gap), into which the plurality of **concentric circular lines** of "**second coil wiring 132**" does not extend, to effectuate Ahn's teaching that both ends of "**second coil wiring 132**" are connected to connection pads 138 (*id.* ¶124). Ex1002 ¶212. The **partial**

disconnection of "**second coil wiring 132**" allows space for wired connections to "**first coil wiring 130**" because "**first coil wiring 130**" is surrounded by "**second coil wiring 132**":

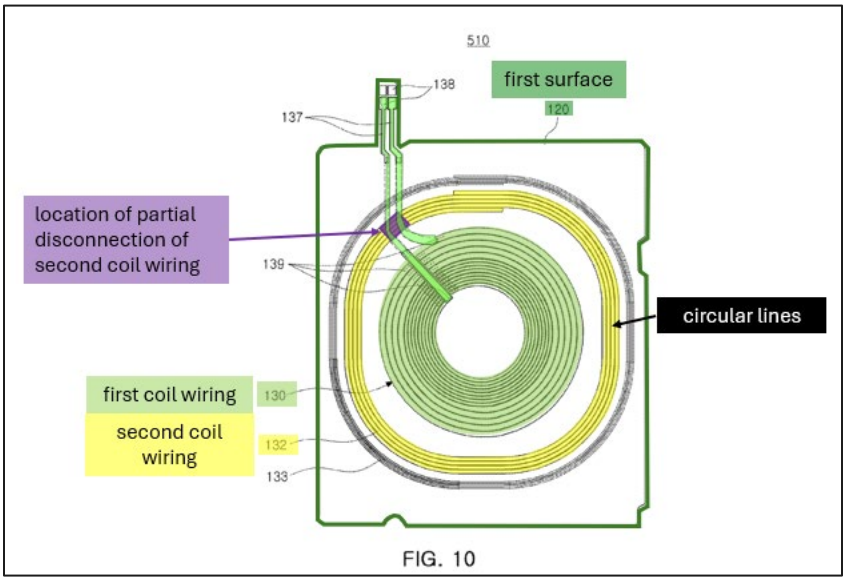


FIG. 10

Ex1007, Fig. 10; Ex1002 ¶212.

In addition, this would have been obvious in view of 721Lee. Ex1002 ¶213. 721Lee teaches "**MST coil 1050**" (outer antenna pattern) has an "**interval of the MST coil 1050**" (radially-extending outer gap) through which "**MST patterns 1055**" extend:

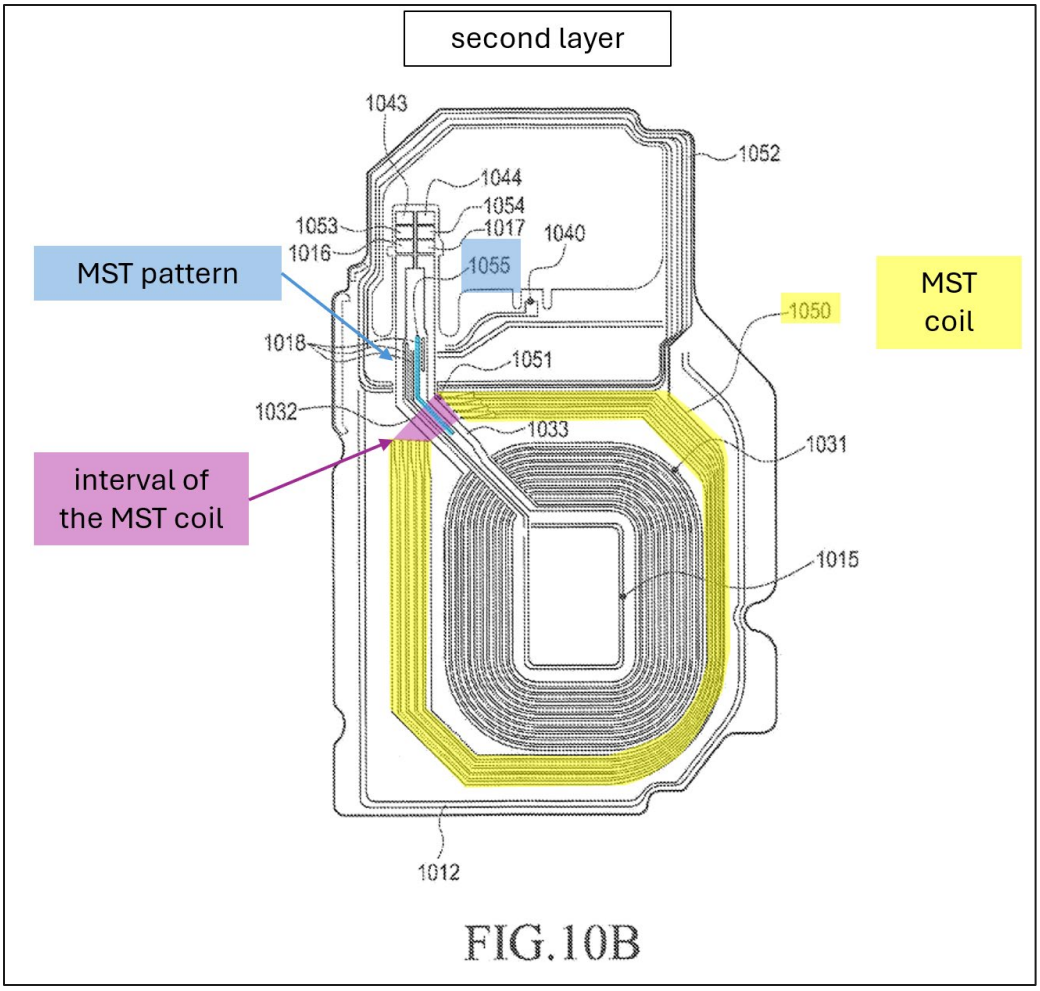


FIG.10B

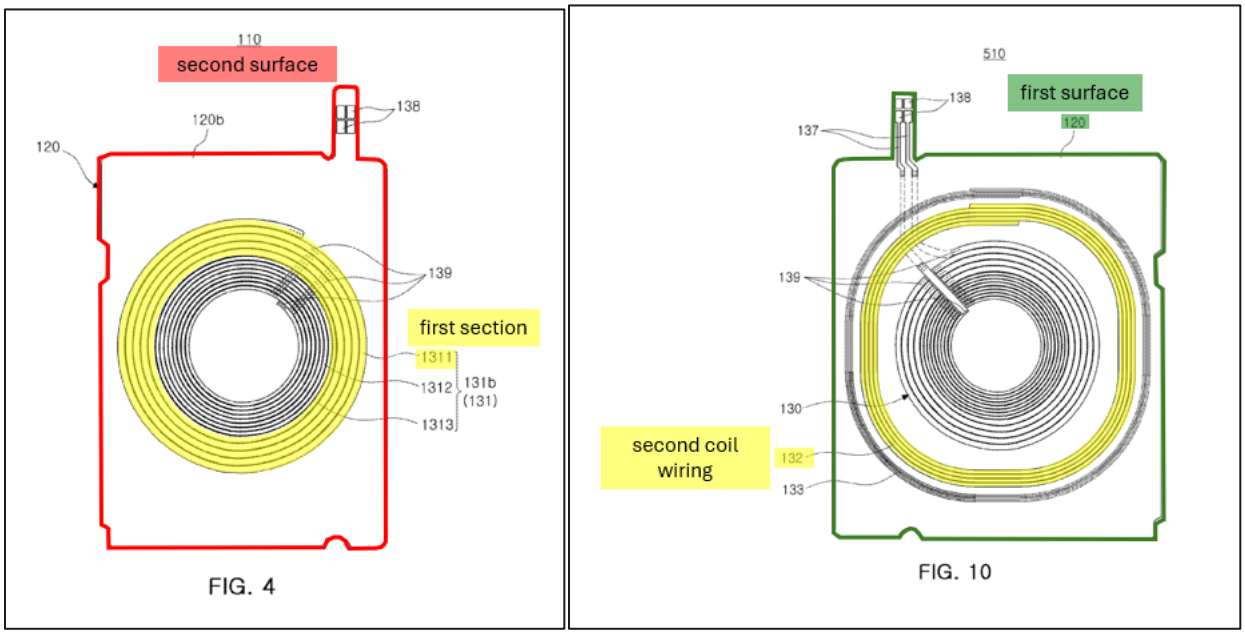
Ex1011 ¶140, Fig. 10B; Ex1002 ¶213.

This outer gap beneficially lets "wireless charging coil 1031" (inner coil) "be connected to the input/output terminals through the interval of the MST coil 1050." Ex1011 ¶140.

It would have been obvious to incorporate 721Lee's radial-gap teachings with Ahn. Section VIII.B.1; Ex1002 ¶215.

Ahn teaches at least part of the concentric **circular lines** of "**second coil wiring 132**" on "**first surface 120a**" (outer antenna pattern) overlaps the "**first**

section 1313" on "**second surface**" (outer coil). Ex1002 ¶216. Ahn teaches and renders obvious forming the antenna patterns from Figures 4 and 10 on opposing surfaces of "**substrate 120**," as can be seen by comparing Ahn's first and second surfaces:



Ex1007, Figs. 4, 10; Ground 2 Limitations [1c]/[1d]; Ex1002 ¶216.

As illustrated, "**second coil wiring 132**" on "**first surface 120a**" (outer antenna pattern) overlaps with "**first section 1311**" on "**second surface**" (outer coil) because both extend near the outer-most boundary of "**substrate 120**." If PO incorrectly argues this is not the case, a POSA would have found it obvious. Ex1002 ¶217. Ahn's antenna configurations may be varied and a POSA would have understood that adjusting the shape and size of "**second coil wiring 132**" and "**first section 1311**," such that they overlap, would have improved the space efficiency of

the layout. Ex1008, ¶¶4, 44-45; *id.* Figs 6-7 (illustrated below depicting overlapping outer coils on either side); Ex1002 ¶217.

Ahn teaches "**second coil wiring 132**" on "**first surface 120a**" (outer antenna pattern) is connected to "**first section 1311**" on "**second surface**" (outer coil) through "**interlayer connection conductors 139**" (plurality of vias):

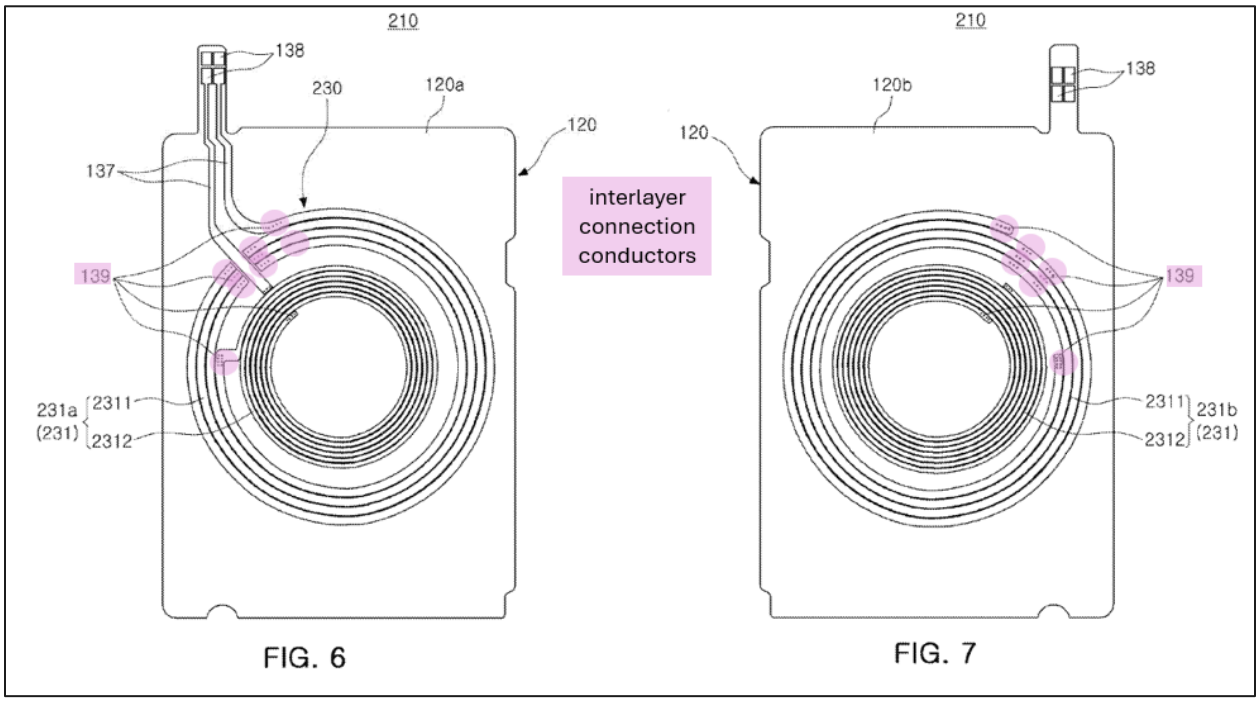


FIG. 6 FIG. 7

Ex1007, Figs. 6-7; Ex1002 ¶218.

It would have been obvious to combine on opposing sides the antenna pattern from Figure 10 and other illustrated antenna patterns, including those on Figures 6-7. Ex1007, ¶¶45, 122-23, 129; Ground 2 Limitation [1c]; Ex1002 ¶219.

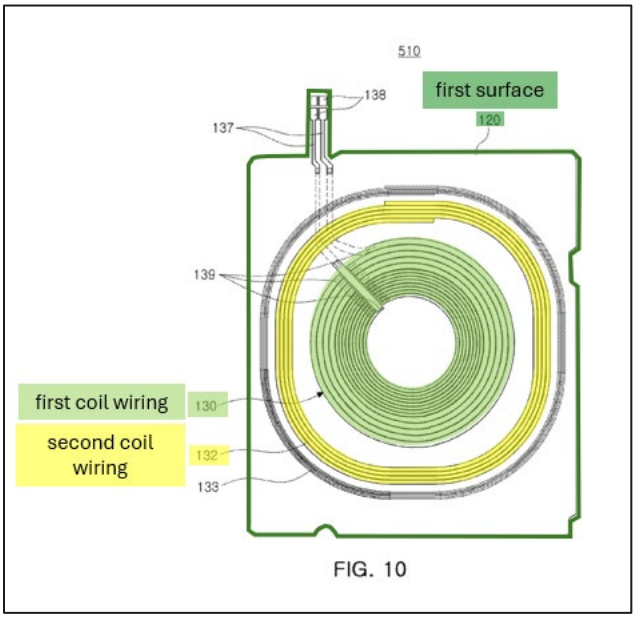
Ahn illustrates several antenna patterns with "**interlayer connection conductors 139**" which electrically connect coils on opposing surfaces. Ex1007, ¶¶13, 74, 108, 113, 120, Cl. 8, Figs. 3-4, 6-7, 10. Any of Ahn's antenna patterns

may incorporate "**interlayer connection conductors 139**" on outer coils and outer antenna patterns because Ahn teaches "features of the examples described [in the specification] may be combined in various ways." Ex1007 ¶45. Ahn teaches "[s]uitable results may be achieved … if components in a described system … are combined in a different manner, and/or replaced or supplemented by other components." Ex1007 ¶129.

g. 1[f]

Ahn teaches this limitation. Ex1002 ¶¶221-222.

At least part of the concentric **circular lines** of Ahn's "**second coil wiring**" generally surround at least part of the concentric **circular lines** of the "**first coil wiring**":

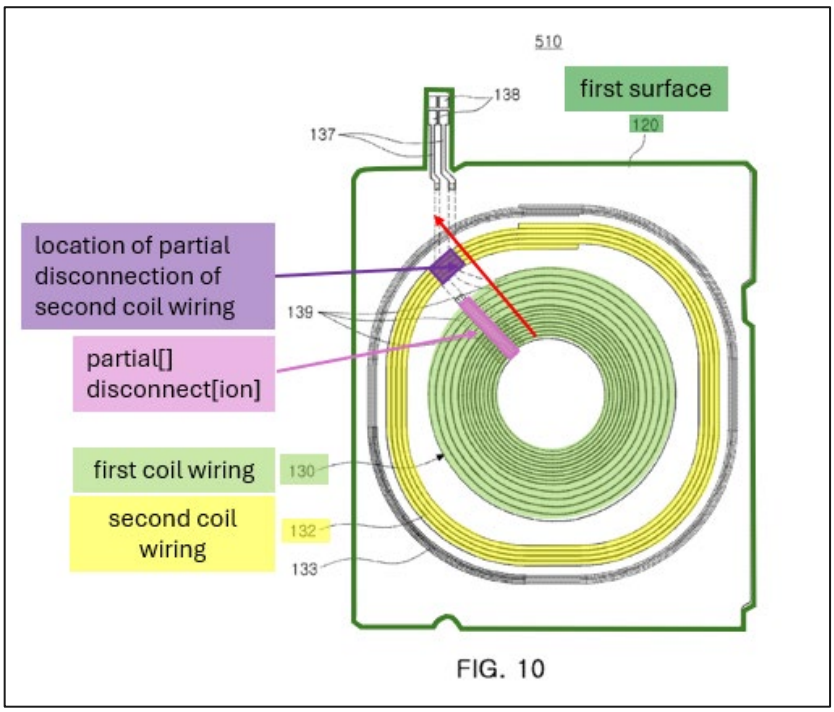


Ex1006, Fig. 10; Ex1002 ¶222.

h. [1g]

The Ahn-721Lee combination renders this limitation obvious. Ex1002 ¶¶223-226.

The Ahn-721Lee combination renders obvious the **partial disconnection** of "**second coil wiring 132**" and the "**partial[] disconnect[ion]**" of "**first coil wiring 130**" are connected and aligned in a **direction**:



Ex1007, Fig. 10; Ground 2 Limitations [1d]/[1e]; Ex1002 ¶224.

In addition, if PO incorrectly argues this limitation requires the radially-extending inner and outer gaps be directly adjacent and/or if Ahn's **partial disconnection** of "**second coil wiring 132**" and the "**partial[] disconnect[ion]**" of "**first coil wiring 130**" are not connected and aligned, a POSA would have found this obvious. Ex1002 ¶¶225-26. Ahn teaches "**second coil wiring 132**" and "**first**

coil wiring 130" may vary in width, turns, shapes, and configurations. Ex1007 ¶¶44, 77, 105, 126. A POSA would have understood a directly adjacent arrangement was possible and would have been motivated to further Ahn's space-efficiency goal (Ex1007 ¶¶4, 65, 68) by arranging the inner and outer coils such that their gaps were tightly connected and aligned. Ex1002 ¶¶225-26.

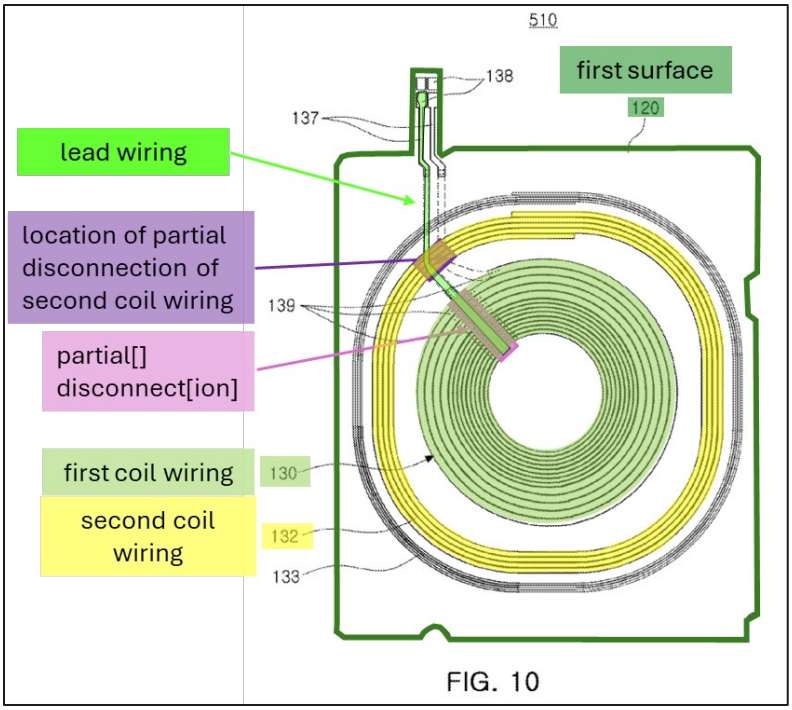
Ahn teaches, and it would have been obvious, to incorporate Ahn's Figures 3-4 teachings with Ahn's Figure 10 teachings. Ground 2 Limitation [1a].

3. [2]

a. [2pre]

The Ahn-721Lee combination renders claim 1 obvious and further renders obvious the remaining limitations of this claim. Ex1002 ¶¶227-229.

Ahn's "**lead wirings 137**" "connect[] one end of the first spiral wiring 131*a* disposed at the center (e.g., the innermost turn) of the first spiral wiring 131*a* and one of the connection pads 138 to each other" (i.e., an inner extension line formed on Ahn's "**first surface**" (second major surface)), and "**lead wirings 137**" "traverse the spiral wiring 131*a* through the **disconnected region** in a diameter (radial) direction of the first spiral wiring 131*a*":



Ex1007 ¶73, Fig. 10; Ex1002 ¶228.

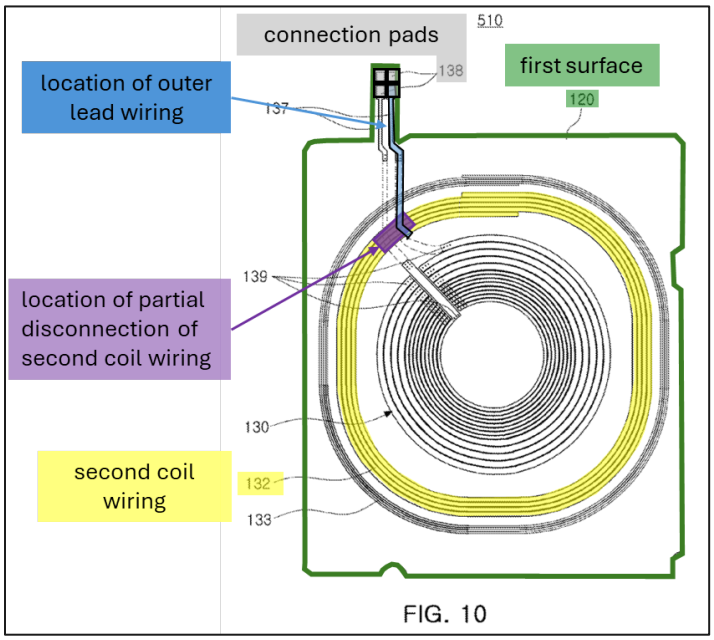
As shown above, Ahn teaches and the Ahn-721Lee combination renders obvious, Ahn's "**lead wirings 137**" extending through the **partial disconnection** of "**second coil wiring 132**" and the at least part of the "**partial[] disconnect[ion]**" of "**first coil wiring 130**." Ground 2 Limitations [1f]/[1g]; Ex1002 ¶229.

b. [2a]

The Ahn-721Lee combination renders this limitation obvious. Ex1002 ¶¶230-234.

Ahn teaches both ends of "**second coil wiring 132**" and "**first coil wiring 130**" on "**first surface 120**" (second major surface) "***need*** to be connected to the connection pads 138." Ex1007, ¶124. For "**first coil wiring 130**," Ahn uses "**lead wirings 137**" running through the "**partial[] disconnect[ion]**" to accomplish this

connection for "**first coil wiring 130**." Ground 2 Limitation [1h]. A POSA would have understood that "**second coil wiring 132**" must be connected to the "connection pads 138" and it would have been logical to do so in the same way, i.e., by an **outer lead wiring** through the **radially-extending outer gap**:



Ex1007, Fig. 10 (modified based on ¶124 to illustrate **outer lead wiring** and **radially-extending outer gap**); Ex1002 ¶231.

In addition, this limitation would have been obvious in view 721Lee. Ex1002 ¶¶232-234.

In 721Lee, "**MST patterns 1055**" formed on the "second layer" electrically connect "**MST coil 1050**" to "MST input/output terminals 1053 and 1054" and extend along the radial direction through the "**interval of the MST coil 1050**." Ex1011 ¶140.

It would have been obvious to incorporate 721Lee's teachings of an outer antenna pattern comprising a radially-extending outer gap through which extension lines run with Ahn. Section VIII.B.1; Ground 2 Limitation [1g]. For similar reasons, a POSA would have been motivated to run an outer extension line (like Ahn's "lead wirings 137") through at least part of a radially-extending outer gap, as 721Lee teaches, to connect Ahn's second coil wiring 132 to connection pads 138 and would have reasonably expected success. Ex1002 ¶234.

4. [3]

The Ahn-721Lee combination renders claim 2 obvious and further renders obvious the remaining limitations of this claim. Ex1002 ¶¶235-242.

Ahn teaches, and the Ahn-721Lee combination renders obvious, "**lead wirings 137**" for "**first coil wiring 130**" and **outer lead wiring** for "**second coil wiring 132**" extend "in a **diameter (radial) direction**" and generally in parallel because they extend together in the same direction:

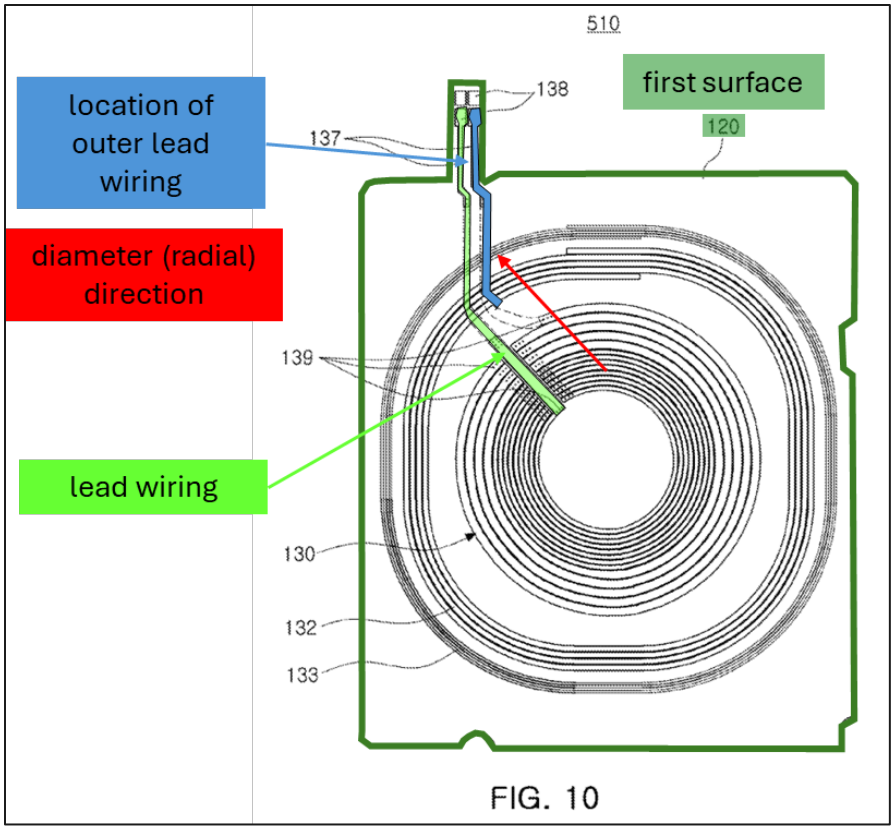


FIG. 10

Ex1007, ¶¶69, 72-74, Fig. 10 (modified based on ¶¶124, 126 to illustrate the location of **outer lead wiring**); Ground 2 Limitations [1h]/[1i]; Ex1002 ¶236.

Further, 721Lee teaches both extension lines extend generally in parallel:

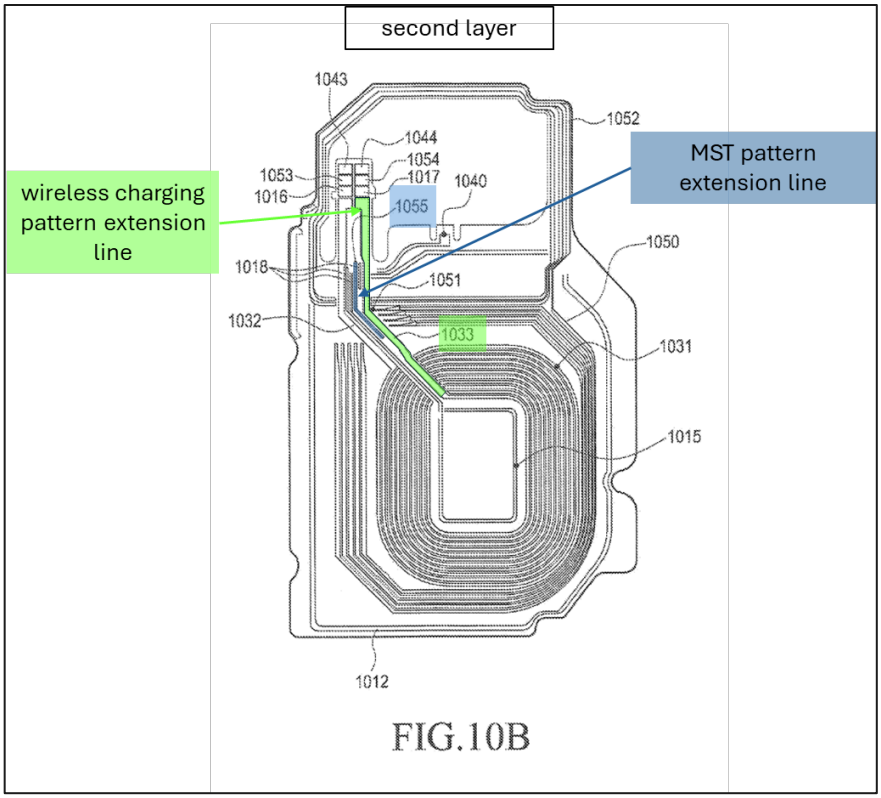
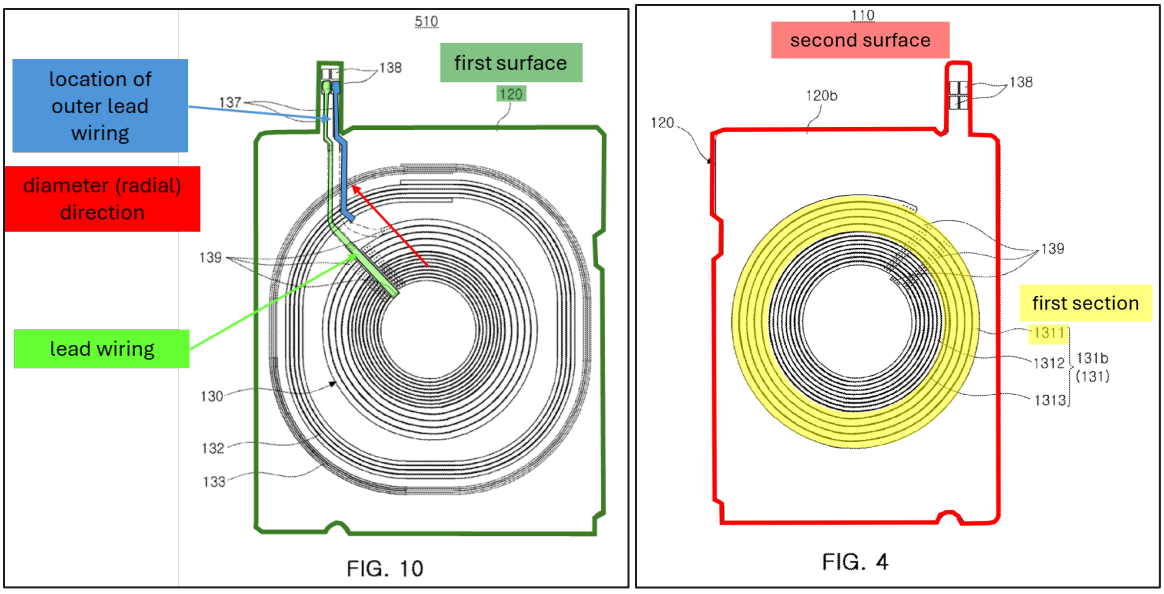


FIG.10B

Ex1011, Fig. 10B; Ex1002 ¶237.

It would have been obvious to incorporate 721Lee's radially-extending gap and extension-lines teachings with Ahn. Section VIII.B.1.

Further, Ahn teaches each of the "**lead wirings 137**" and **outer lead wiring** overlap "**first section 1311**" on the "**second surface**." Ex1002 ¶238. As can be seen by comparing Figures 10 and 4, Ahn teaches locating its coils up to the edges of the substrate, such that Ahn's second major surface extension lines overlap Ahn's first major surface outer coil ("**first section 1311**"):

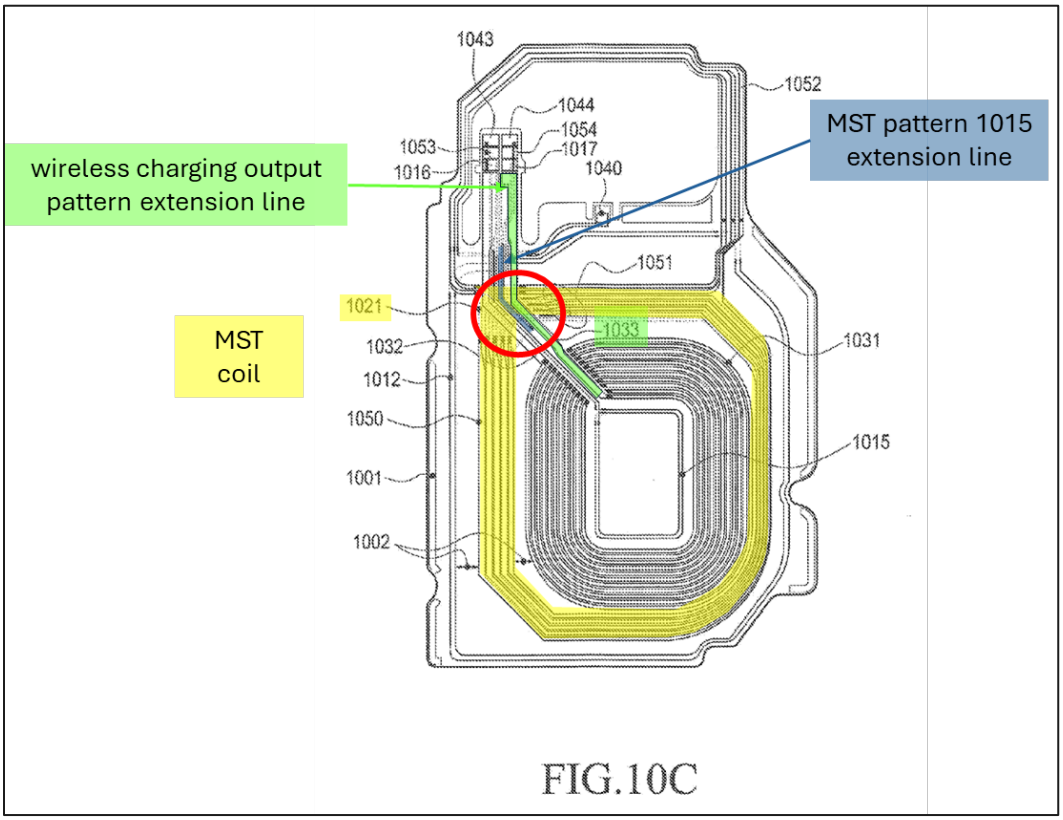


Ex1007, Figs. 4, 10 (modified to illustrate location of **outer lead wiring**); Ex1002 ¶239.

In addition, a POSA would have found the overlapping extension lines obvious. Ex1002 ¶240. Ahn teaches the invention may vary in configuration and layout. Ex1007 ¶¶44, 77, 105, 126. There were a finite number of predictable configurations and layouts for Ahn's coils and overlapping Ahn's coils and extension lines on opposing surfaces would have furthered Ahn's space-efficiency goal by increasing compactness, reducing unused substrate space. Ex1007, ¶¶4, 65, 68, 99-100, 127; Ex1002 ¶240.

Further, this limitation would have been obvious in view of 721Lee. Ex1002 ¶241. 721Lee Figure 10C overlays the two different surfaces shown in 721Lee Figures 10A-10B, showing 721Lee's "**MST patterns 1055**" extension line (outer extension line) and "**wireless charging output pattern**" (inner extension line)

extension line (collectively, the claimed extension lines on the second major surface) **overlap** with "**MST coil 1021**" (outer coil on first major surface):



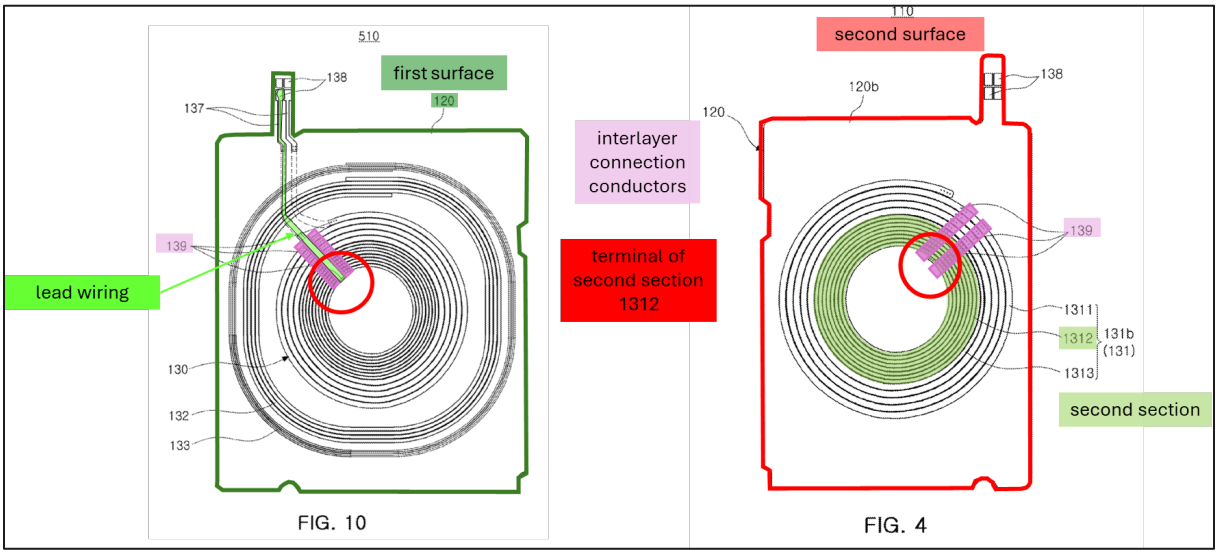
Ex1007, Fig.10C, ¶144. Ex1002 ¶241.

It would have been obvious to incorporate 721Lee's overlapping pattern design and gap teachings with Ahn to improve compactness and reduce unused substrate space. Section VIII.B.1.

5. [4]/[14]

The Ahn-721Lee combination renders claims 2 and 13 obvious and further renders obvious the remaining limitations of these claims. Ex1002 ¶¶243-247.

Ahn teaches "**lead wirings 137**" electrically connected to a "**second section 1312**" **terminal**:



Ex1007 ¶¶69, 72-74, Fig. 10; Ex1002 ¶244.

As Ahn depicts in Figure 10, Ahn's **inner extension line** accomplishes this. Ex1002 ¶245.

Ahn teaches "**first coil wiring 130**" on "**first surface 120**" is connected to "**second section 1312**" on "**second surface**" through vias. Ground 1 Limitation [1d]. A POSA would have understood the **inner extension line** electrically connects to a terminal of the "**second section 1312**" through vias too. Ex1002 ¶246.

Further, at least part of the concentric circular lines of Ahn's "**first coil wiring**" (inner antenna pattern) is in a C-shape:

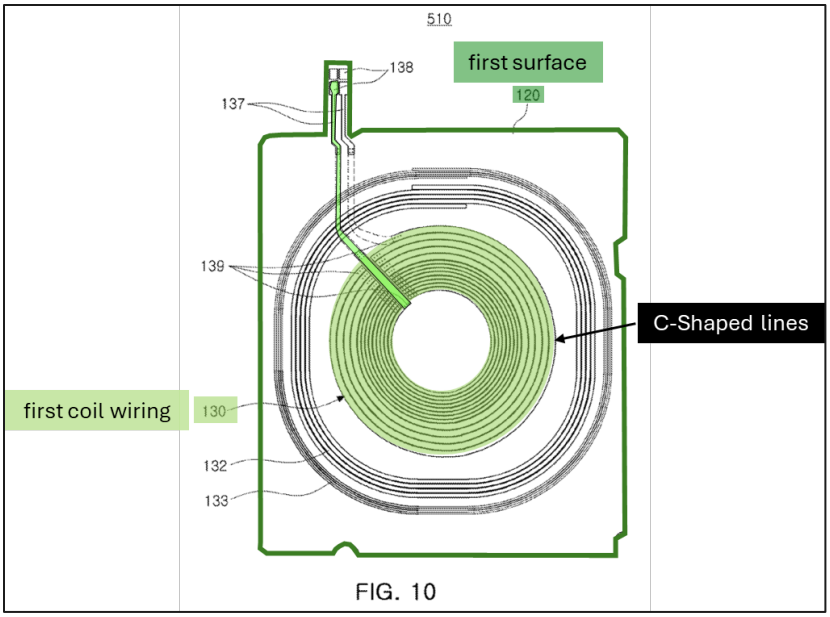


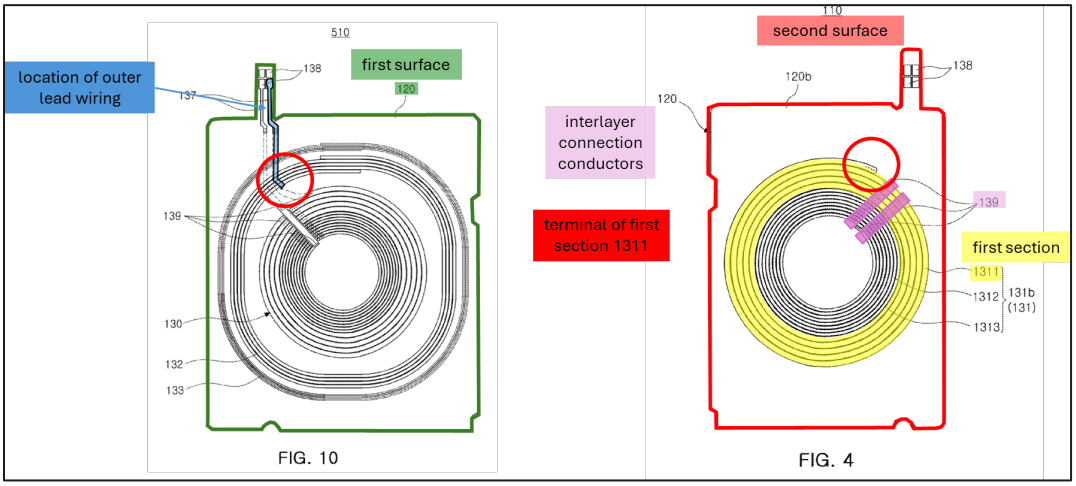
FIG. 10

Ex1007 Fig. 10; Ground 2 Limitation [1d]; Ex1002 ¶247.

6. [5]/[15]

The Ahn-721Lee combination renders claims 2 and 13 obvious and further renders obvious the remaining limitations of these claims. Ex1002 ¶¶248-252.

Ahn teaches "**lead wirings 137**" electrically connected to a "**second coil wiring 132**" **terminal**:

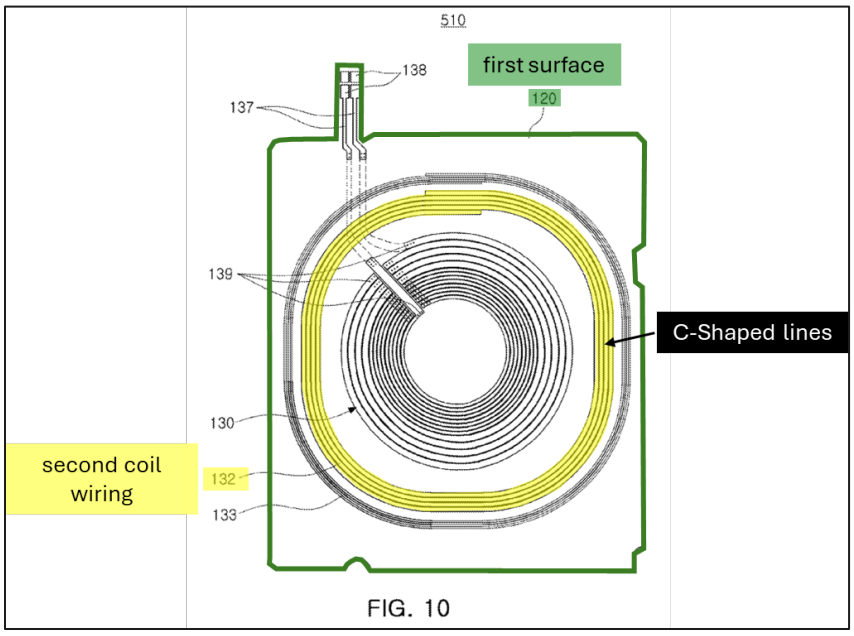


Ex1007, Fig. 10 (modified based on ¶124 to illustrate **outer lead wiring**); Ex1002 ¶249.

As Ahn depicts in Figure 10, Ahn's **outer lead wiring** accomplishes this. Ex1002 ¶250.

Ahn teaches "**second coil wiring 132**" on "**first surface 120**" is connected to "**first section 1313**" on "**second surface**" through vias. Ground 1 Limitation [1e]. A POSA would have understood the **outer lead wiring** electrically connects to a terminal of the "**first section 1313**" through vias too. Ex1002 ¶251.

At least part of the concentric circular lines of Ahn's "**second coil wiring**" (outer antenna pattern) is in a C-shape:



Ex1007 Fig. 10; Ground 2 Limitation [1e]; Ex1002 ¶¶252.

7. [6]/[17]

The Ahn-721Lee combination renders claims 2 and 13 obvious and Ahn further teaches the remaining limitations of these claims. Ex1002 ¶¶253-254.

Ahn teaches, and the Ahn-721Lee combination renders obvious, at least one of "**lead wirings 137**" and **outer lead wiring** is electrically connected to the first antenna pattern on the "**second surface**" through at least one via. Ex1002 ¶254. Ahn teaches and the Ahn-721Lee combination renders obvious, the **inner extension line** and **outer extension line** are electrically connected to the "**second section 1312**" and "**first section 1311**," respectively, through vias. Ground 2 Limitations [4]/[14]/[5]/[15]. And, Ahn's "**second section 1312**" and "**first section 1311**" comprise the first antenna pattern on "**second surface**" (first major surface). Ground 2 Limitations [1b].

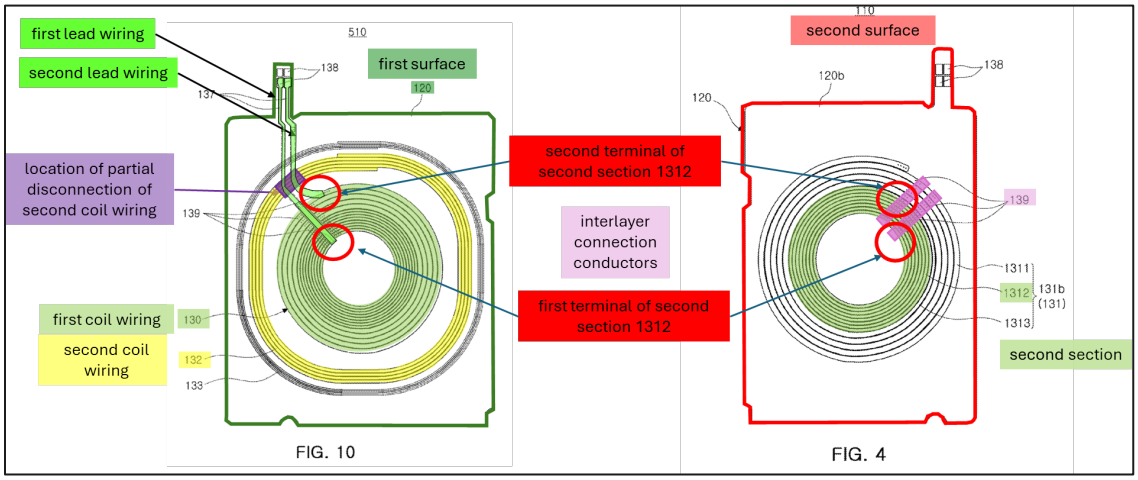
8. [7]/[18]

The Ahn-721Lee combination renders claims 2 and 13 obvious and Ahn further teaches the remaining limitations of these claims. Ex1002 ¶¶255-257.

Ahn teaches and the Ahn-721Lee combination renders obvious a **first inner extension line** electrically connected to a **first terminal** of "**second section 1312**" though via. Ground 2 Limitation [4]/[14].

For the same reasons as Ground 2 Limitations [4]/[14], Ahn also teaches Ahn's smartphone antenna module comprises a **second inner extension line** on the

"**first surface**" (second major surface) that electrically connects to a **second terminal** of "**second section 1312**" through vias, and the **second inner extension line** extends through at least part of the **partial disconnection of second coil wiring**:



Ex1007, Figs. 4, 10 (modified based on ¶¶72-73, 124 to illustrate **partial disconnection** of "**second coil wiring 132**"); Ex1002 ¶257.

9. [8]/[16]

The Ahn-721Lee combination renders claims 1 and 13 obvious and Ahn further teaches and the Ahn-721Lee combination renders obvious the remaining limitations of these claims. Ex1002 ¶¶258-262.

Ahn's "first and second spiral wirings disposed on opposite surfaces of the substrate may be connected to each other in series or in parallel." Ex1007, ¶¶113, 120. Further, "features of the examples described [in the specification] may be combined in various ways," and "[s]uitable results may be achieved … if

components in a described system … are combined in a different manner, and/or replaced or supplemented by other components." Ex1007 ¶¶45, 129.

If PO incorrectly argues Ahn does not teach a parallel electrical connection between "**second section 1312**" (inner coil) and "**first section 1311**" (outer coil), this arrangement would have been obvious. Ex1002 ¶260. There were only two electrical connection possibilities (in parallel or in series), and Ahn teaches electrically connecting wirings in parallel (Ex1007, ¶¶113, 120), so it would have been obvious to try and a simple design choice to electrically connect "**second section 1312**" and "**first section 1311**" in parallel. Ex1002 ¶260.

Further, this limitation would have been obvious in view of 721Lee. Ex1002 ¶261. 721Lee teaches "two coils … may be connected in parallel." 721Lee ¶152; *id.* ¶134 ("sub coils are connected in parallel" but "may be connected in series").

A POSA reading Ahn and 721Lee would have understood electrically connecting coils in series or in parallel was a design choice, and would have been motivated to try connecting Ahn's inner and outer coils in parallel, which would have yielded predictable results. Ex1002 ¶262. 721Lee teaches antennas with coils electrically connected in parallel have a lower recognition rate at higher distances than antennas with coils electrically connected in series, which means parallel connected coils may be more secure, and thus preferable for high-security applications for which only close-distance transactions are desired, including NFC

and payment transactions. 721Lee ¶¶158-59; Ex1002 ¶262. A POSA would have reasonably expected success because electrically connecting two coils in parallel was a well-known, straightforward electrical-connection method Ahn and 721Lee teach. Ex1007 ¶¶113, 120, Figs. 8-9; Ex1002 ¶262.

10. [9]/[19]

The Ahn-721Lee combination renders claims 1 and 13 obvious and Ahn further teaches the remaining limitations of these claims. Ex1002 ¶¶263-266.

In Ahn, "**second section 1312**" (inner coil) includes a wire line having a width different from that of a wire line of "**first section 1311**" (outer coil):

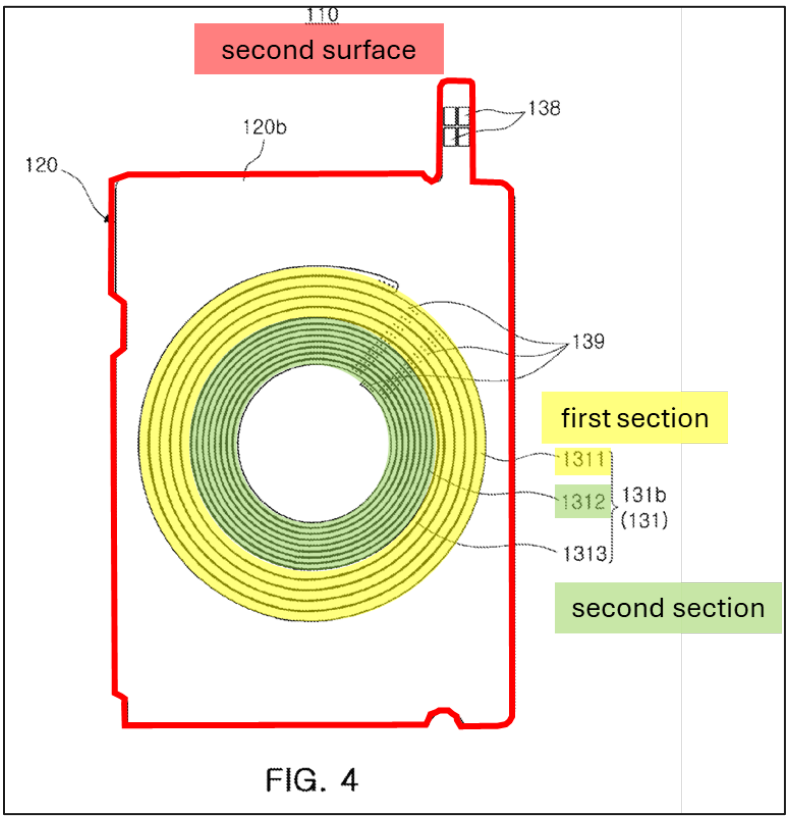


FIG. 4

Ex1007, Fig. 4, ¶¶44, 76-77, 105, 126 (Ahn's coils "may have different widths"); Ex1002 ¶264.

Further, in Ahn, "**second section 1312**" (inner coil) has a first number of turns that is greater than that of "**first section 1311**" (outer coil):

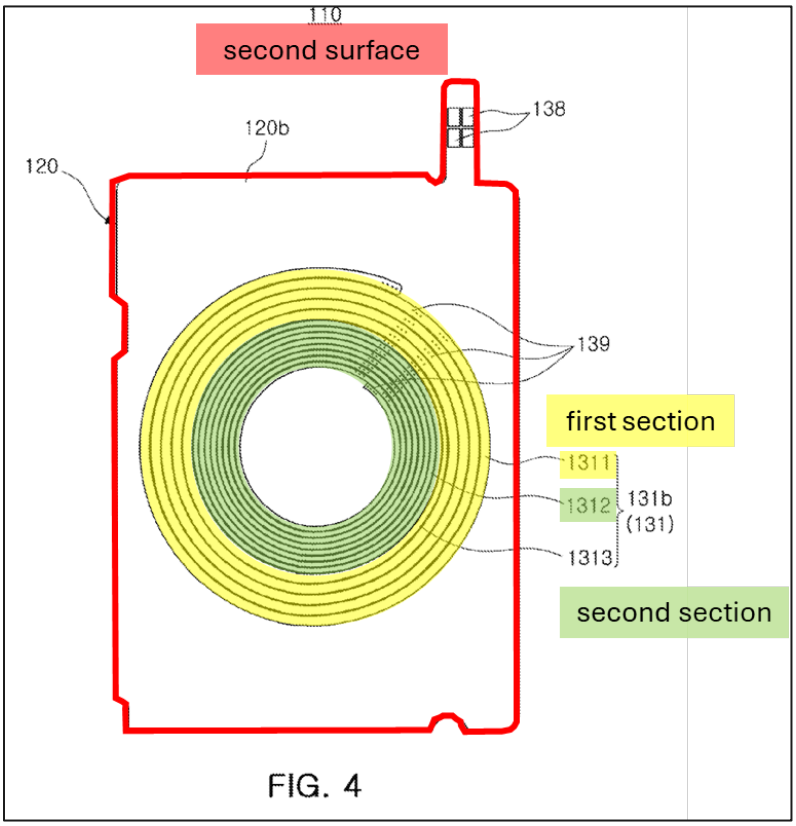


FIG. 4

Ex1007, Fig. 10, ¶¶8, 22, 44, 76-77, 82, 85-87, 89-90, 98, 105, 109, 126, Cls. 3, 17; Ex1002 ¶265.

As shown above, Ahn depicts "**second section 1312**" having approximately 13 turns, and "**first section 1311**" having approximately 5 turns. Ex1007, Fig. 10; Ex1002 ¶266.

11. [10]/[20]

The Ahn-721Lee combination renders claims 1 and 13 obvious and further renders obvious the remaining limitations of these claims. Ex1002 ¶¶267-271.

Ahn's "**third coil wiring 133**" may be "disposed at the center of the **first coil wiring 130**," and "both ends" of "**third coil wiring 133**" "***need*** to be connected to the **connection pads 138**," Ex1007 ¶¶124, 126, which a POSA would have understood is accomplished by running two **additional extension lines** (one for each end of "**third coil wiring 133**") from "**connection pads 138**" to "**third coil wiring 133**." Ex1002 ¶268. A POSA would have also understood that the two **additional extension lines** are connected to "**connection pads 138**" in the same way as Ahn illustrates for the inner "lead wirings 137" for "**first coil wiring 130**"—through Ahn's **partial disconnection** of "**second coil wiring 132**" and the "**partial[] disconnect[ion]**" of "**first coil wiring 130**":

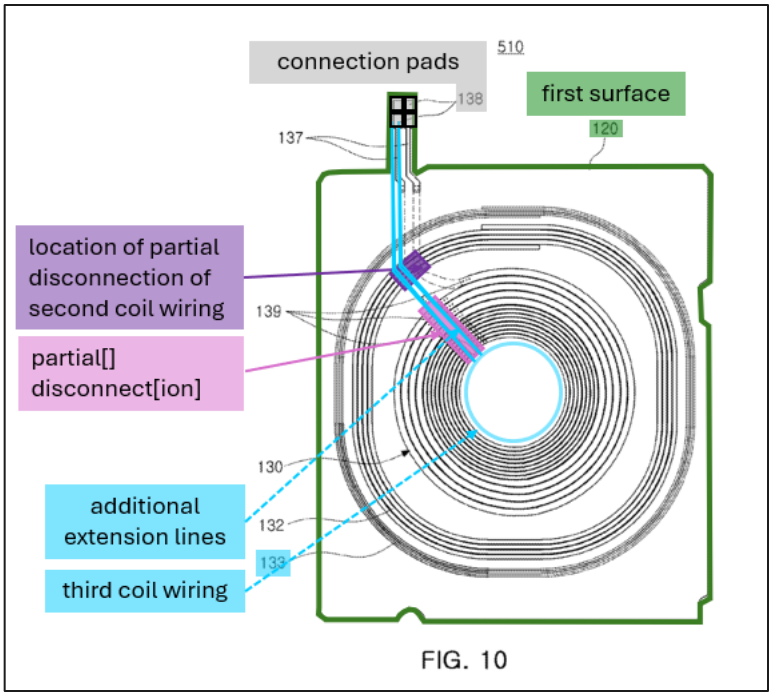


FIG. 10

Ex1007, Fig. 10 (modified based on ¶¶124, 126 to illustrate "**third coil wiring 133**" and its two **additional extension lines**); Ground 2 Limitation [2pre]; Ex1002 ¶268.

Further, this limitation would have been obvious in view 721Lee. Ex1002 ¶¶269-271.

721Lee teaches "**NFC pattern 1018**" (additional extension lines) is connected to the "**NFC coil 1015**" and traverses the "**interval of the MST coil 1050**":

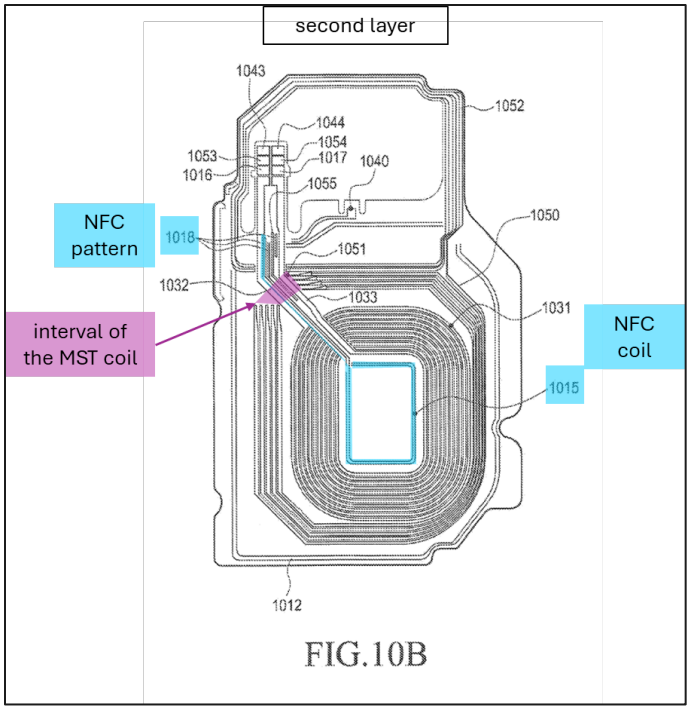


FIG.10B

Ex1011 ¶142, Fig. 10B; Ex1002 ¶270.

It would have been obvious to incorporate 721Lee's radially-extending gap teachings with Ahn. Section VIII.B.1. In the Ahn-721Lee combination, the two additional extension lines formed on Ahn's "**first surface**" (second major surface) extend through both the **partial disconnection** of "**second coil wiring 132**" and the "**partial[] disconnect[ion]**" of "**first coil wiring 130**." Ground 2 Limitation [1g]; Ex1002 ¶271.

12. [11]/[21]

The Ahn-721Lee combination renders claims 10 and 20 obvious and further renders obvious the remaining limitations of these claims. Ex1002 ¶¶272-275.

Ahn's "coil assembly 510" (second antenna pattern) further comprises a "**third coil wiring 133**" (third antenna pattern) generally surrounded by "**first coil wiring 130**" (inner antenna pattern):

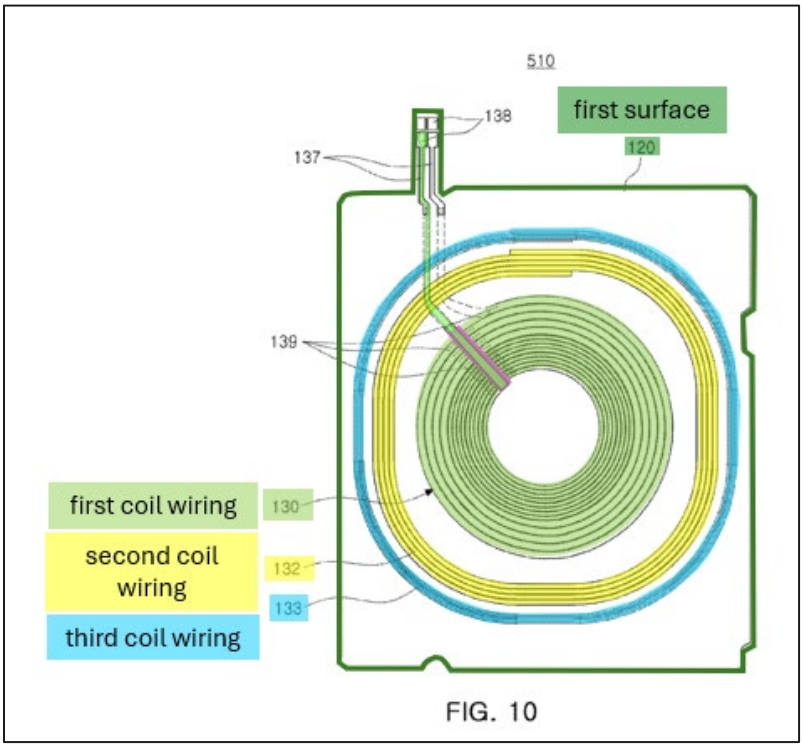


FIG. 10

Ex1007 ¶¶71, 123, 125-26, Fig. 10; Ex1002 ¶273.

While Ahn depicts "**third coil wiring 133**" disposed outside of "**second coil wiring 132**," Ahn teaches "**third coil wiring 133**" "may … be disposed at the center of the **first coil wiring 130**":

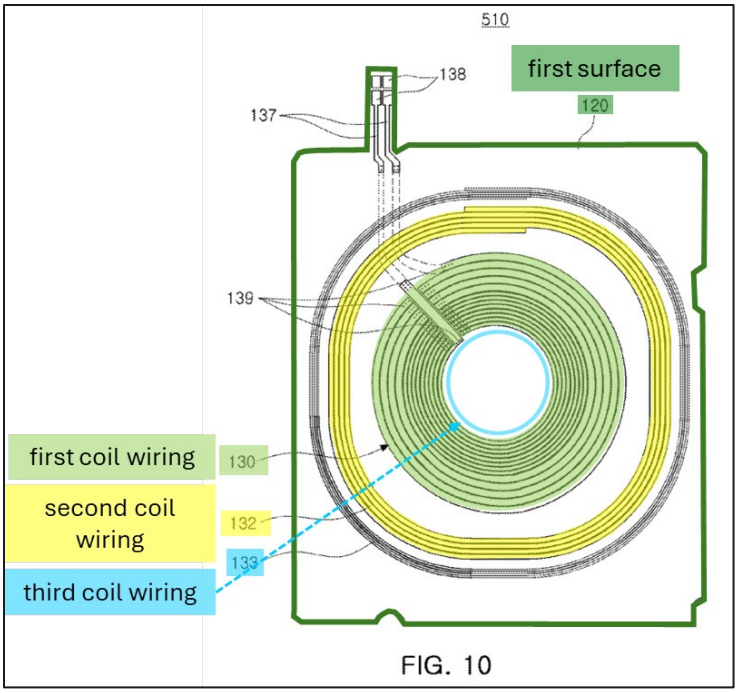


FIG. 10

Ex1007 Fig. 10 (modified per ¶¶71, 123, 125-26); Ex1002 ¶274.

For the same reasons as Ground 2 Elements [10]/[20], Ahn teaches two **additional extension lines** electrically connected to a terminal of "**third coil wiring 133**." Ex1002 ¶275.

13. [12]/[22]

The Ahn-721Lee combination renders claims 10 and 20 obvious and Ahn further teaches, or alternatively, the Ahn-721Lee combination renders obvious the remaining limitations of these claims. Ex1002 ¶¶276-277.

For the same reasons as Ground 2 Limitations [10]/[20]/[11]/[21], Ahn teaches "coil assembly 510" (second antenna pattern) on the "**first surface**" (second major surface) comprises a "**third coil wiring**" (third antenna pattern) generally surrounded by "**first coil wiring**" (inner antenna pattern) wherein at least one of the

two **additional extension lines** contacts "**third coil wiring**" on the "**first surface**." E.g., Ex1007 ¶¶124, 126; Ex1002 ¶277.

14. [13pre]/[13a]/[13b]/[13c]/[13d]

The Ahn-721Lee combination renders claim 2 obvious, and the combination further renders obvious the remaining limitations of this claim. Ex1002 ¶¶278-282.

Ahn teaches a smartphone "configured to wirelessly transmit power":

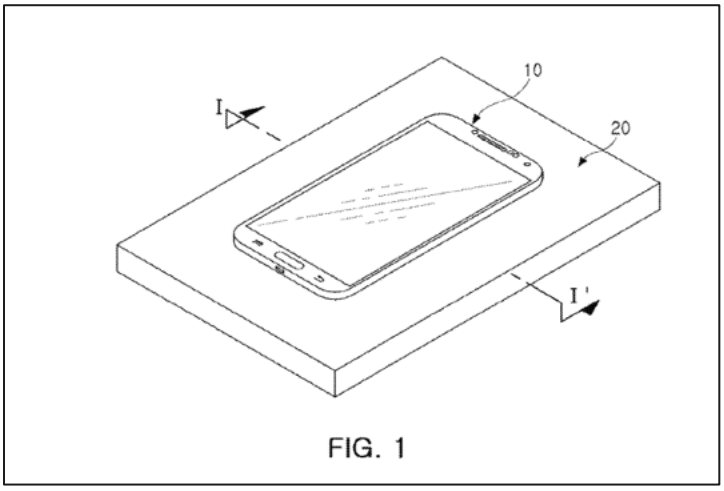


FIG. 1

Ex1007 ¶¶3-4, 48-49, Figs. 1-2; Ex1002 ¶279.

Ahn's outer coil is configured for wireless battery charging. Ex1002 ¶280. A POSA would have understood Ahn's "smartphone[]" with a "wireless charging" antenna module includes a display module comprising a display surface, a rear cover comprising a rear surface facing away from the display surface, a battery placed between the display module and the rear cover, and an antenna module placed between the battery and the rear cover because it is the most logical and common-

sense arrangement; a battery between the antenna module and the rear cover would interfere with or block the wireless-charging signal. Ex1002 ¶280.

Further, this limitation would have been obvious in view of 721Lee. Ex1002 ¶281. 721Lee teaches a "**display**" module, a rear "**cover**" facing away from the "**display**" surface, "**a battery**" placed between the "**display**" and the "**cover**," and **an antenna module** placed between the "**battery**" and the "**cover**":

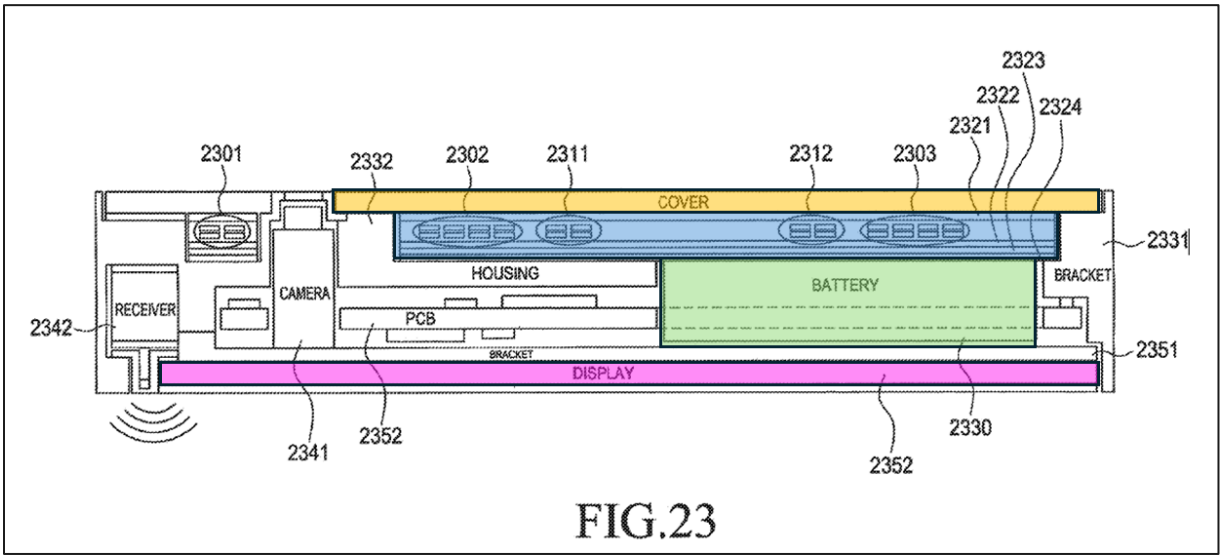


FIG.23

Ex1007, ¶¶189-190, Figs. 23-23; Ex1002 ¶281.

Ahn's outer and inner coils are configured for wireless battery charging (they "may be used to transmit and receive power for wireless charging."). Ex1007 ¶¶48-49, 52, 125, Fig. 2; Ground 2 Limitation [1a]; Ex1002 ¶282. Therefore, a POSA would have understood "**first section 1311**" and "**second section 1312**" are configurable for wireless battery charging. Ex1002 ¶¶282.

C. Ground 3: 005Lee Renders Claims 1-22 Obvious in view of Seong and Cho

1. Motivation To Combine 005Lee, Seong, and Cho

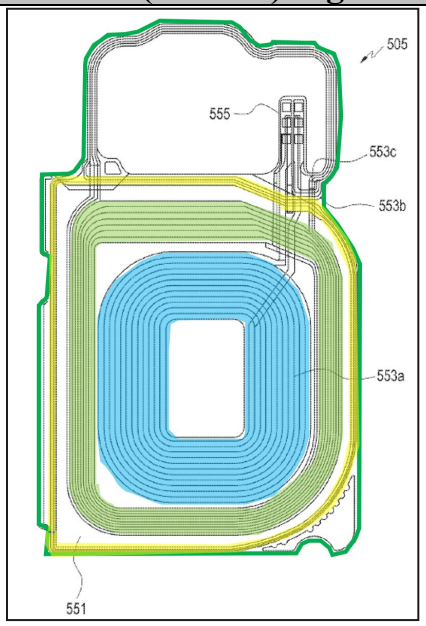
These references overcome limited space in smartphones with space-efficient WPC, NFC, and MST antennas, optimizing shape and layout, including placing coils on both sides of a substrate. Section V. A POSA reading 005Lee would have been motivated to incorporate Seong's and Cho's teachings. Ex1002 ¶¶283-293. All these references teach antenna patterns on both sides of a substrate in a smartphone, including WPC, NFC, and MST antennas. Ex1008, 17:4-9, Figs. 4A-4B, 43D; Ex1006, ¶¶4, 33-34, 77, Figs. 5-6; Ex1010 Cl. 2, 10; ¶¶66-67, 73; Ex1002 ¶283. If 005Lee is found to not teach a claimed limitation, as discussed below, it would have been obvious to a POSA to adopt well-known, predictable, and finite approaches taught by Seong and/or Cho to achieve wireless-communication functions in a space-efficient module. Ex1002 ¶283.

First, a POSA reading 005Lee would have been motivated to incorporate Seong's Figure 6 "bottom surface" coil teachings. Ex1002 ¶284. 005Lee teaches forming coils on opposing sides of a substrate. Ex1008, 17:4-9 ("Each of the conductive patterns" "can be formed on one surface" "or the other surface."), 27:58-67 ("first and second coils" "can be formed in" "different layers (or surfaces) of the flexible printed circuit board"), Figs. 4A-4B, 43D (coils on both substrate sides). However, 005Lee provides detailed coil layouts only for one substrate side. Ex1008,

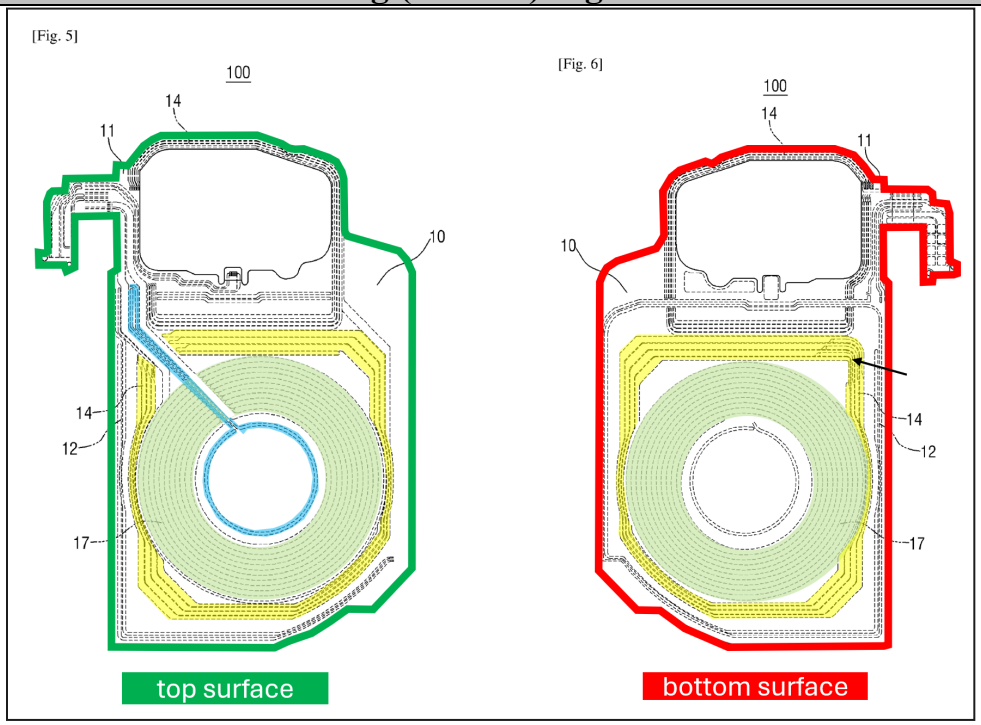
Fig. 5B. A POSA would have been motivated to look for similar references teaching possible coil layouts for 005Lee's substrate's other side, including Seong. Ex1002 ¶284.

As explained in Ground 1, like 005Lee, Seong teaches space-efficient coils, including an innermost **NFC pattern**, surrounded by an **inner MST coil** and an **outer WPC coil**, formed on both substrate sides:

005Lee (Ex1008) Fig. 5B



Seong (Ex1006) Figs. 5-6



Ex1008, Fig. 5B; Ex1006, ¶¶4, 33-34, 77, Figs. 5-6; Ex1002 ¶285.

Given their similarities, a POSA would have been motivated to implement 005Lee's teachings of forming coils on both substrate surfaces with Seong's Figure 6, which shows coils on a substrate's bottom surface, opposite similar patterns on the top surface, as shown in Seong Figure 5 and 005Lee Figure 5B. Ex1006, Figs. 5-6; Ex1008, Fig. 5B; Ex1002 ¶286; Ground 1. This would have combined known elements according to known methods (forming known coil patterns on both substrate sides, as 005Lee and Seong teach) to achieve predictable wireless-communication results furthering both references' space-efficiency goal. Ex1002 ¶286.

A POSA would have reasonably expected success. Ex1002 ¶287. As noted, 005Lee teaches forming coils on both substrate sides and teaches using various coil shapes, and Seong provides concrete examples of how to implement such coils. Forming coils on both substrate sides was common, and Seong's disclosure provides details a POSA would have used to effectively implement 005Lee's teachings. *Id.*

Second, if PO incorrectly argues 005Lee does not teach running its extension lines through coil gaps, a POSA would have found this arrangement obvious in view of Seong. Ex1002 ¶288. 005Lee runs extension lines between its "connection piece" and its "conductive patterns" to electrically connect them "to the control circuit." Ex1008, 17:52-57, Fig. 5B. 005Lee Figure 5B depicts extension lines crossing its conductive patterns. *Id.* A POSA would have understood 005Lee teaches gaps in its conductive patterns for extension lines because extension lines cannot touch conductive patterns without causing short-circuiting. Ex1002 ¶288. In addition, a POSA would have found this approach obvious. Ex1002 ¶288. Reading 005Lee, a POSA would have been motivated to look to references, including Seong, furthering the same space-efficient goals by running extension lines past conductive patterns without touching. *Id.*; Ex1006, Abstract, Fig. 5; Ground 1. 005Lee and Seong teach similar ways of achieving this (concentric coils on multiple surfaces with extension lines). Ex1008, Fig. 5B; Ex1006, Fig. 5; Ex1002 ¶288. Running extension lines through coil gaps was well-known and improves space efficiency by

letting the coils be arranged in a space-efficient, concentric manner. Ex1006, Fig. 5; Ex1014 ¶31 (coil gaps improve space efficiency by up to 70%); Ex1002 ¶288.

A POSA would have reasonably expected success. Ex1002 ¶289. 005Lee teaches using extension lines connecting coils to "connection piece 555." Ex1008, 17:52-57, Fig. 5B. 005Lee teaches using various antenna shapes and layouts. Ex1008, 17:67-18:4, 19:28-35. Incorporating Seong's coil-gaps teachings would have been a straightforward implementation of a known coil-pattern layout to achieve predictable results of space-efficient concentric coils. Ex1002 ¶289.

Third, a POSA would have been motivated to incorporate Cho's teachings of electrically connecting inner and outer coils in parallel with 005Lee. Ex1002 ¶290. Cho's "wireless communication coil" comprises a "first coil portion" and a "second coil portion[,]" which "may be connected in series or in parallel." Ex1010 ¶¶90, 91. There are only two electrical connection possibilities—in parallel or in series, as Cho teaches—so it would have been obvious to try and a simple design choice to electrically connect 005Lee's inner and outer conductive patterns in parallel to yield predictable results. Ex1002 ¶290.

A POSA would have reasonably expected success because electrically connecting two coils in parallel was a well-known, straightforward electrical-connection method as Cho teaches. Ex1010 ¶¶90, 91; Ex1002 ¶291.

Fourth, a POSA would have been motivated to incorporate Seong's and Cho's teaching of connecting coils on opposing surfaces using vias with 005Lee. Ex1002 ¶292. 005Lee teaches coils on opposing substrate surfaces and "a connection element" containing "conductive material" that "electrically interconnect[s]" them. Ex1008, 21:39-51. Seong teaches connecting coils on different surfaces using vias. Ground 1 Limitations [1d]/[1e]. Cho also teaches "wireless charging coil 111 on one surface 11 of the substrate may be connected through via holes to the wireless charging coil 112 formed on the other surface 12 of the substrate." Ex1010 ¶¶66-67, Cls. 2, 10. Seong's and Cho's teachings of connecting coils on two opposite substrate surfaces using a plurality of vias was a common and effective way to connect 005Lee's opposing-surface antenna patterns, and vias would have been obvious to try as one of a finite number of predictable solutions for this purpose. Ex1002 ¶292.

A POSA would have reasonably expected success. Ex1002 ¶293. Vias were commonly used for this purpose, would have been straightforward to implement, and 005Lee already teaches electrically interconnecting various components. *Id.*

2. [1]

a. [1pre]

To the extent the preamble is limiting, 005Lee teaches it. Ex1002 ¶¶294-296.

005Lee teaches a "smartphone" including a "flexible printed circuit board" comprising "a plurality of loop antennas" and "conductive patterns" for "NFT," "MST," and "wireless charg[ing]":

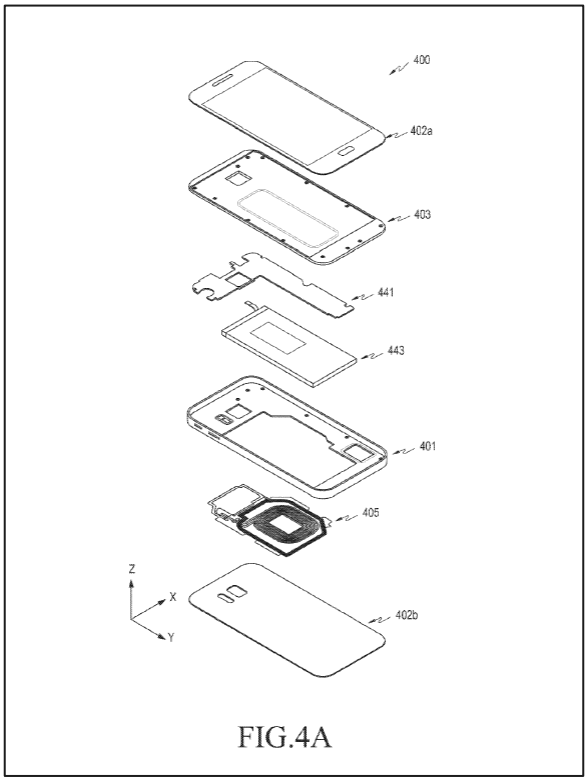


FIG.4A

Ex1008, 1:65-67, 6:23, 17:24-31, 19:5-12, Fig. 4A.

This is a smartphone antenna module including because it comprises multiple antennas. Ex1002 ¶¶295-296.

b. [1a]

005Lee teaches this limitation. Ex1002 ¶¶297-299.

005Lee teaches "**base member 551**" (substrate) can be "in the form of a multi-layer circuit board" with "loop antennas for **NFT**, **MST**" and "wireless

charge" and "[e]ach of the conductive patterns … can be formed on **one surface** of the base member 551 or the **other surface**" of the "**base member 551**":

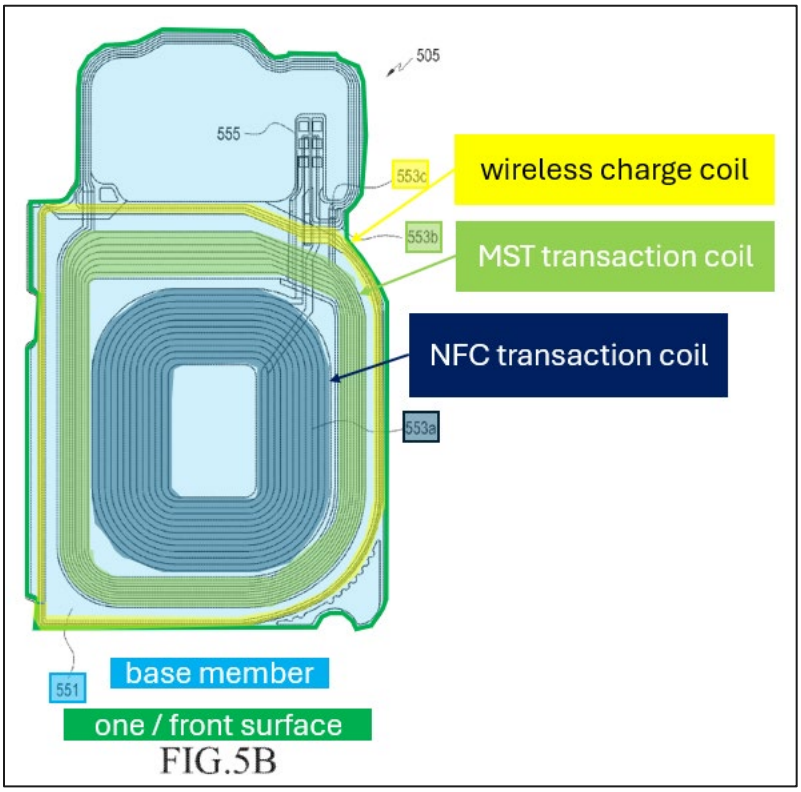


FIG.5B

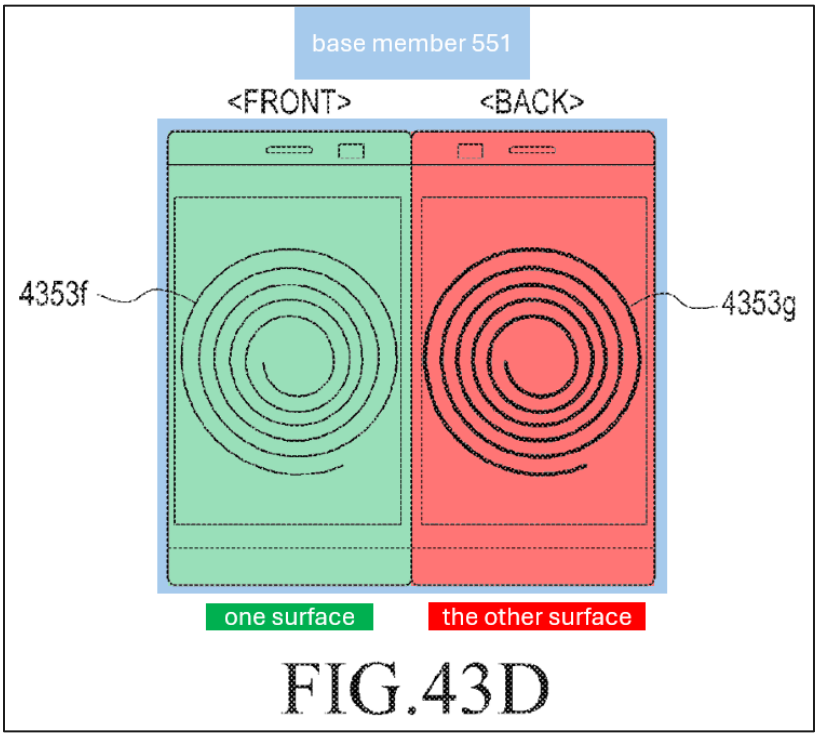
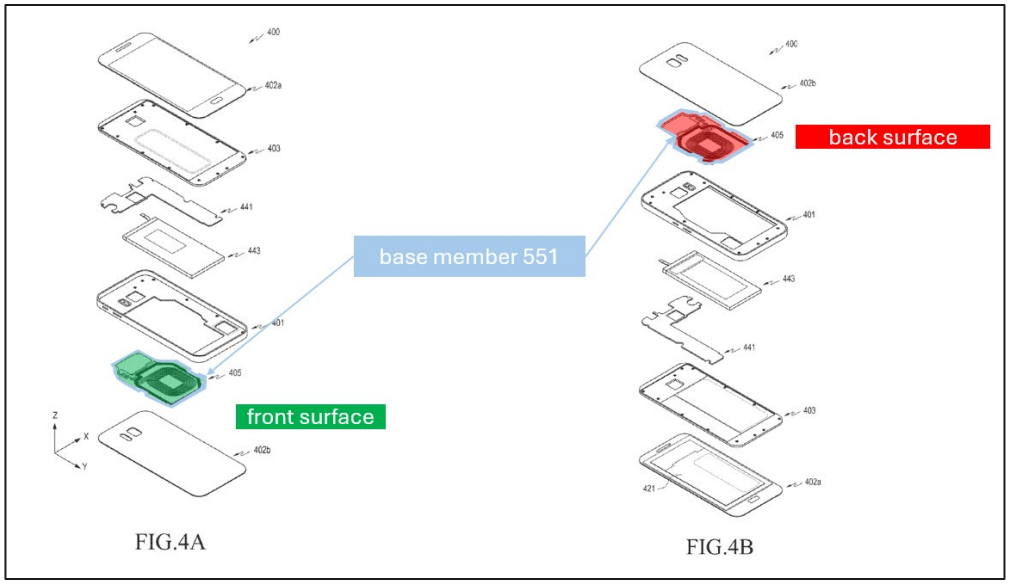


FIG.43D



Ex1008, 17:4-19, 18:36-40, 19:5-12, 49:59-62, Figs. 4A (depicting "**one surface**" from a top view), 4B (depicting "**other surface**" from a bottom view), 5B (depicting "**one [front] surface**"), 43D (depicting coil antennas "separated from each other" on the "**front**" and "**back**" surfaces), 27:58-67 ("the first and second coils … can be formed in … different layers (or surfaces) of the **flexible printed circuit board**"); Ex1002 ¶298.

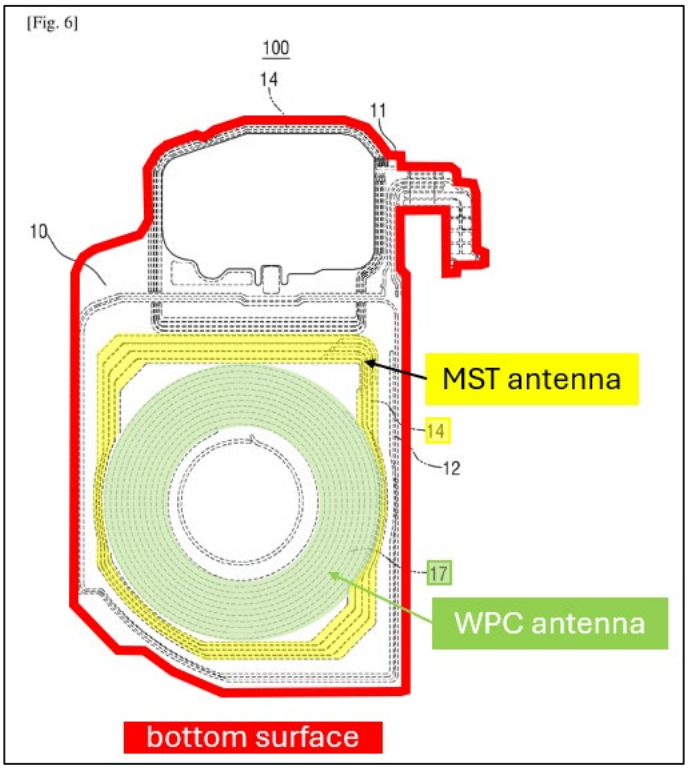
The "**other surface**" / "**back**" surface of 005Lee's "**base member 551**" is the claimed first major surface, and the "**one surface**" / "**front**" surface (depicted in Figure 5B) is the claimed second major surface facing away from the first major surface. Ex1002 ¶299.

c. [1b]

005Lee in view of Seong renders this limitation obvious. Ex1002 ¶¶300-303.

As explained in Ground 3 Limitation [1a], 005Lee teaches forming antenna patterns on the "**other surface**" / "**back**" surface. Ex1008, Figs. 4B, 43D; Section VIII.C.1. However, 005Lee does not explicitly disclose the details of the antenna patterns for this surface. Thus, a POSA would have been motivated to look for teachings of complementary coil layouts for the "**other surface**" / "**back**" surface. Ex1002 ¶301.

Seong teaches a first antenna pattern on the "**bottom surface**" comprises "**WPC antenna**" and "**MST antenna**" surrounding "**WPC antenna**":



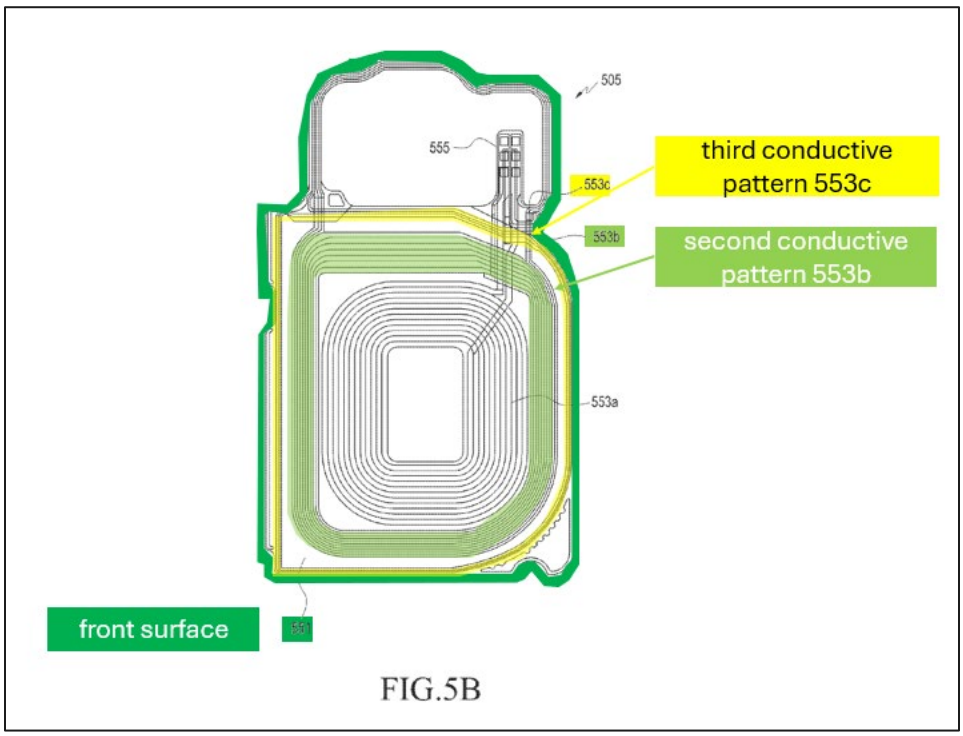
Ex1006 ¶64, Fig. 6; Ground 1 Limitation [1b]; Ex1002 ¶302.

It would have been obvious to incorporate Seong's "bottom surface" coil pattern teachings with 005Lee. Section VIII.C.1.

d. [1c]

005Lee teaches this limitation. Ex1002 ¶¶304-305.

005Lee teaches a second antenna pattern formed on the "**front surface**" (second major surface), comprising a "**second conductive pattern 553b**" (an inner pattern) and "**a third conductive pattern 553c**" (an outer pattern) surrounding the "**second conductive pattern 553b**":



Ex1008, 17:14-16, 19:28-34, Fig. 5B; Ex1002 ¶305.

e. [1d]

005Lee this limitation or alternatively renders it obvious in view of Seong and Cho. Ex1002 ¶¶306-312.

005Lee teaches a "**second conductive pattern 553b**" or **MST transaction coil** comprising a plurality of **concentric circular lines** defining a **radially-**

extending inner gap into which the plurality of **concentric circular lines** of **MST transaction coil** does not extend (especially when using 005Lee's concentrically circular coils):

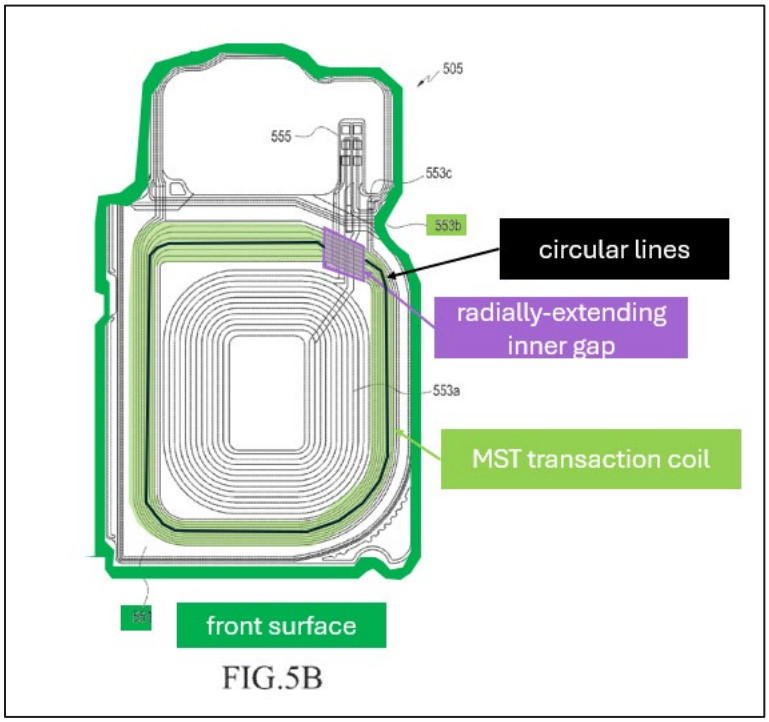
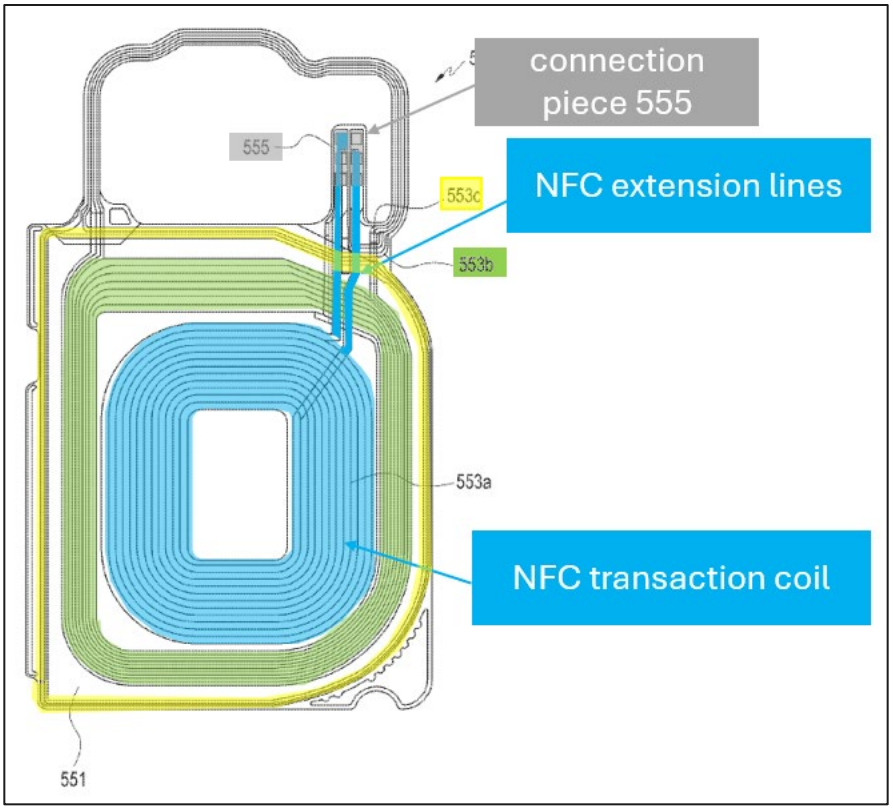


FIG.5B

Ex1008, 19:28-34, Fig. 5B (modified to illustrate **radially-extending inner gap**); Ex1002 ¶307.

A POSA would have understood that 005Lee's Figure 5B shows a **radially-extending inner gap**. Ex1002 ¶308. 005Lee teaches "**connection piece 555**" "connect[s] the **conductive patterns 553a**, 553b, and 553c to the control circuit" and depicts **NFC extension lines** performing this connection:

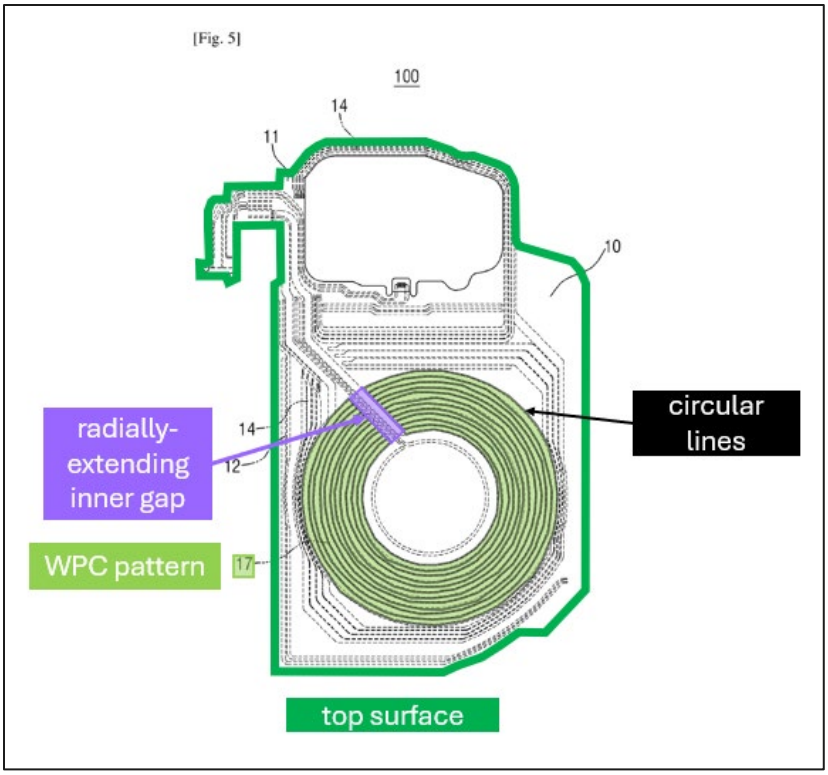


Ex1008, 17:52-57, Fig. 5B; Ex1002 ¶308.

For the depicted **NFC extension lines** to function without interfering with conductive patterns **553b** and **553c**, extension lines and conductive patterns cannot touch, as such contact would cause short circuiting. Ex1002 ¶309. Thus, a POSA would have understood a **radially-extending inner gap** exists through which **NFC extension lines** run.

Further, it would have been obvious to use a **radially-extending inner gap** in view of Seong. Section VIII.C.1.

Seong teaches a **radially-extending inner gap**:



Ex1006, Fig. 5; Ex1002 ¶311; Ground 1 Limitation [1d].

Further, the 005Lee-Seong-Cho combination renders obvious at least part of the concentric circular lines of the "**second conductive pattern**" on the "**front**" surface overlaps Seong's "**WPC antenna**" on the opposing surface, which would improve compactness and reduce unused substrate space, and it would have been obvious in view of Seong and Cho to connect them through vias. Ground 1 Limitation [1d]; Section VIII.C.1; Ex1002 ¶312.

f. [1e]

005Lee teaches this limitation or alternatively, in view of Seong and Cho renders it obvious. Ex1002 ¶¶313-316.

005Lee teaches the "**third conductive pattern 553c**" or **wireless charging coil** comprises a plurality of concentric circular lines defining a **radially-extending outer gap** into which the plurality of **concentric circular lines** of the "**wireless charging coil**" does not extend:

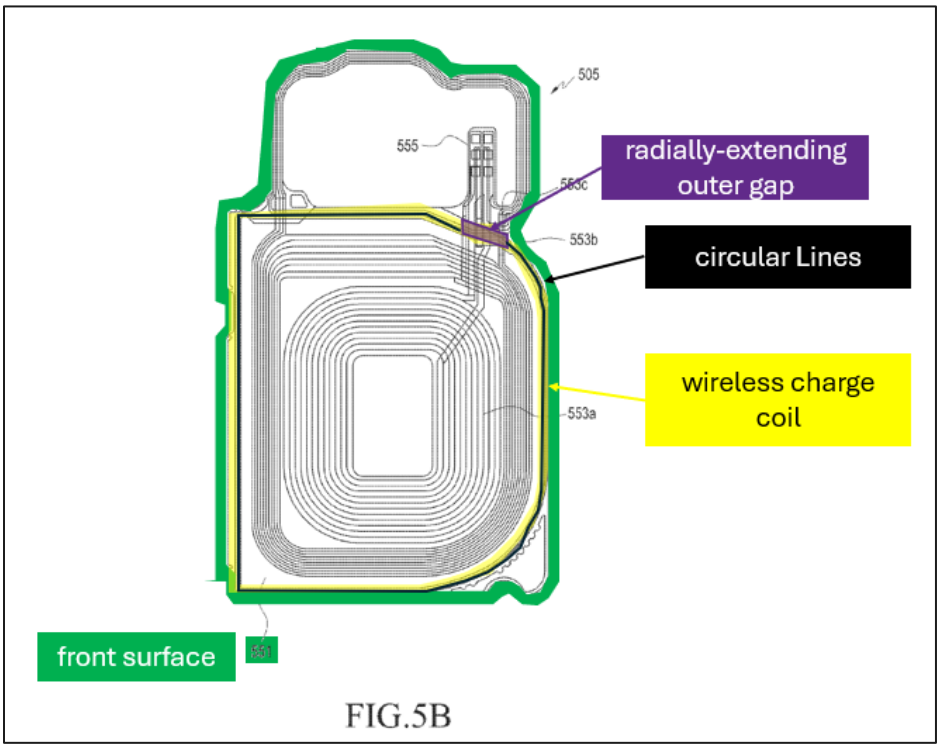


FIG.5B

Ex1008, 19:28-34, Fig. 5 (modified to illustrate the **radially-extending outer gap**); Ground 3 Limitation [1d]; Ex1002 ¶314.

In addition, this limitation would have been obvious in view of Seong's teachings on gaps and circular lines (Ground 1 Limitation [1e]) for similar reasons as Ground 3 Limitation [1d].; Section VIII.C.1.

Further, the 005-Lee-Seong-Cho combination renders obvious at least part of the concentric circular lines of the "**third conductive pattern 553c**" on the "**front**"

surface overlaps Seong's "**MST antenna**" on the opposing surface, which would improve compactness and reduce unused substrate space, and it would have been obvious in view of Seong and Cho to connect them through vias. Ground 1 Limitation [1e]; Section VIII.C.1; Ex1002 ¶¶315-316.

g. [1f]

005Lee teaches this limitation or alternatively renders it obvious in view of Seong. Ex1002 ¶¶317-319.

In 005Lee, at least part of the concentric **circular lines** of "**third conductive pattern 553c**" generally surround at least part of the concentric **circular lines** of "**second conductive pattern 553b**":

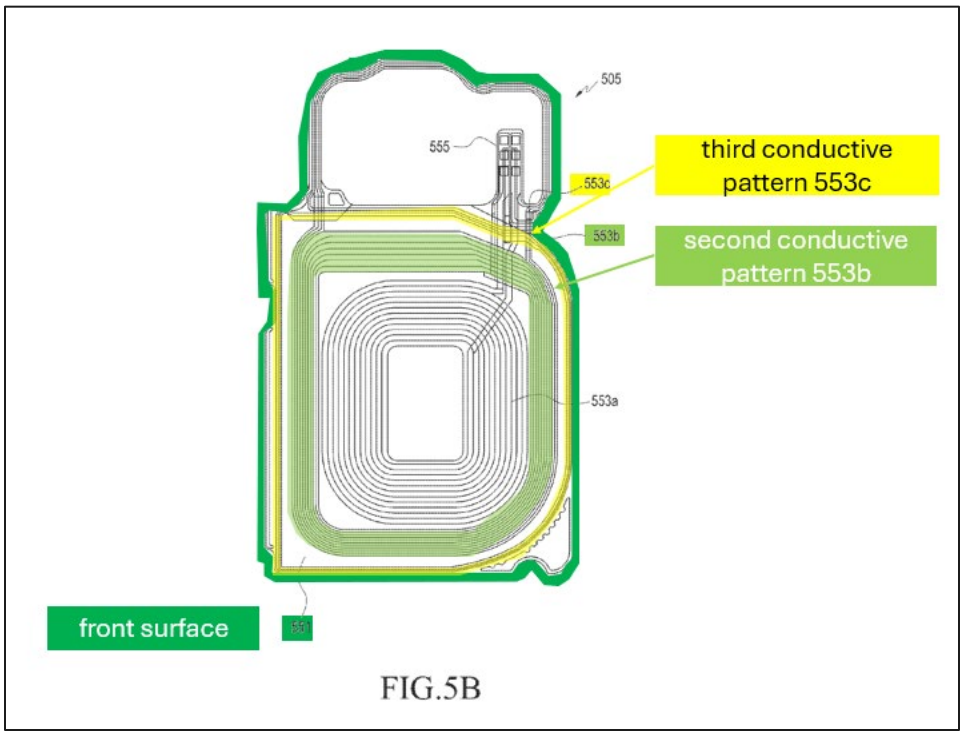


FIG.5B

Ex1008, 17:14-16, 19:28-34, Fig. 5B; Ex1002 ¶318.

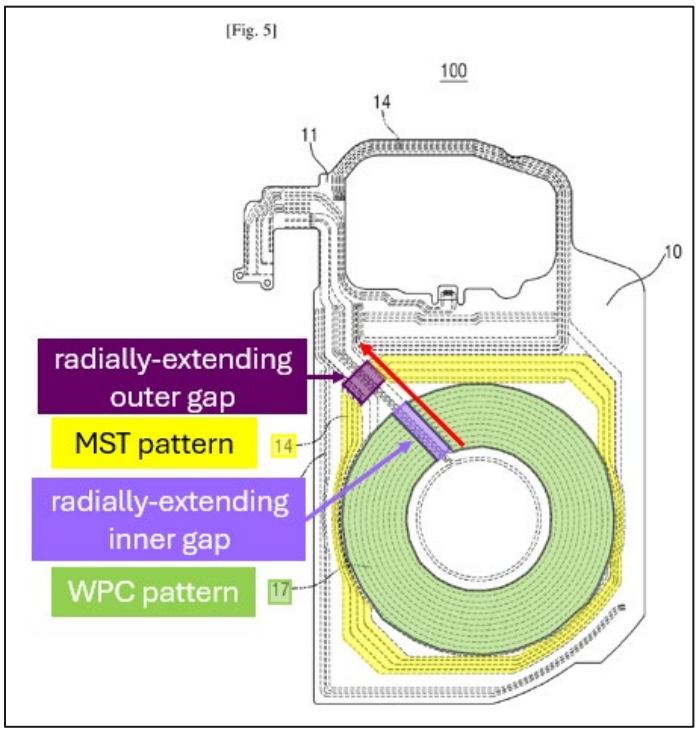
It would have been obvious to incorporate Seong's circular-line teachings with 005Lee, (Section VIII.C.1; Ground 1 Limitations [1d]/[1e]; Ex1006, Fig. 5), such that the combination taught a "**third conductive pattern 553c**" and a "**second conductive pattern 553b**" comprise a plurality of **concentric circular lines**. Ex1002 ¶319.

h. [1g]

005Lee in view of Seong renders this limitation obvious. Ex1002 ¶¶320-324.

005Lee teaches and further, in view of Seong renders obvious, using radially-extending inner and outer gaps. Ground 3 Limitations [1d]/[1e].

Seong teaches this limitation:



Ex1006, Fig. 5; Ex1002 ¶322; Ground 1 Limitation [1g].

It would have been obvious to incorporate Seong's coil-gaps and C-shaped lines teachings with 005Lee. Section VIII.C.1. The combination satisfies this limitation:

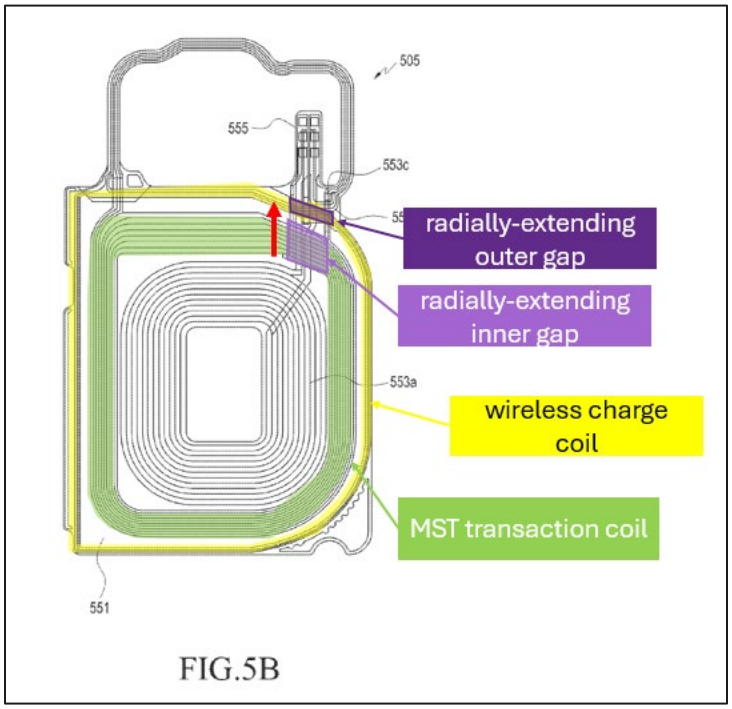


FIG.5B

Ex1008, 19:28-34, Fig. 5; Ex1002 ¶323.

This limitation is also satisfied when 005Lee's coils are concentric circles (Ground 3 Limitations [1d]/[1e]/[1f]). Ex1006, 19:28-34; Ex1002 ¶324.

3. [2]

a. [2pre]

The 005Lee-Seong-Cho combination renders claim 1 obvious, and further renders obvious the remaining limitations of this claim. Ex1002 ¶¶325-327.

005Lee teaches or further, in view of Seong renders obvious, radially-extending inner and outer gaps through which extension lines run. Ground 3 Limitations [1d]/[1e]/[1f].

005Lee further teaches an **inner extension line** formed on the "**front**" surface (second major surface), and renders obvious in view of Seong **inner extension line** extending through both the **radially-extending inner gap** and at least part of the **radially-extending outer gap**:

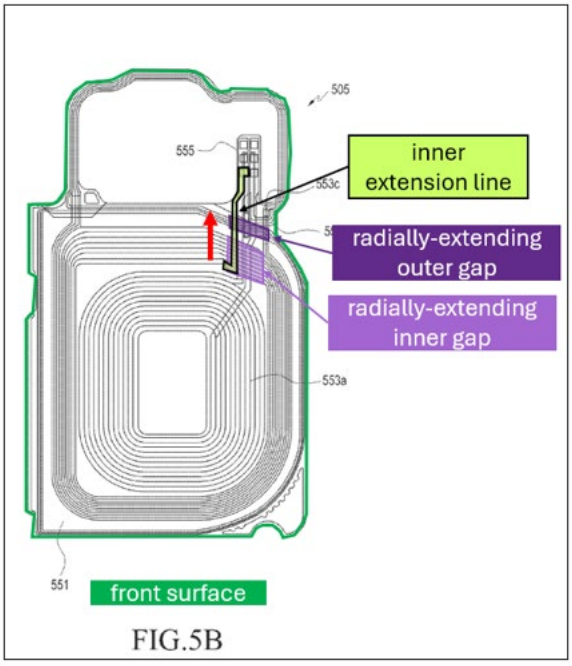


FIG.5B

Ex1008, 17:53-63, Fig. 5B; Ex1002 ¶327; Section VIII.C.1.

b. [2a]

005Lee in view of Seong renders this limitation obvious. Ex1002 ¶¶328-330.

005Lee in view of Seong renders obvious a radially-extending outer gap through which extension lines run. Ground 3 Limitations [1e]/[1f].

005Lee further teaches an **outer extension line** formed on the "**front**" surface (second major surface), and renders obvious in view of Seong **outer extension line** extending through at least part of the **radially-extending outer gap**:

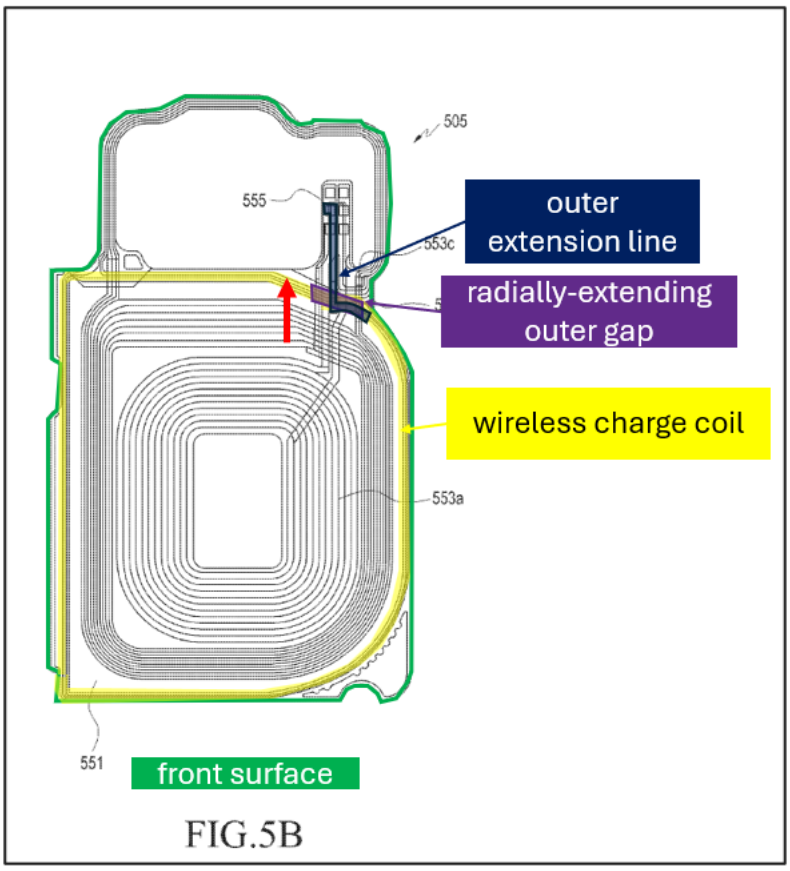


FIG.5B

Ex1008, 17:53-63, Fig. 5B; Ex1002 ¶330; Section VIII.C.1.

4. [3]

The 005Lee-Seong-Cho combination renders claim 2 obvious, and further renders obvious the remaining limitations of this claim. Ex1002 ¶¶331-334.

005Lee's **inner extension line** and **outer extension line** are extending generally in parallel:

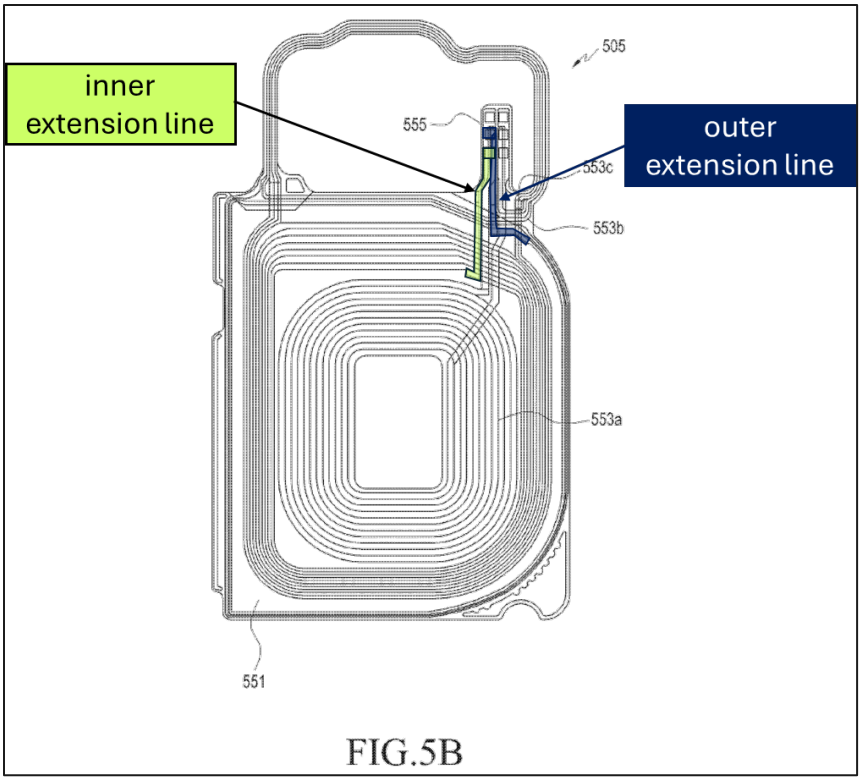


FIG.5B

Ex1008, 17:53-63, Fig. 5B; Ex1002 ¶332.

Further, 005Lee teaches forming "conductive patterns 553a, 553b, and 553c" on both its "**front**" and "**back**" surfaces. Ground 3 Limitations [1a]/[1b]/[1c]. It would have been obvious to incorporate Seong's "bottom surface" coil antenna pattern teachings with 005Lee. Section VIII.C.1. In the combination, each of the **inner extension line** and **outer extension line** on the "**front**" surface (second major surface) overlaps the outer coil on 005Lee's "**back**" surface (first major surface):

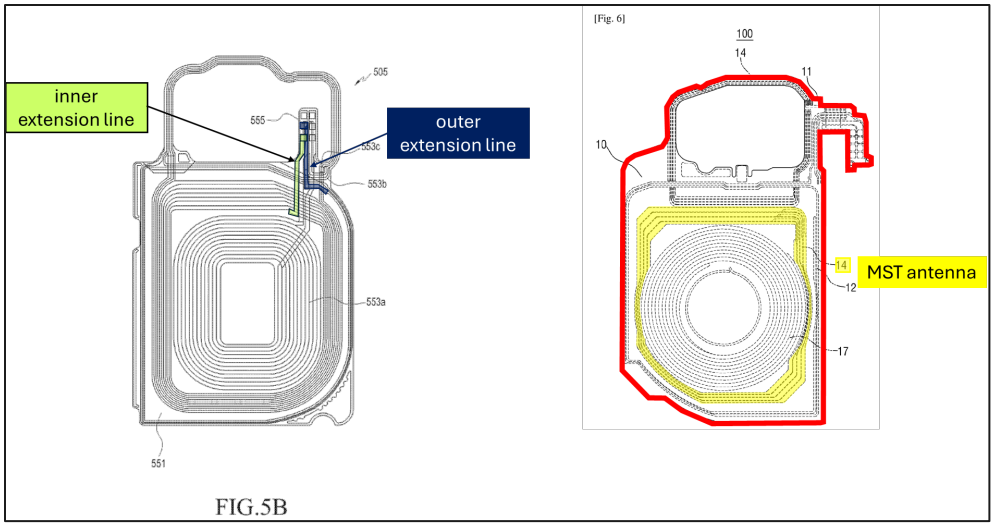


FIG.5B

Ex1008, Fig. 5B; *id.*, Figs. 4A-4B, 43D, Ground 3 Limitation [1a]; Ex1002 ¶333.

Further, a POSA would have found an arrangement with an overlap portion to be obvious. Ex1002 ¶334. 005Lee teaches shaping its coils in concentric circles. Ex1008, 19:28-34. A POSA would have found it obvious to shape 005Lee's coils on both surfaces in tight, concentric circles to maximize space efficiency, and when so shaped, the combination satisfies this limitation. Ex1002 ¶334.

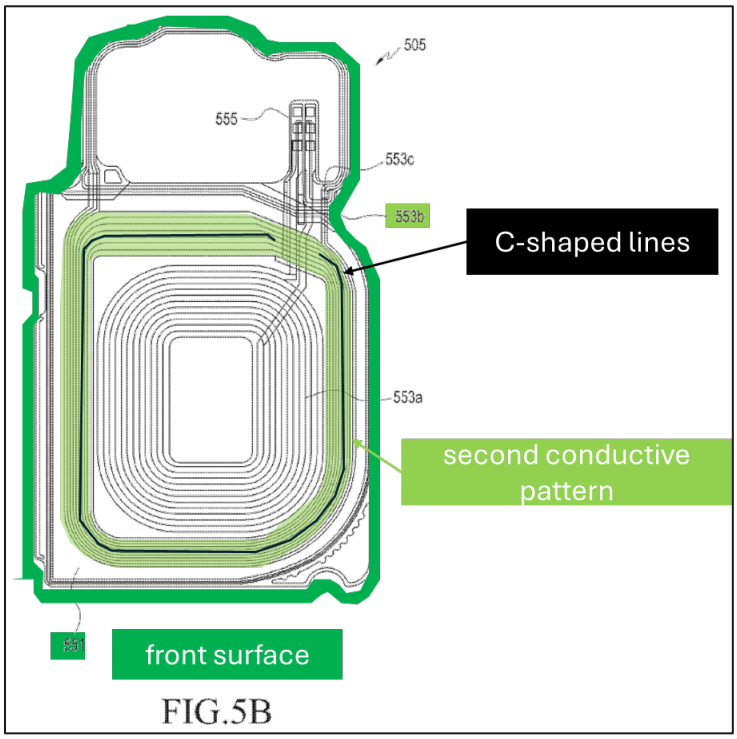
5. [4]/[14]

The 005Lee-Seong-Cho combination renders claims 1 and 11 obvious, and further renders obvious the remaining limitations of these claims. Ex1002 ¶¶335-337.

005Lee teaches an inner extension line (Ground 3 Limitation [2pre]) and the 005Lee-Seong-Cho combination renders obvious electrically connecting 005Lee's Figure 5B coils with Seong's Figure 6 coils using vias (Ground 3 Limitations

[1d]/[1e]; Section VIII.C.1). This electrical connection occurs at a terminal of the inner coil because that is where the via is located. Ex1002 ¶336.

At least part of the concentric circular lines of 005Lee's "**second conductive pattern 553b**" on the "**front**" surface (inner antenna pattern) is in a C-shape (especially when 005Lee's coils are concentric circles):



Ex1008 Fig. 5B; Ground 3 Limitation [1d]; Ex1002 ¶337.

6. [5]/[15]

The 005Lee-Seong-Cho combination renders claims 1 and 11 obvious and further renders obvious the remaining limitations of these claims. Ex1002 ¶¶338-340.

005Lee teaches an outer extension line (Ground 3 Limitation [2a]) and the 005Lee-Seong-Cho combination renders obvious electrically connecting 005Lee's Figure 5B coils with Seong's Figure 6 coils using vias (Ground 3 Limitations [1d]/[1e]; Section VIII.C.1). This electrical connection occurs at a terminal of the outer coil because that is where the via is located. Ex1002 ¶339.

At least part of the concentric circular lines of 005Lee's "**third conductive pattern**" (outer antenna pattern) is in a C-shape (especially when 005Lee's coils are concentric circles):

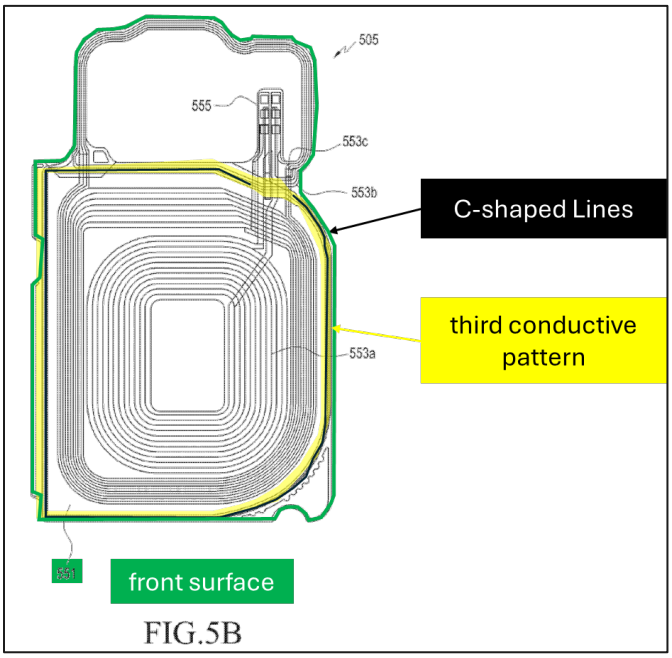


FIG.5B

Ex1008 Fig. 5B; Ground 3 Limitation [1e]; Ex1002 ¶340.

7. [6]/[17]

The 005Lee-Seong-Cho combination renders claims 2 and 13 obvious and further renders obvious the remaining limitations of these claims. Ex1002 ¶¶341-342.

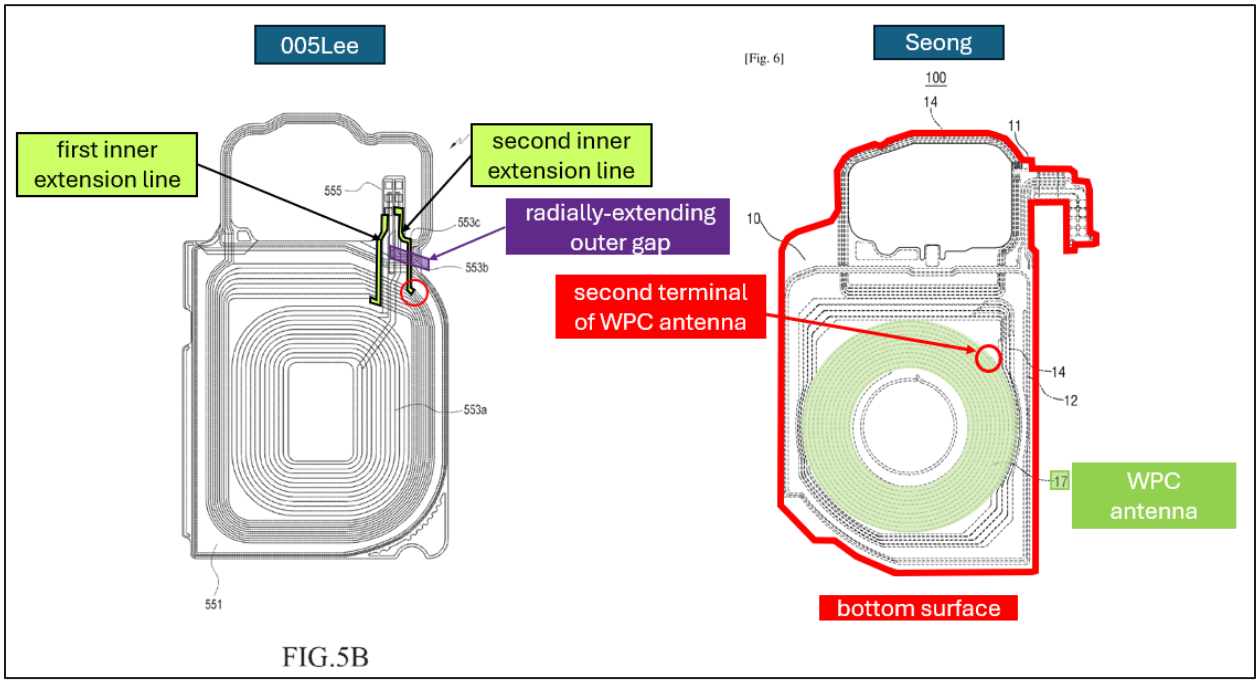
005Lee teaches, and the 005Lee-Seong-Cho combination renders obvious, at least one of the **inner extension line** and **outer extension line** is electrically connected to the first antenna pattern formed on the "**back**" through at least one via. Ex1002 ¶342. 005Lee teaches and the 005Lee-Seong-Cho combination renders obvious, the **inner extension line** and **outer extension line** are electrically connected to the "**WPC antenna**" and "**MST antenna**" on the "**bottom**" surface, respectively, through vias. Ground 3 Limitations [1d]/[1e]/[2pre]/[2a]. And, Seong's "**WPC antenna**" and "**MST antenna**" comprise the first antenna pattern on "**back**" surface (first major surface). Ground 3 Limitations [1b].

8. [7]/[18]

The 005Lee-Seong-Cho combination renders claims 1 and 11 obvious and further renders obvious the remaining limitations of these claims. Ex1002 ¶¶343-345.

The 005Lee-Seong-Cho combination renders obvious a **first inner extension line** electrically connected to a **first terminal** of "**second conductive pattern**" on the "**bottom**" surface though via. Ground 3 Claims [4]/[14].

For the same reasons discussed with Ground 3 Claims [4]/[14], the 005Lee-Seong-Cho combination renders obvious 005Lee's smartphone antenna module comprises a **second inner extension line** formed on the "**front**" surface (second major surface) that electrically connects to a **second terminal** of "**WPC antenna**" on the "**bottom**" surface though vias, and the **second inner extension line** extends through at least part of the **radially-extending outer gap**:



Ex1008, 17:53-63, Fig. 5B; Ex1002 ¶345; Section VIII.C.1.

9. [8]/[16]

The 005Lee-Seong-Cho combination renders claims 1 and 13 obvious and further renders obvious the remaining limitations of these claims. Ex1002 ¶¶346-348.

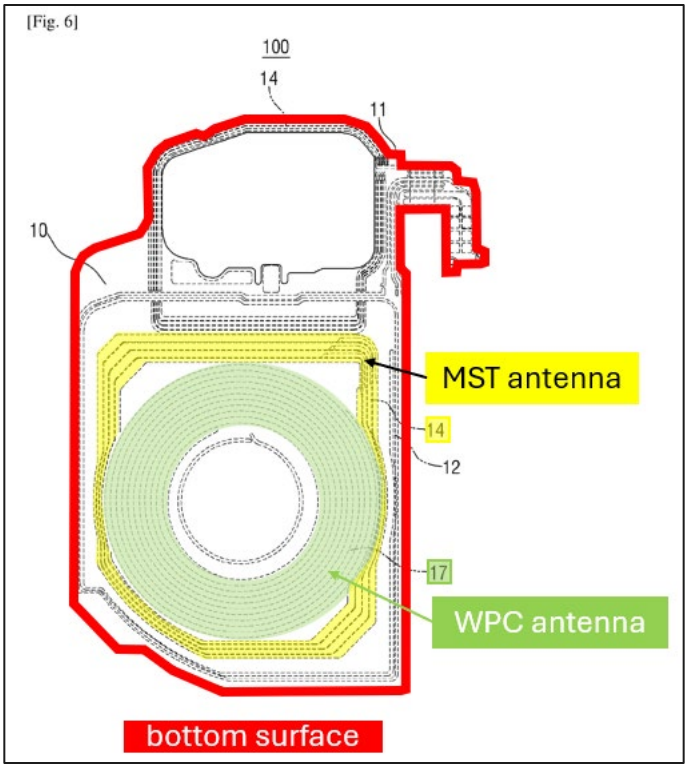
Cho teaches electrically connecting inner and outer coils in parallel. Ex1002 ¶347. Cho's "wireless communication coil" comprises a "first coil portion" and a "second coil portion[,]" which "may be connected in series or in parallel." Ex1010 ¶¶90, 91.

It would have been obvious to incorporate Cho's parallel-electrical-connection teachings with the combined 005Lee-Seong teachings to electrically connect 005Lee's MST and wireless charge coils (inner and outer coils) in parallel. Section VIII.C.1. Ex1002 ¶348.

10. [9]/[19]

The 005Lee-Seong-Cho combination renders claims 1 and 13 obvious and further renders obvious the remaining limitations of these claims. Ex1002 ¶¶349-352.

Seong's "**WPC antenna**" on the "**bottom**" surface (inner coil) includes a wire line having a width different from that of a wire line of "**MST antenna**" on the "**bottom**" surface (outer coil):



Ex1006 ¶64, Fig. 6; Ground 1 Limitation [1b]; Ex1002 ¶350. Seong's coil's wire lines' widths may vary, as Seong Figure 6 depicts. Ex1006 ¶63; Ex1002 ¶350.

Further, Seong's "**WPC antenna**" on the "**bottom**" surface (inner coil) has a first number of turns, "**MST antenna**" on the "**bottom**" surface (outer coil) has a second number of turns, wherein the first number of turns is greater than the second number of turns. Ex1006 ¶64, Fig. 6; Ground 1 Limitation [1b]; Ex1002 ¶351. As shown above, Seong depicts "**WPC antenna**" having approximately 11 turns, and "**MST antenna**" having approximately 4 turns. Ex1002 ¶351. Seong teaches antenna pattern "shape" and "arrangement" "may be varied," including the number of coil turns. Ex1006 ¶63; Ex1002 ¶351.

It would have been obvious to incorporate Seong's bottom-surface coil-pattern teachings with 005Lee. Section VIII.C.1.

11. [10]/[20]

The 005Lee-Seong-Cho combination renders claims 1 and 13 obvious and 005Lee further teaches the remaining limitations of these claims. Ex1002 ¶¶353-355.

005Lee in view of Seong renders obvious radially-extending inner and outer gaps through which extension lines extend. Ground 3 Limitations [1d]/[1e]/[1f].

005Lee further teaches a "**NFC transaction coil**" and depicts, and renders obvious in view of Seong, two "**NFC transaction coil**" extension lines (two additional extension lines) formed on the "**front**" surface (second major surface) extending through both the **radially-extending inner gap** and the **radially-extending outer gap**:

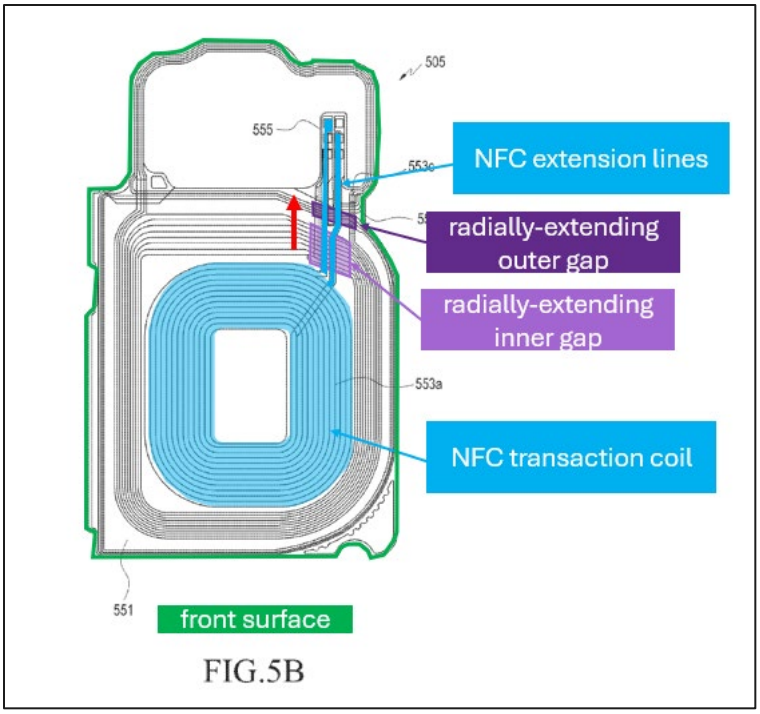


FIG.5B

Ex1008, 17:53-63, 19:28-30, Fig. 5B; Ex1002 ¶355; Section VIII.C.1.

12. [11]/[21]

The 005Lee-Seong-Cho combination renders claims 10 and 20 obvious and 005Lee further teaches the remaining limitations of these claims. Ex1002 ¶¶356-358.

005Lee teaches its second antenna pattern formed on the "**front**" (second major surface) comprises "**NFC transaction coil**" (third antenna pattern) generally surrounded by "**second conductive pattern 553b**" (inner antenna pattern):

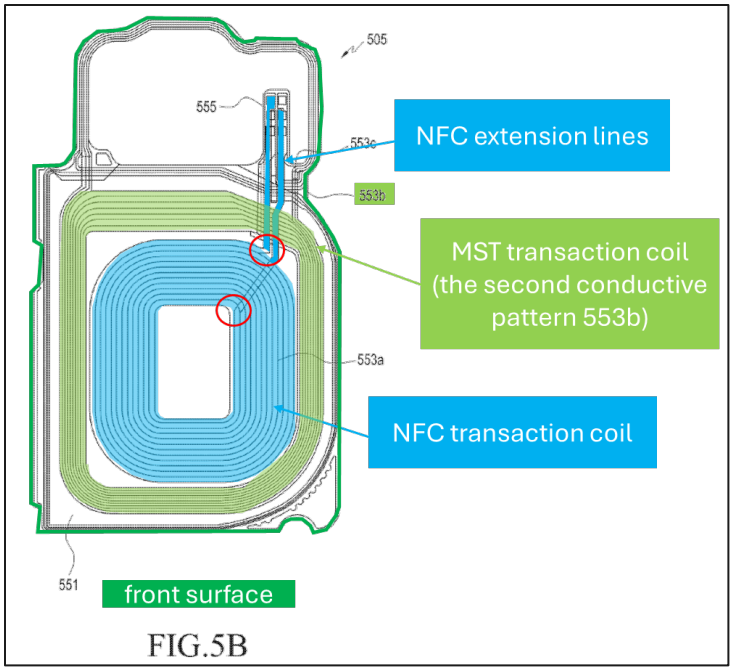


FIG.5B

Ex1008, 19:28-30, Fig. 5B; Ground 3 Limitation [10]/[20]; Ex1002 ¶357.

As Figure 5B depicts, 005Lee illustrates each of the two "**NFC transaction coil**" extension lines is electrically connected to a terminal of "**NFC transaction coil**." *Id.*, Fig. 5b; 17:53-63; Ex1002 ¶358.

13. [12]/[22]

The 005Lee-Seong-Cho combination renders claims 10 and 20 obvious and further renders obvious the remaining limitations of these claims. Ex1002 ¶¶359-360.

Seong teaches a second antenna pattern formed on the "**front**" (second major surface) comprises "**NFC transaction coil**" (third antenna pattern) generally surrounded by "**second conductive pattern 553b**" (inner antenna pattern), wherein at least one of the two "**NFC transaction coil**" extension lines (two additional

extension lines) contacts "**NFC transaction coil**" on the "**front**" surface (second major surface). Ground 1 Limitations [10]/[20]/[11]/[21]; Ex1008, 17:53-63, 19:28-30, Fig. 5B; Ex1002 ¶360.

14. [13pre]/[13a]/[13b]/[13c]/[13d]

The 005Lee-Seong-Cho combination renders claim 2 obvious and 005Lee further teaches the remaining limitations of this claim. Ex1002 ¶¶361-363.

005Lee teaches a smartphone comprising "**a front cover 402*a***" (display module) comprising a "**display device 421**" (display surface), "**a rear surface 402*b***" facing away from the "**display device**," "**battery 443**," placed between the "**front cover**" and the "**rear surface**," and "**a conductive pattern unit**" placed between the "**battery**" and the "**rear surface**":

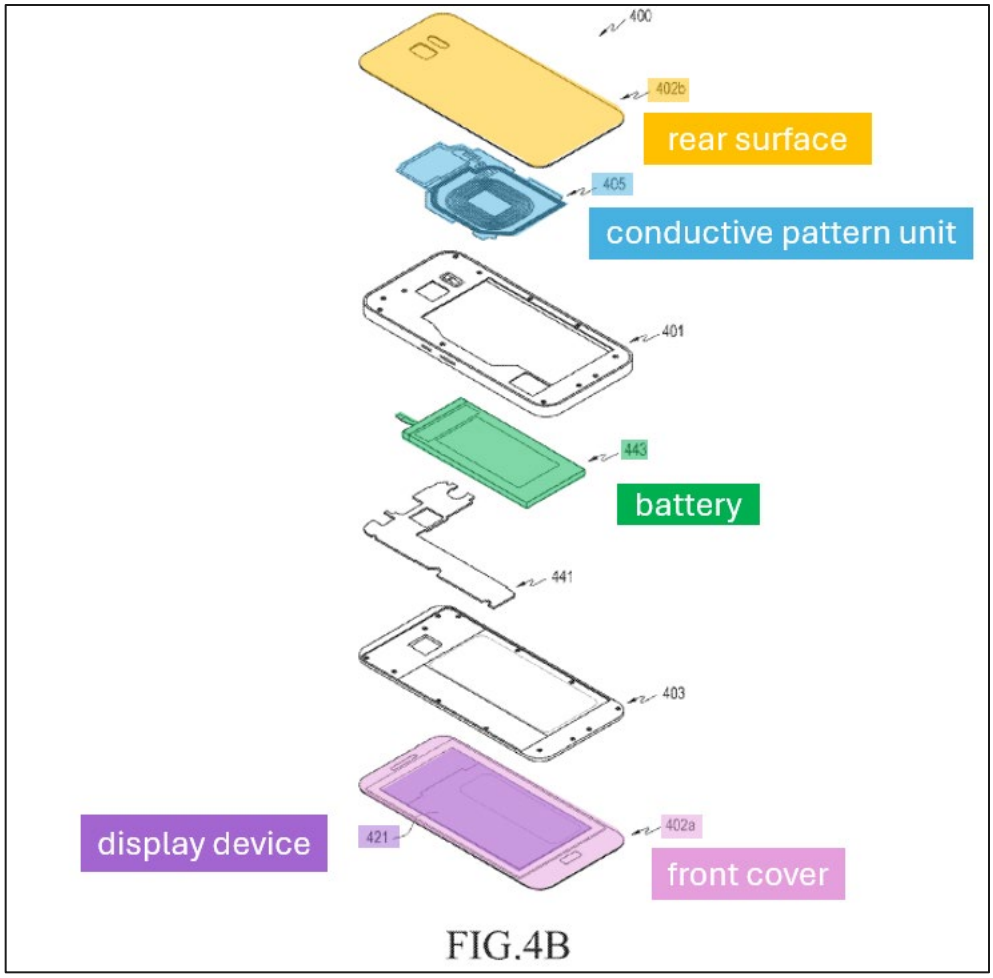


FIG.4B

Ex1008, 6:23, 15:18-31, 15:41-63, Figs. 4A, 4B; Ex1002 ¶362.

Seong teaches an inner and outer coil configured for wireless charging. Ground 1 Claim [13]. It would have been obvious to incorporate Seong's bottom-surface coil-pattern teachings with 005Lee. Section VIII.C.1.

IX. SECONDARY CONSIDERATIONS

Petitioners are unaware of any secondary considerations of non-obviousness.

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

A. Real Parties-in-Interest

Petitioners identify themselves as the real parties-in-interest.

B. Related Matters

To the best of Petitioners' knowledge, apart from the above-mentioned litigation, *AQ Corporation v. Samsung Electronics Co., Ltd. et al.*, Case No. 2:25-cv-01012-JRG (EDTX), the '564 Patent has not been involved in any litigation, *inter partes* or post-grant review prior to this proceeding.

C. Lead and Backup Counsel, Service, and Power of Attorney

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Petitioners concurrently submit a Power of Attorney, 37 C.F.R. § 42.10(b), and consent to electronic service at Samsung-AQ@kirkland.com.

XI. PAYMENT OF FEES UNDER 37 C.F.R. §42.103

Petitioners concurrently electronically submit the required fees for this Petition. The Board is authorized to charge Deposit Account No. 506092 for any fee deficiency.

Date: January 26, 2026

Respectfully submitted,

/s/ Robert A. Appleby

Robert A. Appleby, P.C.
Reg. No. 40,897

Attorneys for Petitioner

CERTIFICATE OF COMPLIANCE

This Petition complies with the type-volume limitations as mandated in 37 C.F.R. § 42.24, totaling 13,474 words. Counsel has relied upon the word count feature provided by Microsoft Word.

/s/ Robert A. Appleby
Robert A. Appleby (Reg. No. 40,897)

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that a copy of the foregoing document with the accompanying Exhibits listed in Petitioners' Exhibit List was caused to be served by Federal Express, costs prepaid, to Patent Owner at the following address of record:

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14532 Dufief Mill Road
North Potomac, MD 20878

A copy was also served via electronic mail and FTP on the attorneys of record in the following related matter, *AQ Corporation v. Samsung Electronics Co., Ltd. et al.*, Case No. 2:25-cv-01012-JRG (EDTX):

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