UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.
Petitioner

v.

SCRAMOGE TECHNOLOGY LTD.
Patent Owner

U.S. Patent No. 10,461,426

DECLARATION OF R. JACOB BAKER, PH.D., P.E. IN SUPPORT OF PETITON FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 10,461,426

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I, R. Jacob Baker, Ph.D., P.E., declare as follows:

I. INTRODUCTION

1. I have been retained by Samsung Electronics Co., Ltd. ("Petitioner") as an independent expert consultant in this proceeding before the United States Patent and Trademark Office ("PTO") regarding U.S. Patent No. 10,461,426 ("the '426 Patent") (Ex-1001).[1]

2. I am being compensated at a rate of $655/hour for my work in this proceeding.

3. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other interest in this proceeding.

4. I have been asked to consider whether certain references disclose or suggest the features recited in claims 1-12, 17-29, 34-45, 50-52 of the '426 Patent. My opinions are set forth below.

II. BACKGROUND AND QUALIFICATIONS

5. I presently serve as a Professor of Electrical and Computer Engineering at the University of Nevada, Las Vegas (UNLV). All of my opinions stated in this

[1] Where appropriate, I refer to exhibits that I understand are to be attached to the petition for *Inter Partes* Review of the '426 patent.

declaration are based on my own personal knowledge and professional judgment. In forming my opinions, I have relied on my knowledge and experience in designing, developing, researching, and teaching regarding integrated circuit design and power electronics.

6. I am over 18 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein. I understand that a copy of my current curriculum vitae, which details my education and professional and academic experience, is being submitted by Petitioner as Exhibit 1003. The following provides an overview of some of my experience that is relevant to the matters set forth in this declaration.

7. I have been teaching electrical engineering at UNLV since 2012. Prior to this position, I was a Professor of Electrical and Computer Engineering at Boise State University from 2000. Prior to my position at Boise State University, I was an Associate Professor of Electrical Engineering between 1998 and 2000 and Assistant Professor of Electrical Engineering between 1993 and 1998 at the University of Idaho. I have been teaching electrical engineering since 1991.

8. I received my Ph.D. in Electrical Engineering from the University of Nevada, Reno in 1993. I also received a MS and BS in Electrical Engineering from UNLV in 1988 and 1986, respectively.

9. As described in my CV, I am a licensed Professional Engineer and have more than 30 years of industry and academic experience, including extensive experience in power electronics circuit design. My PhD dissertation developed a way to stack power MOSFETs to increase the maximum voltage that they could switch in nanoseconds. The work from this dissertation was published in the paper "Transformerless Capacitive Coupling of Gate Signals for Series Operation of Power MOS Devices," and published in the IEEE Transactions on Power Electronics. The work was well-received and it won the best paper award from this journal in 2000. Further, my research has focused on the design of inductors using novel fabrication techniques. One of my Master's students fabricated a three-dimensional inductor using thru-vias to minimize the inductor's size. This work was reported in the Thesis "Design Guide for CMOS Process On-Chip 3D Inductors using Thru-Wafer Vias" published in 2011. More recently I've been looking at ways to supply power to remote regions of the world. This effort resulted in a doctoral student finishing his dissertation entitled "Designing, Building, and Testing a Solar Thermoelectric Generation, STEG, for Energy Delivery to Remote Residential Areas in Developing Regions" published in 2015.

10. I have taught courses in integrated circuit design (analog, digital, mixed-signal, memory circuit design, etc.), linear circuits, microelectronics,

communication systems, power electronics, and fiber optics. As a professor, I have been the main advisor to over 100 Master's and Doctoral students.

11. I am the author of several books covering the area of integrated circuit design including: DRAM Circuit Design: Fundamental and High-Speed Topics (two editions), CMOS Circuit Design, Layout, and Simulation (four editions), and CMOS Mixed-Signal Circuit Design (two editions). I have authored, and coauthored, more than 100 papers and presentations in the areas of solid-state circuit design, and I am the named inventor on 152 granted U.S. patents.

12. I have received numerous awards for my work, including the Frederick Emmons Terman (the "Father of Silicon Valley") Award. The Terman Award is bestowed annually upon an outstanding young electrical/computer engineering educator in recognition of the educator's contributions to the profession.

13. I am a Fellow of the IEEE for contributions to memory circuit design. I have also received the IEEE Circuits and Systems Education Award (2011).

14. I have received the President's Research and Scholarship Award (2005), Honored Faculty Member recognition (2003), and Outstanding Department of Electrical Engineering Faculty recognition (2001), all from Boise State University. I have also received the Tau Beta Pi Outstanding Electrical and Computer Engineering Professor award four of the years I have been at UNLV.

15. I am not an attorney and offer no legal opinions, but in the course of my work, I have had experience studying and analyzing patents and patent claims from the perspective of a person skilled in the art.

III. MATERIALS REVIEWED

16. The opinions contained in this Declaration are based on the documents I reviewed, my professional judgment, as well as my education, experience, and knowledge regarding inductors, including the fabrication, packaging, and use of inductors in various applications like wireless charging and wireless communication.

17. In forming my opinions expressed in this Declaration, I reviewed the ’426 patent (Ex-1001); the prosecution file history for the ’426 patent (Ex-1004); Korean Patent Publication KR10-2015-0010063 to Kim *et al*. (“Kim”) (Ex-1005); U.S. Patent No. 9,276,642 to Shostak (“Shostak”) (Ex-1006); Korean Patent No. KR10-1185681 to Kim *et al*. (“Kim ’681”) (Ex-1007); PCT Patent Publication WO2013/141658 to An *et al*. (“An”) (Ex-1008); U.S. Patent No. 9,413,191 to Kim (Ex-1009); U.S. Patent No. 9,735,606 to Koyanagi *et al*. (“Koyanagi”) (Ex-1010); Korean Patent No. KR10-1400623 to Lee *et al*. (“Lee”) (Ex-1011); U.S. Patent No. 9,357,631 to Ho *et al*. (Ex-1012); U.S. Patent No. 9,252,611 to Lee *et al*. (Ex-1013); Shah, IEEE Transactions on Biomedical Engineering, Vol. 45, No. 7, July 1998 (Ex-1014); U.S. Patent Publication No. 2007/0095913 to Takahashi *et al*. (Ex-1015);

Tang, IEEE Transactions on Power Electronics, Vol. 15, No. 6, November 2000 (Ex-1016); U.S. Patent Pub. No. 2012/0274148 to Sung *et al*. ("Sung") (Ex-1017); U.S. Patent No. 9,496,082 to Park (Ex-1018); U.S. Patent Pub. No. 2010/0112940 to Yoon (Ex-1019); U.S. Patent Pub. No. 2010/0190436 to Cook (Ex-1020); U.S. Patent No. 4,075,591 to Haas (Ex-1022); U.S. Patent No. 9,761,928 to Han (Ex-1024); U.S. Patent Pub. No. 2016/0126639 to Kim (Ex-1025); Korean Patent Publication KR10-2013-0000926 to Yu *et al*. ("Yu") (Ex-1026); U.S. Patent Pub. No. 2008/0164840 to Kato (Ex-1027); U.S. Patent No. 9,820,374 to Bois (Ex-1028); and any other materials I refer to in this Declaration in support of my opinions.

18. All of the opinions contained in this declaration are based on the documents I reviewed and my knowledge and professional judgment. My opinions have also been guided by my appreciation of how a person of ordinary skill in the art would have understood the claims and the specification of the '426 patent at the time of the alleged invention, which I have been asked to consider was the mid 2010's (including July 6, 2015, the filing date of Korean Patent Application No. 10-2015-0096051 to which the '426 patent claims priority). My opinions reflect how one of ordinary skill in the art would have understood the '426 patent, the prior art to the '426 patent, and the state of the art at the time of the alleged invention.

19. Based on my experience and expertise, it is my opinion that certain references disclose or suggest all the features recited in claims 1-12, 17-29, 34-45, 50-52 ("challenged claims") of the '426 patent, as I discuss in detail below.

IV. PERSON OF ORDINARY SKILL IN THE ART

20. Based on my knowledge and experience, I understand what a person of ordinary skill in the art would have known at the time of the alleged invention. My opinions herein are, where appropriate, based on my understandings as to a person of ordinary skill in the art at that time. In my opinion, based on the materials and information I have reviewed, and based on my experience in the technical areas relevant to the '426 patent, a person of ordinary skill in the art at the time of the alleged invention of the '426 patent would have had at least a bachelor's degree in electrical engineering, computer engineering, applied physics, or a related field, and at least one year of experience in the research, design, development, and/or testing of wireless charging systems, or the equivalent, with additional education substituting for experience and vice versa. More education can supplement practical experience and *vice versa*. I apply this understanding in my analysis herein.

21. My analysis of the '426 patent and my opinions in this declaration are from the perspective of one of ordinary skill in the art, as I have defined it above, during the relevant time frame, which I have been asked to assume is the mid 2010's (including July 6, 2015, the filing date of Korean Patent Application No. 10-2015-

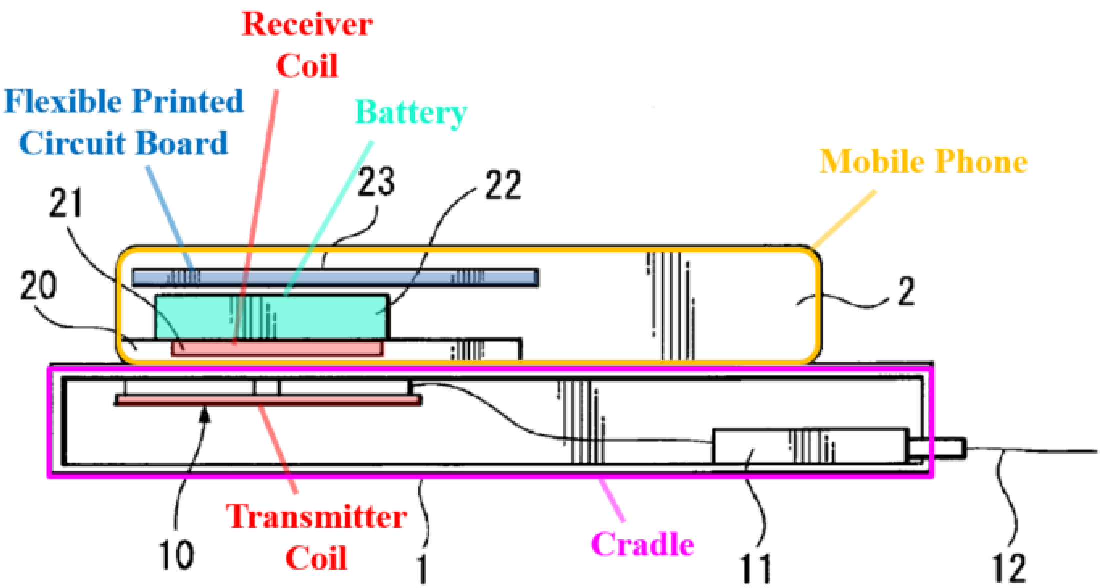
0096051 to which the ’426 patent claims priority). During this time frame, I possessed at least the qualifications of a person of ordinary skill in the art, as defined above.

V. TECHNICAL BACKGROUND

A. Wireless Charging

22. In order to avoid having to use a specified wired connection to charge portable devices like mobile phones, wireless charging, which relies on electromagnetic induction, can be used to provide power to charge the batteries of such devices. (Ex-1027, ¶¶[0003], [0005]; Ex-1017, ¶¶[0003], [0006]-[0007].) A charging cradle, pad, or other device generates a changing magnetic field in response to an applied current. (Ex-1027, ¶¶[0048], [0052]-[0054].) When a portable device like a mobile phone is placed in the magnetic field, a current is induced in a receiving coil on the portable device, where that current can be used to charge the battery on the device. (*Id*., ¶¶[0049], [0054].) Figure 3 of Kato below shows a mobile phone in a cradle with the corresponding transmitting and receiving coils that enable the wireless power transfer.

FIG. 3

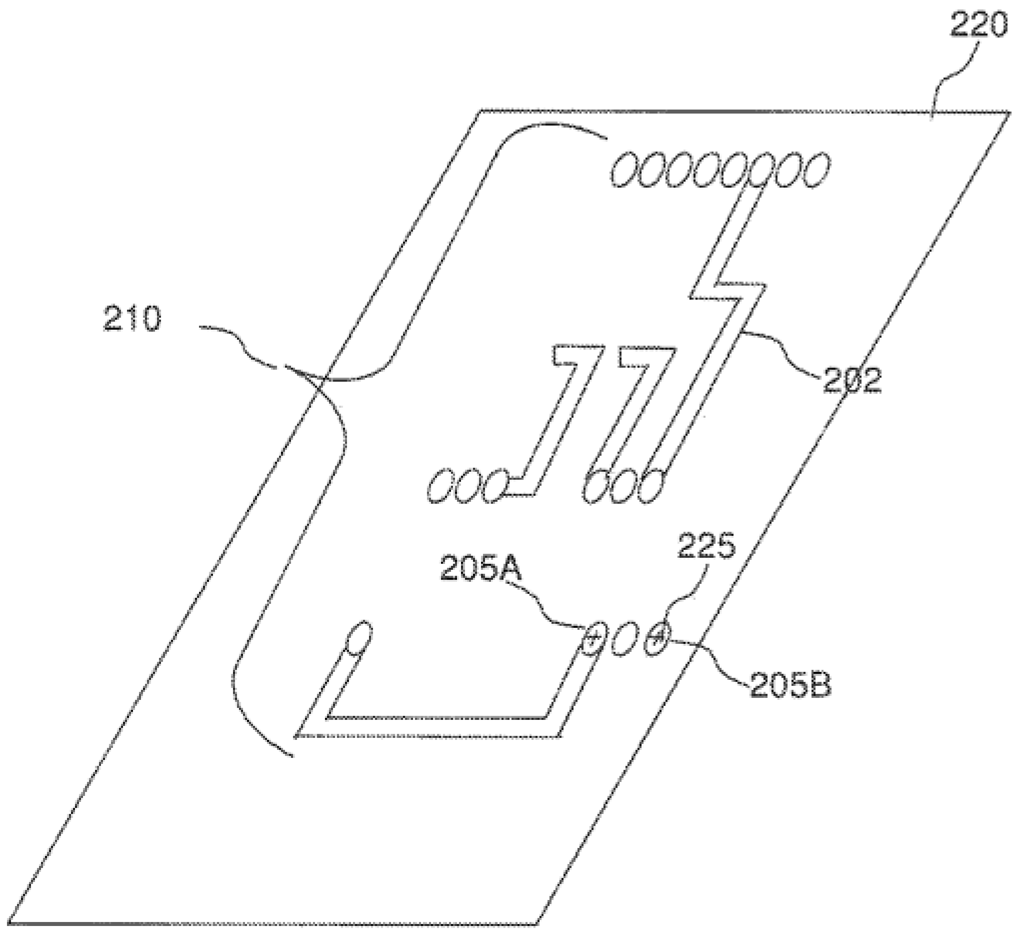


(*Id*., FIG. 3 (annotated).)

B. Flexible Printed Circuit Boards

23. Printed circuit boards, or PCBs, were a standard component in "[v]irtually every electronic device" by 2009. (Ex-1028, 1:6-10.) Generally, "PCBs are relatively thin, layered substrates upon which integrated circuit and other electronic components are mounted. A printed circuit board typically includes a plurality of electrically conductive and insulating layers arranged in a sandwich-like fashion." (*Id.,* 1:10-12.) The conductive layers are "conductive paths or traces ... isolated from one another by insulating material and routed within a plane." (*Id.,* 1:13:16.) The traces are "generally designed to electrically contact conductive portions of the electronic components mounted on the PCB, forming electrical

interconnects." (*Id*., 1:16-19.) "Insulating layers electrically isolate conductive layers from one another." (*Id*., 1:19-20.) As shown in figure 2 of Bois below, traces 202 and pads 205A-B "enable signals to flow from one point of PCB subcomponent 200 to another." (*Id*., 3:1-3, FIG. 2.)



(Ex-1028, FIG. 2.)

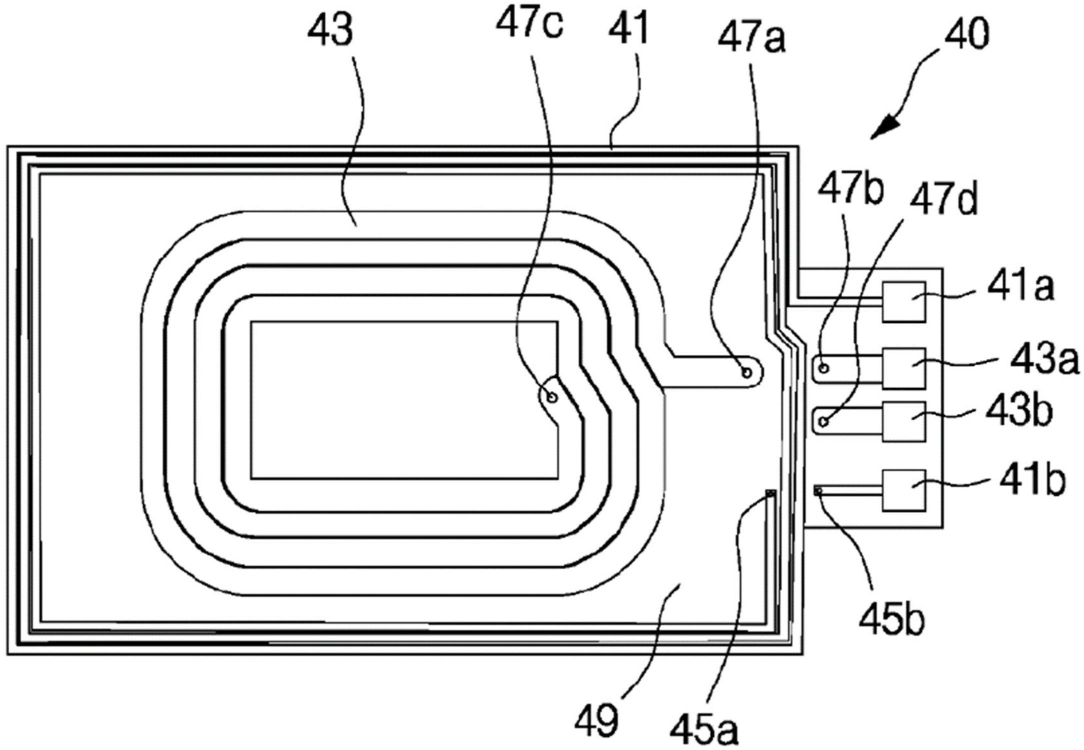
24. The location and arrangement of the various components on a printed circuit board was rudimentary and based on the discretion of the designer. In other words, there were many different choices as to how to design the printed circuit board, but all achieved the same purpose of interconnecting the components on the

board to achieve the desired circuit. For example, components could be placed in a manner that optimizes their interaction. The interconnect between those components could include conductive traces (each of which could be formed on different layers), combinations of traces formed on multiple layers, and vias or other conductive through holes that connect the conductors on different layers. A person of ordinary skill in the art would have been aware of the various options for the printed circuit board design and implementation, as such boards have been a fundamental aspect of electronic devices for decades.

25. Antennas used for wireless charging and wireless communication in portable devices include coils formed on, or attached to, printed circuit boards, including flexible printed circuit boards. (Ex-1015, ¶¶[0041]-[0043]; Ex-1017, ¶¶[0062]-[0064], FIG. 3.) The shape of such coils can be altered and the number of windings can be set to meet specifications. (Ex-1015, ¶[0050].)

26. For example, figure 18 of Lee (Ex-1013) shows "a dual-antenna structure in which an antenna for near field communications (NFC) and an antenna for a wireless charger are formed by using a flexible printed circuit board (FPCB)." (Ex-1013, 7:18-21, FIG. 18; *see also id.*, 17:32-18:19.) As shown below, the flexible printed circuit board includes NFC antenna coil 41, with associated terminals 41a and 41b for the NFC antenna coil, and wireless charging coil 43, with associated

terminals 43a and 43b for the wireless charging coil. (*Id.*, 17:32-35, 42-48, 60-64, FIG. 18.)



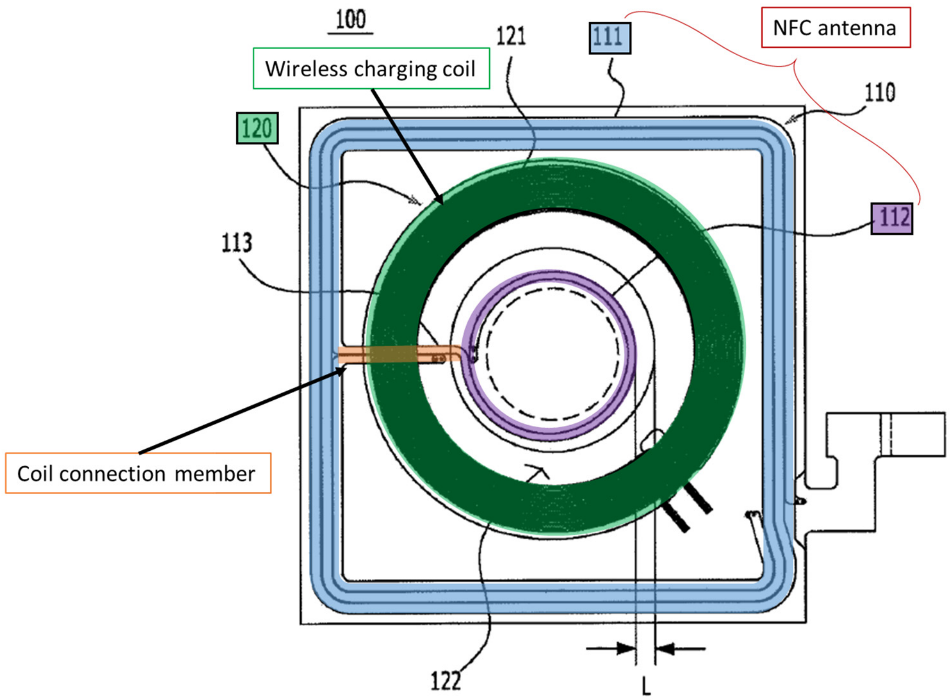
(*Id.*, FIG. 18 (annotated).)

VI. OVERVIEW OF THE '426 PATENT

27. The '426 Patent, titled "Wireless Antenna for Wireless Charging and NFC Communication and Wireless Terminal to Which Same is Applied," relates to "a wireless antenna capable of simultaneously supporting wireless charging and near field communication (NFC)." (Ex-1001, Title, 1:22-25) The '426 Patent intends to address limitations of conventional antennas for smartphones that have both a wireless charging antenna and an antenna for near-field communication ("NFC").

(*Id.*, 1:39-64 ("[I]n recent smart phones, a loop antenna having a wireless charging function and a loop antenna having the above-mentioned NFC function are provided together in order to enhance user convenience.").) In such antennas, "since a very small smartphone has had to be provided with a loop antenna that supports magnetic induction wireless charging and a loop antenna that supports NFC, charging efficiency may be reduced or NFC recognition efficiency may be deteriorated due to interference between the two loop antennas." (*Id.*, 1:51-56.) Thus, the '426 Patent provides "a wireless antenna designed such that a loop antenna that supports an NFC function is added inside a loop antenna that supports wireless charging, and a wireless terminal to which the same is applied." (*Id.*, 1:60-64.)

28. With respect to figure 1 below, the '426 Patent concerns "a wireless antenna including a near field communication (NFC) antenna [110] including a first coil member [111 (highlighted blue)] and a second coil member [112 (purple)] each including at least one first loop pattern, and a charging antenna [120 (green)] including an induction coil member including at least one second loop pattern formed between the first coil member [111] and the second coil member [112]." (*Id.*, 2:4-12, *see also id.*, 3:44-62, 4:40-58.) "The NFC antenna may further include a coil connection member [113 (orange)] connected to one side of an inner surface of the first coil member and to one side of an outer surface of the second coil member." (*Id.*, 2:13-16, *see also id.*, 4:59-5:4.)



(*Id.*, FIG. 1 (annotated).)

VII. CLAIM CONSTRUCTION

29. I understand that claim terms are typically given their ordinary and customary meaning, as would have been understood by a person of ordinary skill in the art, at the time of the alleged invention, which I understand is the mid 2010's (including July 6, 2015, the filing date of Korean Patent Application No. 10-2015-0096051 to which the '426 patent claims priority). In considering the meaning of the claims, however, I understand that one must consider the language of the claims, the specification, and the prosecution history of record.

VIII. OVERVIEW OF THE PRIOR ART

A. Kim

30. Kim, titled "Antenna Structure for Near Field Communication," "relates to an antenna structure for near field communication [("NFC")[2]] capable of non-contact charging and near field communication by generating an induced electromotive force." (Ex-1005, Title, ¶[0001].) Kim discloses that an antenna structure in a mobile device (e.g., a mobile phone) with "both a non-contact charging function and a near field wireless communication function" should be equipped with "two antennas (coils) for inducing an electromotive force to each." (*Id.* ¶[0010] ("to equip both a non-contact charging function and a near field wireless communication function in a mobile communication terminal represented by a mobile phone, two antennas (coils) for inducing an electromotive force to each are required.").)

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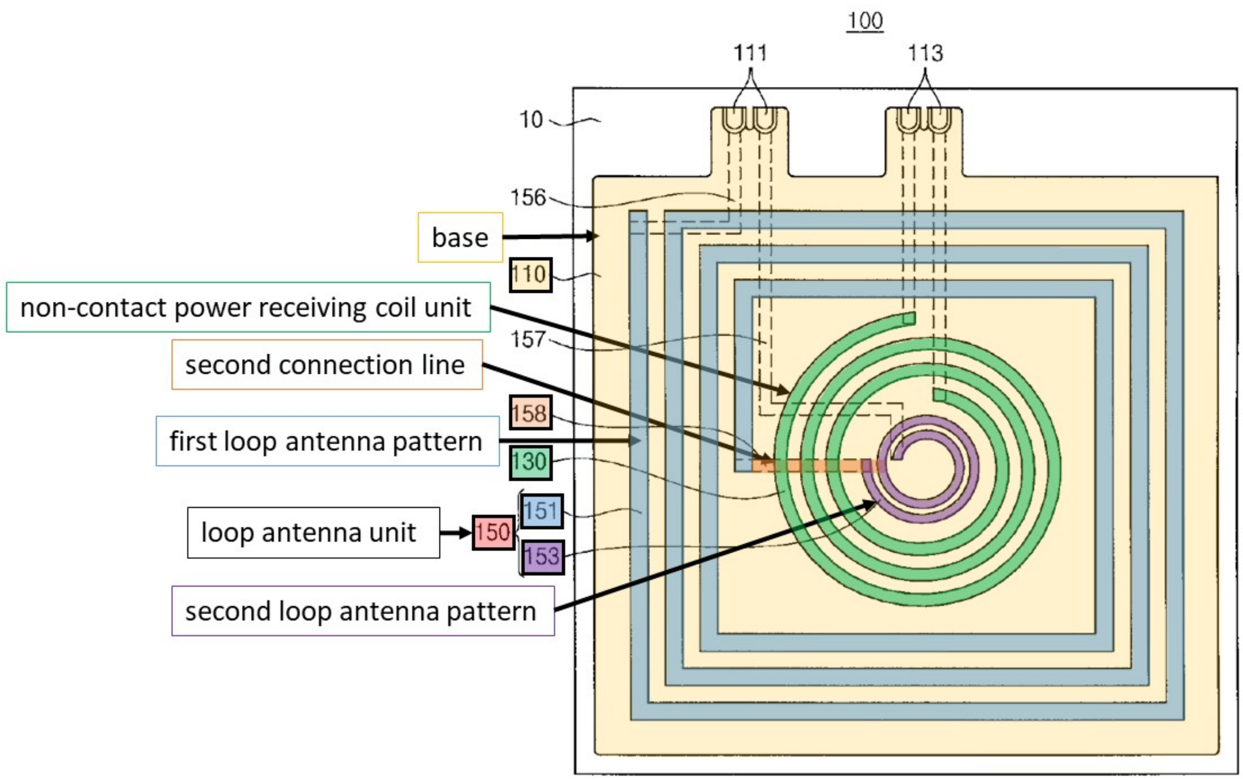
[2] Kim alternatively uses the terms "RFID" and "near field communication" (or "NFC"). (*See e.g.*, Ex-1005, ¶[0009].) As Kim acknowledges, NFC is a type of RFID communication. (*Id.*, ¶[0007]-[0009]; *see* also Ex-1019, ¶[0006] ("Near Field Communication (NFC) is a type of Radio Frequency IDentification (RFID)"); Ex-1020, ¶[0006] ("Near-Field Communication (NFC) system (commonly known as a type of 'RFID')").)

31. Kim describes that in such an antenna structure, "the recognition distance for near field communication may vary depending on the relative position between the antenna and the RFID tag [which is used for NFC]." (*Id.*) Therefore, Kim discloses that "[a]n object of the present invention is to provide an antenna structure for near field communication capable of securing a stable recognition distance [for near field communication] regardless of the relative position between an antenna and an RFID tag." (*Id.* ¶¶[0010]-[0011].) To achieve this object, Kim discloses an antenna structure comprising a loop antenna unit having two loop antenna patterns used for NFC. (*Id.*, ¶[0012].)

> To achieve an object of the present invention, the antenna structure for near field communication according to embodiments of the present invention comprises a base, a non-contact power receiving coil unit disposed in the center of the upper portion of the base and having a loop shape, and a loop antenna unit disposed on the upper portion of the base and having a first loop antenna pattern formed to surround by being spaced apart from the non-contact power receiving coil unit and a second loop antenna pattern electrically connected to the first loop antenna and formed in a loop of the non-contact power receiving coil unit.

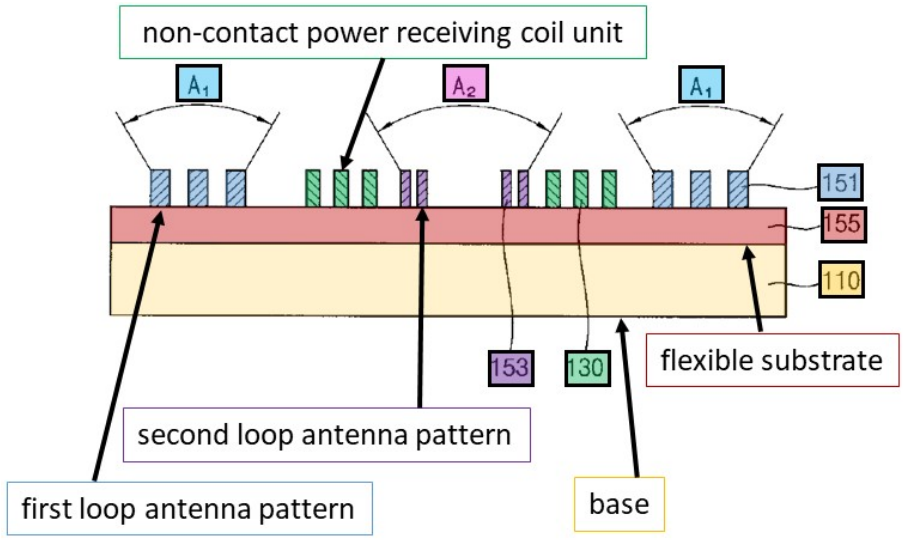
(*Id.*)

32. As shown in annotated figure 1 below, Kim describes an antenna structure 100. (*Id.*, ¶¶[0012]-[0013], [0025]-[0035], FIG. 1.) The antenna 100 includes a loop antenna unit 150 for NFC including a first loop antenna pattern 151 and a second loop antenna pattern 153. (*Id*, ¶¶[0030]-[0031], FIGs. 1, 2.) Kim's antenna 100 also has a non-contact (i.e., wireless) power receiving coil unit 130 disposed between the first loop antenna pattern 151 and the second loop antenna pattern 153. (*Id.*, ¶¶[0026], [0028]-[0029], [0031], FIG. 1.) The coils are disposed on the upper portion of a base 110. (*Id*. ¶¶[0028], [0030], FIGs. 1, 2.) The two loop patterns of the NFC antenna further include a connection line 158 traversing the wireless power coil and connecting the two loop antenna patterns. (*Id*. ¶¶[0031]-[0032], FIG. 1.)



(*Id.*, FIG. 1 (annotated).)

33. Kim further describes that "the loop antenna unit (150) may further comprise a flexible substrate (155), first connection lines (156, 157), and a second connection line (158)." (*Id.* ¶[0032].) As shown in annotated figure 2 below, which is a cross-section of figure 1, "[t]he first and second loop antenna patterns (151, 153) are formed on one surface of the flexible substrate (155)." (*Id.* ¶[0033].) "The second connection line (158) is formed on the other surface of the flexible substrate (155)." (*Id.* ¶[0035].) "The second connection line (158) can interconnect the first and second loop antenna patterns (151, 153) through contact vias (not shown) formed by penetrating the flexible substrate (155)." (*Id.*.)



(*Id.*, FIG. 2 (cross-section of FIG. 1) (annotated).)

34. To reiterate, an object of Kim's disclosure "is to provide an antenna structure for near field communication capable of securing a stable recognition distance [for near field communication] regardless of the relative position between an antenna and an RFID tag." (*Id.* ¶[0011].) To achieve this purpose, as shown in annotated figure 2 above, the loop antenna unit 150 has a first loop antenna pattern 151 which enables NFC with an RFID tag located in the A1 region adjacent to the edge of the base 110, and a second loop antenna pattern 153 which enables NFC with an RFID tag adjacent to the location in the A2 region corresponding to the center portion of the base 110:

> The loop antenna unit (150) has a first loop antenna pattern (151) formed to surround by being spaced apart from the non-contact power receiving coil unit and a second loop antenna pattern (153) electrically connected to the first

> loop antenna (151) and formed in a loop of the non-contact power receiving coil unit (130). Therefore, while the first loop antenna pattern (151) enables near field communication with an RFID tag located in the A1 region adjacent to that location corresponding to the edge of the base (110), the second loop antenna pattern (153) can enable near field communication with an RFID tag adjacent to the location in the A2 region corresponding to the center portion of the base (110). Accordingly, the antenna structure (100) for near field communication can have a consistent recognition distance regardless of the relative position between the RFID tags.

(*Id.*, ¶[0031].)

B. Shostak

35. Shostak, titled "Computing Device having Multiple co-located Antennas," relates to a computing device which "supports both wireless communication (e.g., near field communication (NFC)) and wireless charging (WC)." (Ex-1006, Title, 1:58-61.) The computing device "can be any of a variety of different types of devices, such as a laptop computer, a cellular or other wireless phone, a tablet device, a phablet device, a personal digital assistant, an entertainment device, an audio or video playback device, a personal navigation device, a touch screen input device, a stylus or pen-based input device, and so forth." (*Id.*, 2:41-47; *see also id.*, 2:50-52 ("The computing device 102 is oftentimes a portable or mobile

device that is designed to be easily moved to different locations.").) Shostak explains that to support different types of wireless functionality in one device, "a computing device typically includes a different antenna for each different type of wireless functionality." (*Id.*, 1:15-27.)

36. Shostak provides an example layout in figure 3, showing the general structure of its antenna apparatus, including the communication and charging antennas, with a cross-section of that layout in figure 4. (*Id.*, 4:34-7:23.) This example layout show the coils of Shostak's communication and wireless charging antennas as shaded regions, whereas the remaining antenna layouts discussed throughout the rest of the patent show particular coil patterns. (*Compare* FIGs. 3, 4, *with* FIGs. 5-10.) With reference to figures 3 and 4, Shostak describes a wireless communication (NFC) antenna 304, comprising antenna coil portions 314 (labeled 412 and 416 in figure 4) and 316 (414 in figure 4) connected by portion 318 (418 in figure 4), and a wireless charging antenna comprising wireless charging coil 302 (420, 422 in figure 4). (*Id.*, 4:44-5:32, 6:21-25, 6:42-50, FIGs. 3, 4.) As shown in Shostak's figures, communication antenna "portion 314 is positioned about the outer periphery 306 of the [wireless charging] antenna 302 [(420 and 422 in figure 4)], and "portion 316 is positioned within the inner

boundary 308 of the [wireless charging] antenna 302." (*Id.*, 4:58-59, 5:5-6.) "The portion 318 traverses the [wireless charging] antenna 302, interconnecting the portions 314 and 316 of the [wireless communication] antenna 304." (*Id.*, 5:13-14.)

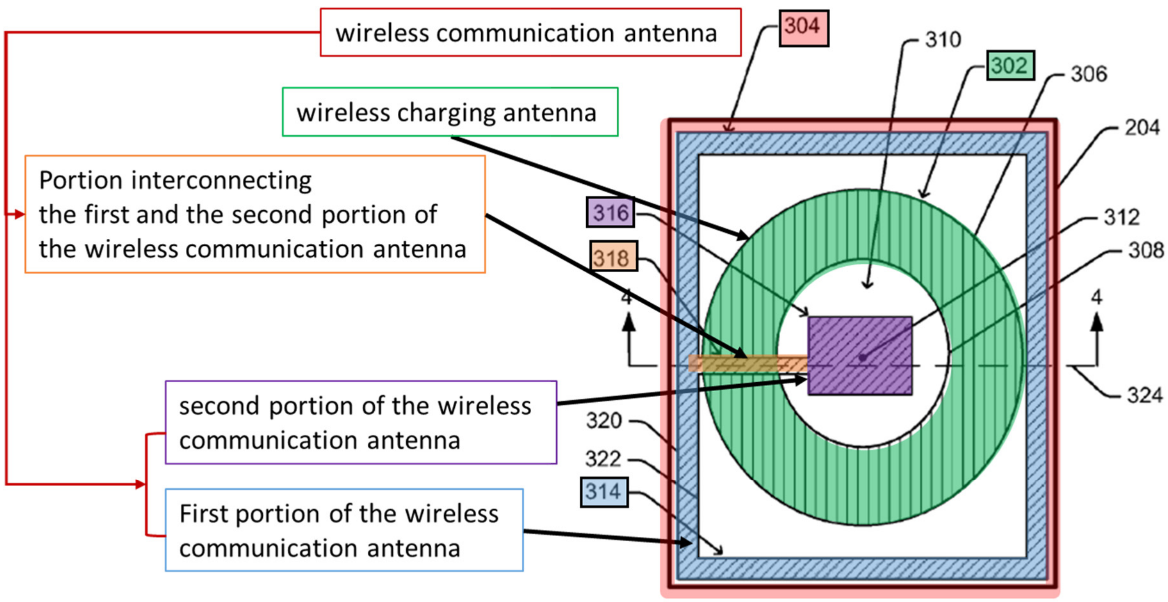


FIG. 3

(*Id.*, FIG. 3 (annotated).)

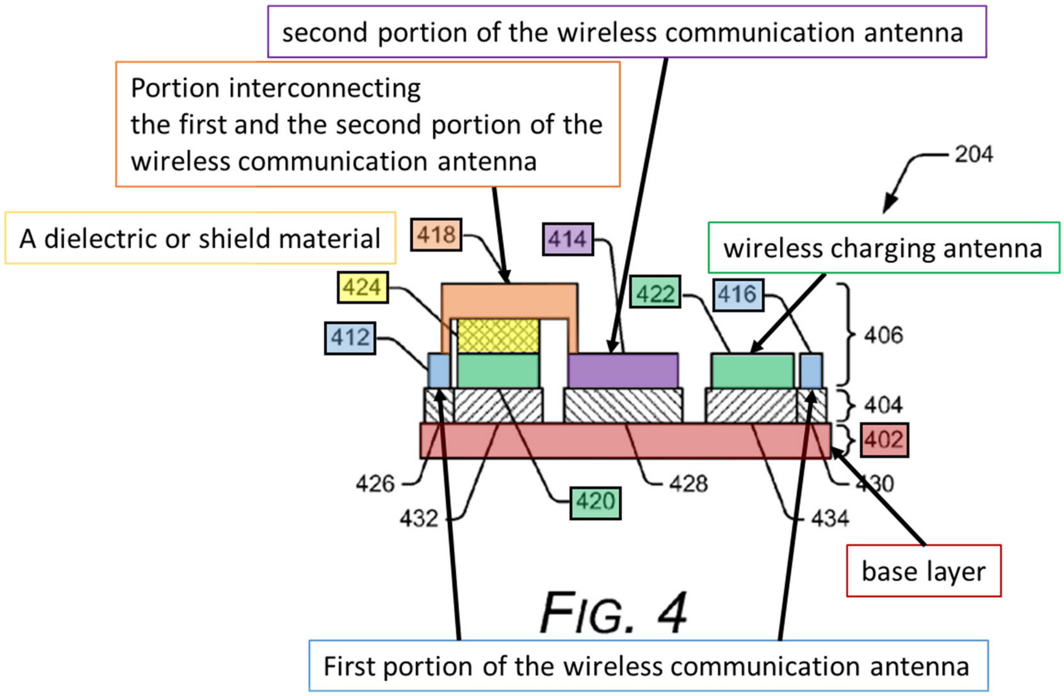


FIG. 4

(*Id.*, FIG. 4 (annotated).)

37. As also shown in annotated figure 4 above, Shostak's antenna apparatus further includes a base layer 402, which can be a "flexible sheet[]." (*Id.* 6:25-27, 6:36-38.) The communication antenna 304, 314, 316 (412, 414, 416, in figure 4), its connection portion 318 (418 in figure 4), and wireless charging antenna 302 (420 and 422 in figure 4), are formed on base layer 402. (*Id.* FIG. 4.)

38. As mentioned above, Shostak discloses particular coil patterns in its other figures. For example, in figure 9 (annotated below), Shostak depicts a wireless communication antenna 504 including a first coil portion 314 and a second coil portion 316, connected by portion 318, and a wireless charging antenna 502 formed between the first portion 314 and the second portion 316 of the wireless

communication antenna. (*Id.* 9:55-10:12.) Shostak explains that "[a]lthough illustrated as a shape that is substantially rectangular, it should be noted that the portion 316 can form various other shapes, such as shapes that are substantially circular, shapes that are substantially elliptical, and so forth," and illustrates a substantially circular portion 316 in figure 10. (*Id.*, 10:26-40.)

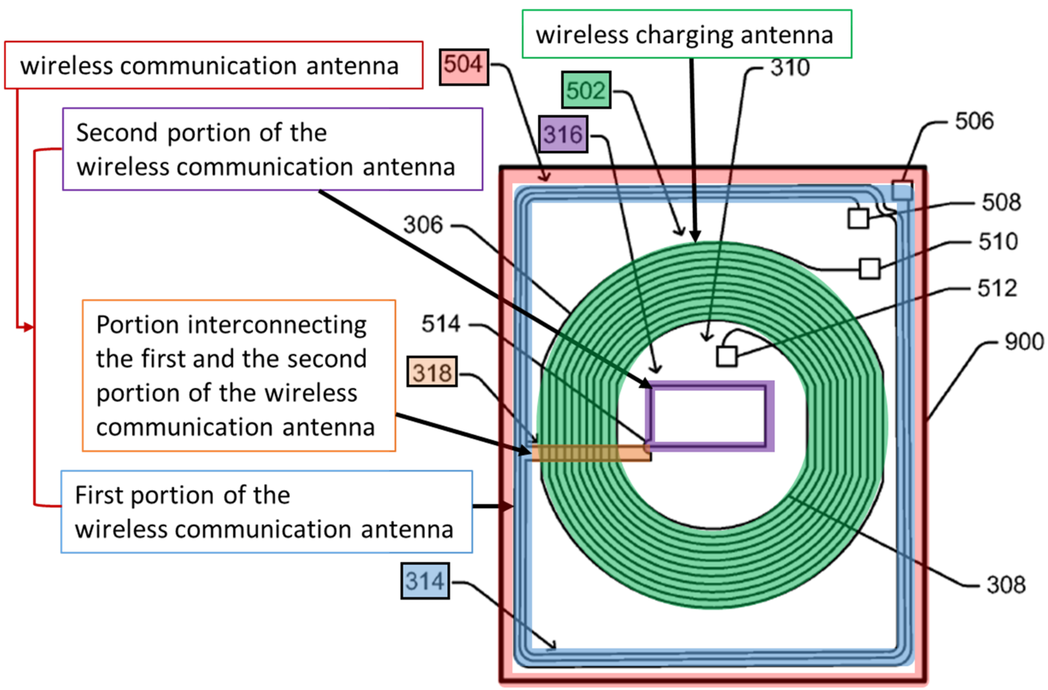


FIG. 9

(*Id.*, FIG. 9 (annotated).)

39. Shostak explains that by positioning its two antennas in the same area as discussed above, it "improv[es] the performance of the functionality (e.g., wireless communication) associated with one antenna while reducing performance

degradation of the functionality (e.g., wireless charging) associated with the other antenna." (*Id*. 2:23-28.) Again, as shown in annotated figures 3 and 9 above, Shostak describes a computing device including a wireless communication antenna 304 (504 in figure 9) including a first portion 314 (blue) and a second portion 316 (purple), and a wireless charging antenna 302 (green, 302 in figure 3, 502 in figure 9) formed between the first portion 314 and the second portion 316 of the wireless communication antenna. (*Id*. 2:9-22, 4:36-40, 4:55-58, 9:58-66.)

C. Kim '681

40. Kim '681, titled "Antenna for both Non-Contact Charging and Near Field Wireless Communication in Mobile Communication Terminal," relates to an antenna which supports both non-contact charging and near field wireless communication. (Ex-1007, Title, ¶[0001].) Kim '681 explains that "to equip both a non-contact charging function and a near field wireless communication function in a mobile communication terminal represented by a mobile phone, two antennas (coils) for inducing an electromotive force to each are required, and therefore, two antennas are equipped on the battery cover." (*Id*., ¶[0013].) The object of Kim '681 is to "unify the antennas required for non-contact charging and near field wireless communication from two to one." (*Id*., ¶[0016].)

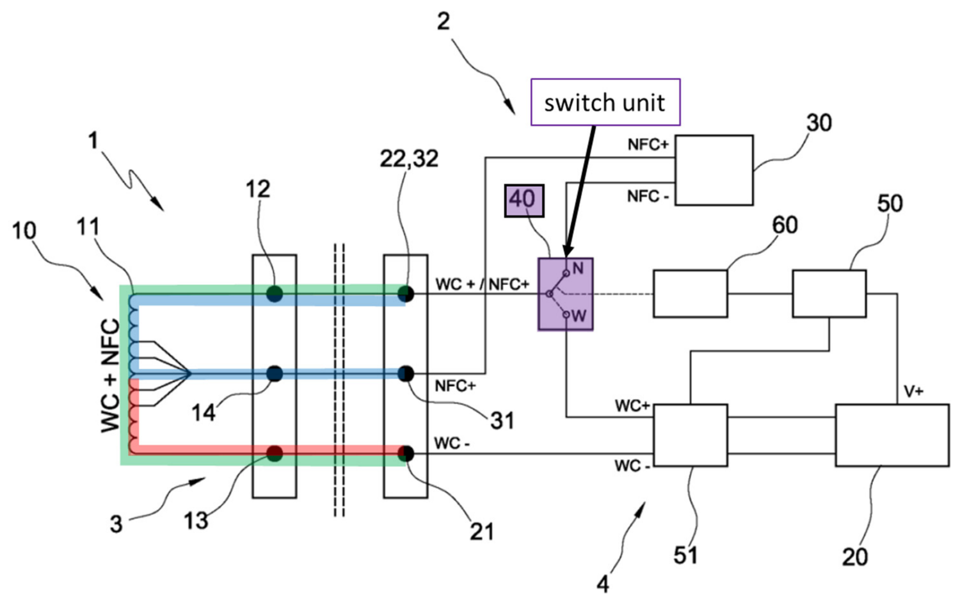
> The object of the present invention is to, in relation to a mobile communication terminal equipped with both non-contact charging (WPC) and near field wireless

> communication (NFC), unify the antennas required for non-contact charging and near field wireless communication from two to one, and also, make it possible to use the antenna by selectively activating it for non-contact charging or for near field wireless communication depending on the use mode of non-contact charging and near field wireless communication, thereby reducing the burden of antenna installation for non-contact charging and near field wireless communication in a mobile communication terminal.

(*Id*.)

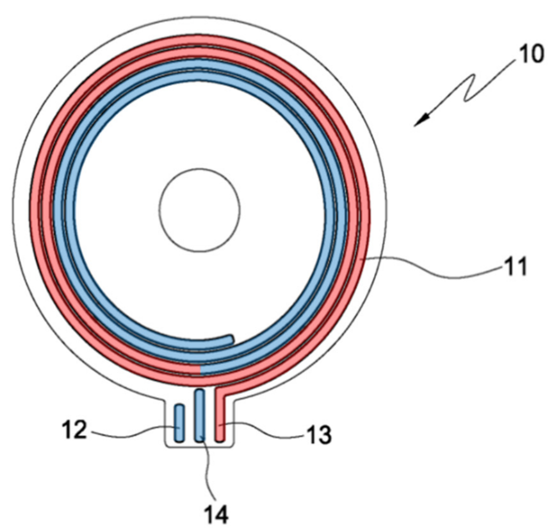
41. As shown in figures 1 and 2 below, Kim '681 discloses a coil antenna unit (10), where the entire coil antenna unit between the first terminal (12) and the second terminal (13) (red and blue sections together) is used for non-contact charging, and a subset of the coil antenna unit between the first terminal (12) and the third terminal (14) (blue section) is used for NFC. (*Id*., ¶¶[0044]-[0046], [0059]-[0060], FIGs. 1, 2.)

Fig. 2



(*Id*., FIG. 2 (annotated).)

Fig. 1



(*Id*., FIG. 1 (annotated).)

The antenna unit (10), as illustrated in Fig. 1, as in the prior art in the related technical field, comprises a coil unit (11)

> in which a conductor, such as copper foil, is etched in the form of a spiral coil (loop form), a first terminal (12) formed at one end of the coil unit (11), and a second terminal (12) formed on the other end of the coil unit (11), but according to the characteristics of the present invention, further comprises a third terminal (14) drawn out from the coil unit (11) between the first terminal (12) and the second terminal (13).
>
> In other words, the antenna unit (10) applied to the present invention is a three-terminal antenna unit in which a third terminal (14) is additionally formed by tab-branching the coil unit (11) at an appropriate position between the first terminal (12) and the second terminal (13) at both ends.
>
> In this case, the coil unit (11) between the first terminal (12) and the second terminal (13) is formed to have a characteristic of generating an induced electromotive force of a frequency (300 kHz) for relatively long non-contact charging, and the branching position of the third terminal (14) is set to ensure that the coil unit (11) between the first terminal (12) and the third terminal (14) generates an induced electromotive force of a relatively short frequency (13.56 MHz) for NFC.

(*Id.*, ¶¶[0044]-[0046].)

42. Since Kim '681's antenna is for combined use of non-contact charging and NFC, it further discloses "a selection means of the antenna unit for selecting

whether to use the antenna unit (10) for non-contact charging or for NFC." (*Id.*, ¶[0056].) Kim '681 enables such a selection of the antenna unit by the switch unit 40. (*Id.*, ¶[0057].) "The switch unit (40) is a switch for activating or deactivating non-contact charging by selectively connecting the first terminal (12) to the non-contact charging circuit (20) or activating or deactivating NFC by selectively connecting the first terminal (12) to the NFC circuit (30)." (*Id.*, ¶[0058].)

> In the embodiment illustrated in Fig. 2, when the switching unit (40) is connected to the W terminal, the first terminal (12) gets connected to the non-contact charging circuit (20) and the second terminal (13) is always connected to the non-contact charging circuit (20), therefore non-contact charging gets activated, entering the state of being able to charge, and NFC gets deactivated.
>
> Conversely, when the switching unit (40) is connected to the N terminal, the first terminal (12) gets connected to the NFC circuit (30) and the third terminal (14) is always connected to the NFC circuit (30), therefore NFC gets activated, entering the state in which it can be used, and non-contact charging gets deactivated.

(*Id.*, ¶¶[0059]-[0060].)

D. An

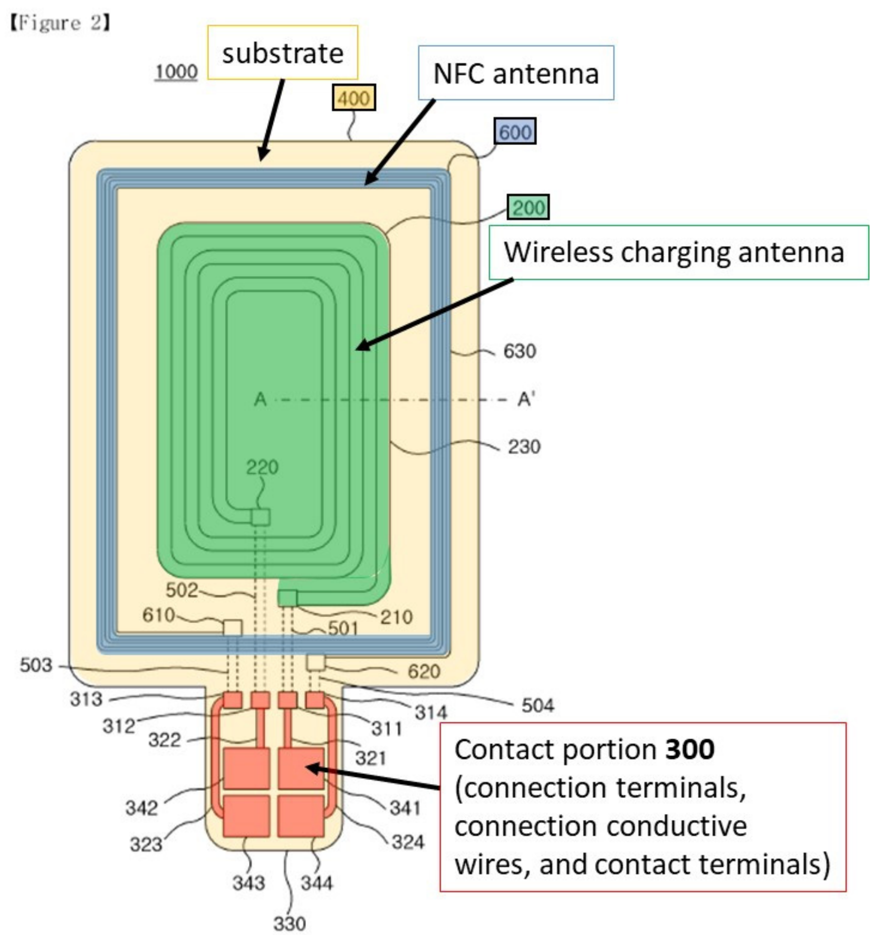
43. An, titled "Antenna Assembly and Method for Manufacturing Same," relates to "an antenna assembly including an antenna, which is wirelessly

rechargeable, and a method of manufacturing the same." (Ex-1008, ¶[1].) The antenna assembly is intended for electronic devices including mobile phones and similar devices. (*Id.*, ¶[68].) "[A] typical antenna assembly [for mobile phones] embedded in a terminal" at the time of the invention had a thin thickness, and thus, "the manufacturing process of the antenna assembly [was] complicated." (*Id.*, ¶[4].) An solves this problem by disclosing "an antenna assembly including an antenna, wirelessly charged, having a thinned thickness, and capable of simplifying the manufacturing process thereof, and a method of manufacturing the same." (*Id.*, ¶[5].)

44. The antenna assembly 1000 includes a wireless charging coil (inner antenna 200), a near field communication coil (NFC antenna 600) surrounding the wireless charging coil, and a contact part 300. (*Id.*, ¶¶[6]-[7], [64]-[66], [70]-[72], FIG. 2.) An discusses how the antenna assembly may be embedded in the back cover of the mobile device, such that "the antenna assembly 1000 may be electrically connected to the [mobile] device through the contact portion 300 of the antenna assembly 1000." (*Id.*, ¶[68].)

45. "The contact part 300 electrically makes contact with the terminal device, and includes a plurality of connectors [310], a plurality of connection conductive lines 320, a substrate 330, and a plurality of contact terminals 340. The connectors 310 include first to fourth connectors 311 to 314. The connection

conductive lines 320 include first to fourth connection lines 321 to 324. The contact terminals 340 include first to fourth contact terminals 341 to 344." (*Id.*, ¶[76], FIG. 2.) As shown in annotated figure 2 below, "the inner antenna (200) may be electrically connected to the battery of the terminal device through the plurality of contact terminals (340) electrically connected to the inner antenna (200), and the outer antenna (600) may be electrically connected to the wireless communication module of the terminal device through the plurality of contact terminals (340) electrically connected to the outer antenna (600)." (*Id.*, ¶[86], FIG. 2.)



(*Id.*, FIG. 2.)

46. As I discussed above, the contact part 300 is used to electrically connect the antenna assembly 1000 to the terminal device "when the back cover of the terminal device is coupled to the terminal device." (*Id.*, ¶[68].) In detail, "if a back cover of the terminal device is coupled to the terminal device," the wireless charge antenna 200 "may be electrically connected to the battery of the terminal device through the first and second contact terminals 341 and 342," and the wireless communication antenna 600 "may be electrically connected to the wireless communication module of the terminal device through the contact terminals 343 and 344." (*Id.*, ¶[86].) The contact portion 300, including the connectors, is likely disclosed to simply the manufacturing process of the antenna embedded in mobile devices. (*Id.*, ¶[12] ("[A]ccording to the embodiment, the inner terminal of the spiral antenna pattern is connected to the connector provided at the outside of the spiral antenna pattern through the conductive bridge, so that the fabrication process of the antenna assembly can be simplified.").)

47. An further explains that "[t]he connectors 310, the connection conductive lines 320, and the contact terminals 340," "provided in the form of conductive patterns," are "formed on the substrate 330." (*Id.*, ¶¶[70], [82]-[83], FIG. 2.) The entire antenna assembly 1000, including wireless charging antenna 200 and NFC antenna 600 are disposed on substrate 400, which can be a flexible PCB substrate. (*Id.*, ¶¶[70]-[71], FIG. 2.) Contact portion 300 is similarly disposed on a

substrate 330, which can be the same flexible PCB substrate 400 on which the rest of the antenna assembly 1000 is disposed. (*Id.*, ¶[85] ("the substrate (330) and the substrate (400) may be formed in an integrated manner"), FIG. 2; *see also id.*, ¶[83] ("The substrate (330) may be a printed circuit board or a flexible circuit board."; "In particular, the material of the substrate (330) may be polyimide (PI) film.").)

IX. THE PRIOR ART DISCLOSES OR SUGGESTS ALL OF THE FEATURES OF CLAIMS 1-12, 17-29, 34-45, 50-52

A. Kim discloses the Features of Claims 1-5, 9-16, and 50

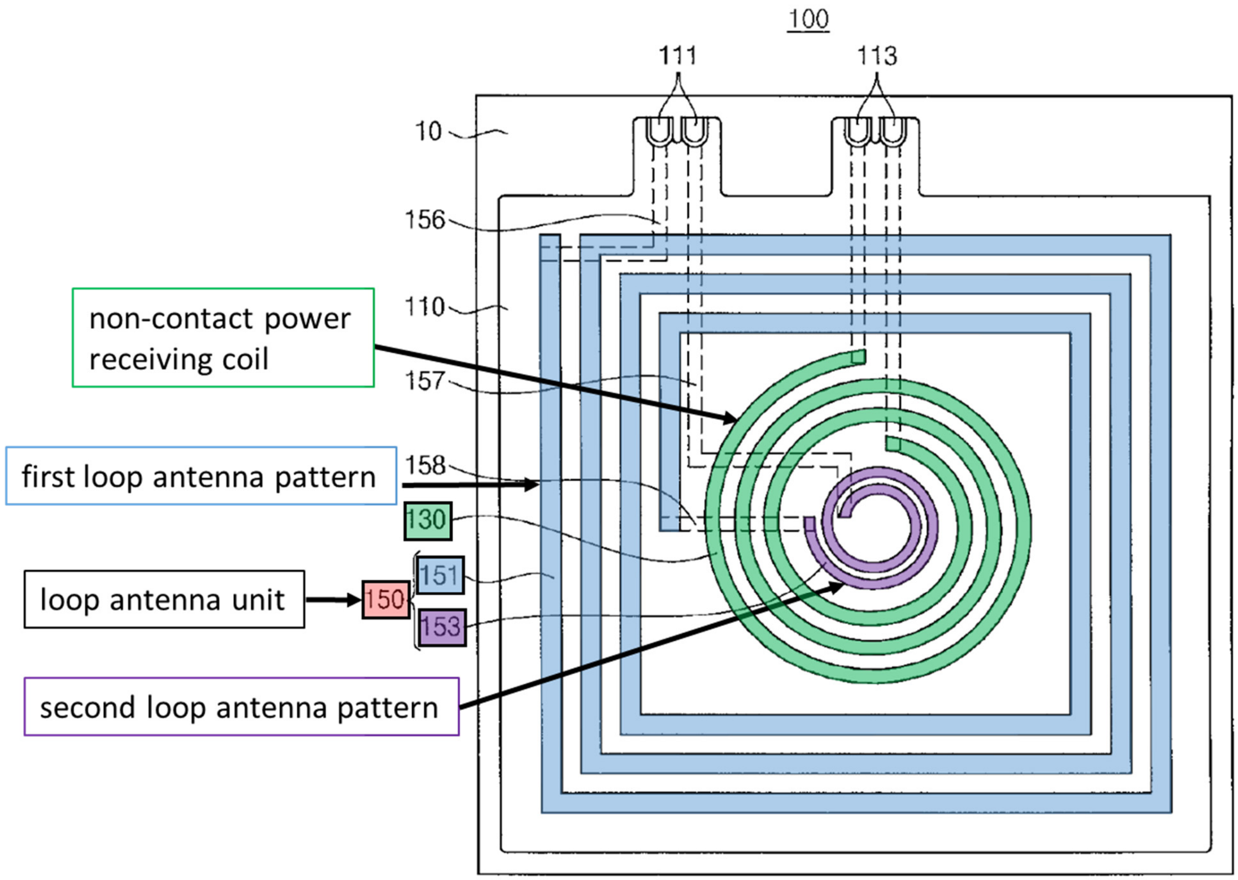
1. Claim 1

a) 1[pre]: A wireless antenna comprising:

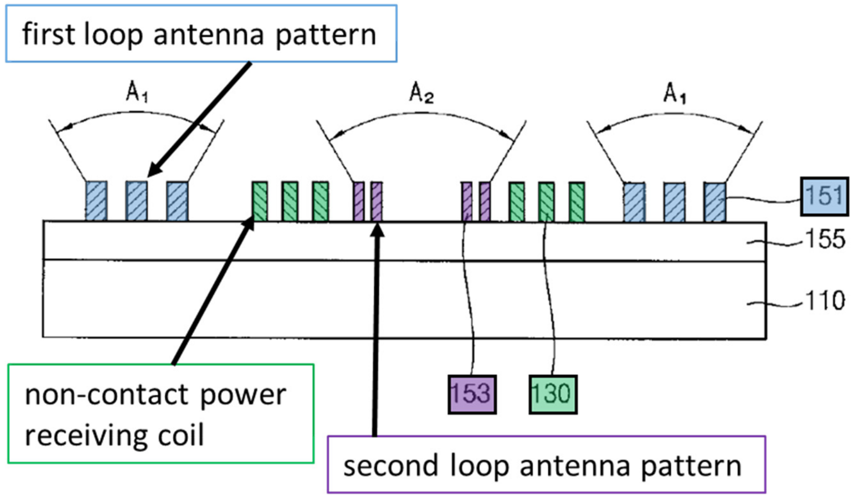
48. I understand that "[a] wireless antenna comprising" is the preamble of claim 1. I have been asked to assume that the preamble of claim 1 is limiting. Under that assumption, it is my opinion that Kim discloses this feature. For example, Kim discloses "an **antenna structure** for near field communication capable of **non-contact charging** and **near field communication** by generating an induced electromotive force." (Ex-1005, ¶[0001] (emphasis added); *see also id.*, Title, Abstract, ¶¶[0004]-[0012], [0025]-[0026], [0031], FIGs. 1, 2.)

49. Kim's antenna structure includes a loop antenna unit 150 with a first loop antenna pattern 151 and a second loop antenna pattern 153 that are electrically connected. (*Id.*, ¶¶[0012]-[0013], [0025]-[0026], [0031].) The antenna also

includes a non-contact power receiving coil unit 130 disposed between the first loop antenna pattern 151 and the second loop antenna pattern 153. (*Id.*)



(*Id.*, FIG. 1 (annotated).)

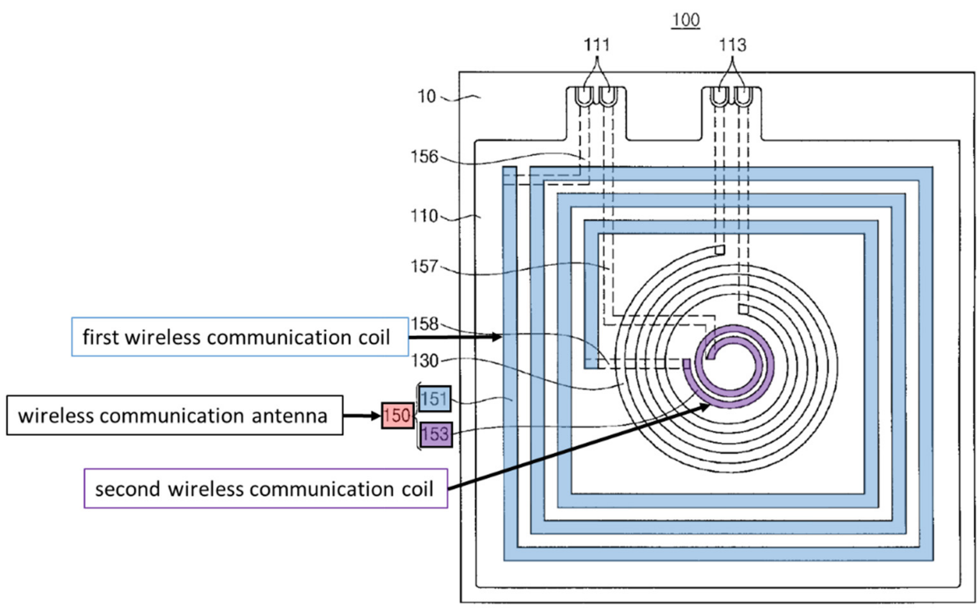


(*Id.*, FIG. 2 (annotated).)

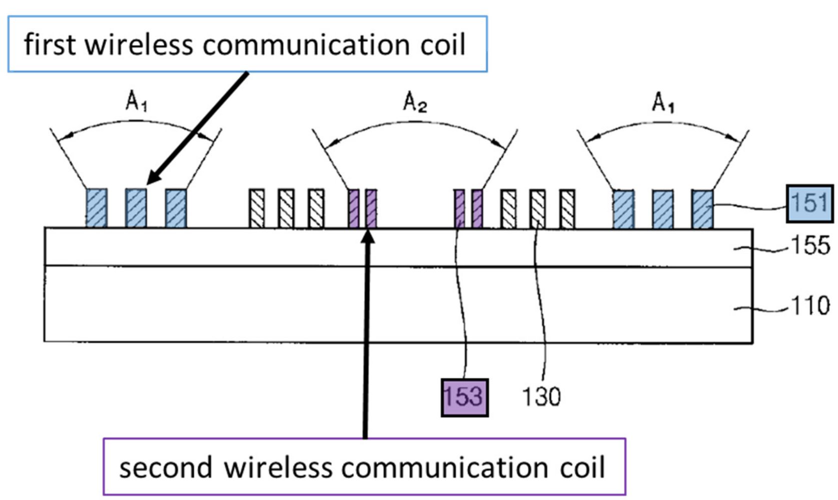
b) 1[a]: a wireless communication antenna comprising a first wireless communication coil and a second wireless communication coil; and

50. Kim discloses these features. For instance, Kim discloses a loop antenna unit 150 that has a first loop antenna pattern 151 and a second loop antenna pattern 153 electrically connected to the first loop antenna pattern 151. (Ex-1005, ¶[0031], FIGs. 1, 2.) The first loop antenna 151 is a first wireless communication coil and the second loop antenna 153 is a second wireless communication coil. Annotated figures 1 and 2 below show first loop antenna pattern 151 ("first wireless communication coil") surrounding a non-contact power receiving coil unit 130, and second loop antenna pattern 153 ("second wireless communication coil") inside of the non-contact power receiving coil. (*Id.*) The first loop antenna pattern 151 and the second loop antenna pattern 153 are each depicted as coils. (*Id.*, FIG. 1.) In fact, Kim calls the "non-contact power receiving coil unit" 130 a **coil**, and there is no

structural difference between coil unit 130 and the first loop antenna pattern 151 and the second loop antenna pattern 153. (Ex-1005, ¶[0026], FIG. 1.) In fact, Kim calls the "non-contact power receiving coil unit" 130 a **coil**, and there is no structural difference between coil unit 130 and the first loop antenna pattern 151 and the second loop antenna pattern 153. (*Id.*, ¶[0026], FIG. 1.)



(*Id.*, FIG. 1 (annotated).)



(*Id.*, FIG. 2 (cross-section of FIG. 1) (annotated).)

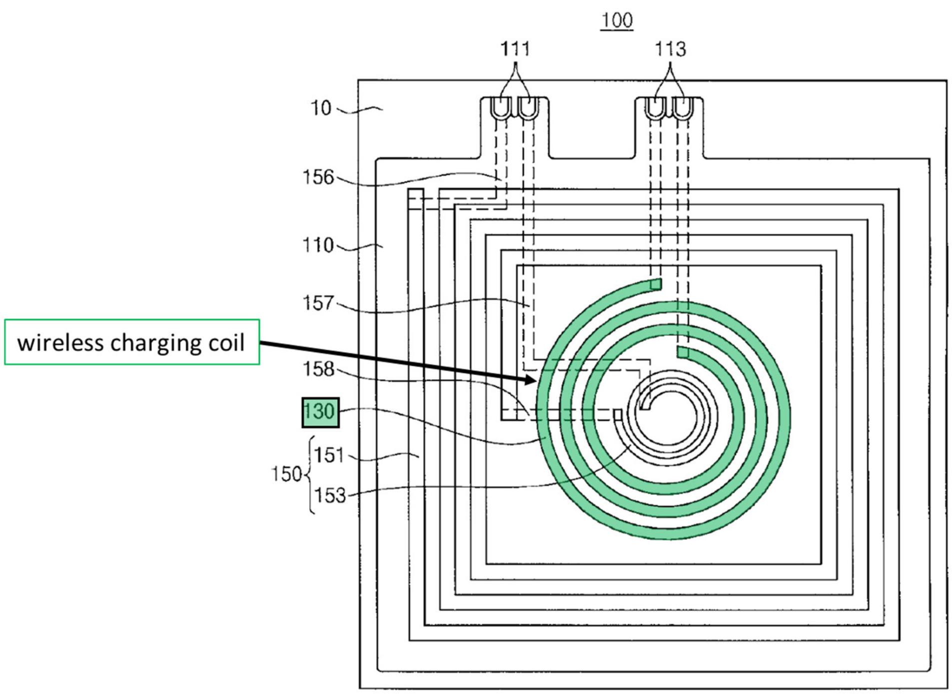
51. Kim discloses that "[t]he loop antenna unit (150) enables near field **communication**," and "is electrically connected to the terminals for near field **communication** (111)." (*Id.*, ¶[0030]-[0031] (emphasis added).) Kim also discloses that "the first loop antenna pattern (151) enables near field **communication** with an RFID tag located in the A1 region adjacent to that location corresponding to the edge of the base (110)," and that "the second loop antenna pattern (153) can enable near field **communication** with an RFID tag adjacent to the location in the A2 region corresponding to the center portion of the base (110)." (*Id.*, ¶[0031] (emphasis added), FIG. 2.) Thus, Kim's first and second loop antenna patterns 151, 153 correspond to the claimed first and second wireless communication coils at least because they are in a coil-shaped pattern and because they enable near field communications.

52. Therefore, Kim discloses "a wireless communication antenna comprising a first wireless communication coil and a second wireless communication coil."

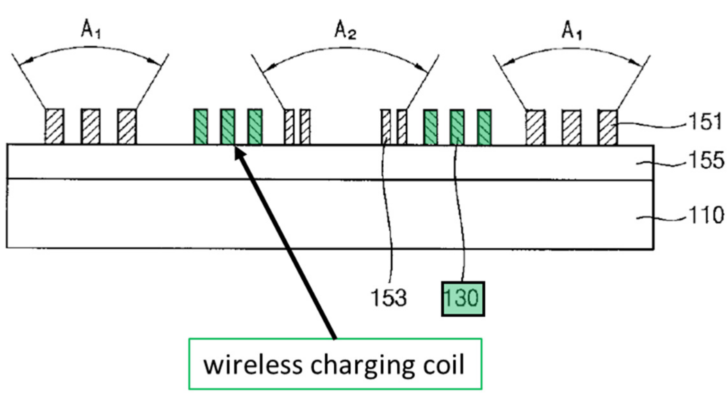
c) 1[b]: a wireless charging antenna comprising a wireless charging coil,

53. Kim discloses this feature. For instance, Kim discloses a non-contact power receiving coil unit 130. (Ex-1005, ¶[0028] ("The non-contact power receiving coil unit (130) is a part of a WPC (wireless power charger) and is connected to charging terminals (113), which allows it to charge the battery (10) in

a non-contact manner."), FIGs. 1, 2.) The non-contact power receiving coil unit 130 is a wireless charging antenna comprising a wireless charging coil. As shown below in the annotated figures from Kim, the non-contact power receiving coil unit 130 (green) is disclosed as a spiral-shaped coil disposed on base 110 and flexible substrate 155. (*Id.*, ¶[0028], FIGs. 1, 2.)



(*Id.*, FIG. 1 (annotated).)



(*Id.*, FIG. 2 (annotated).)

54. Kim explains that a "non-contact (wireless) charging" utilizes "a loop **antenna** in the form of a **spiral coil**." (*Id.*, ¶¶[0004]-[0005] (emphasis added).) Kim further discloses that "[w]hen the non-contact power receiving coil unit (130) is positioned on top of the primary coil installed in a non-contact charger (not shown), an induced electromotive force is generated in a frequency band of several hundred kHz (e.g., 300 kHz or less) between the coil unit (130) and the primary coil, making it possible to charge the battery (10) equipped with the antenna structure for near field communication (100)." (*Id.*, ¶[0029].)

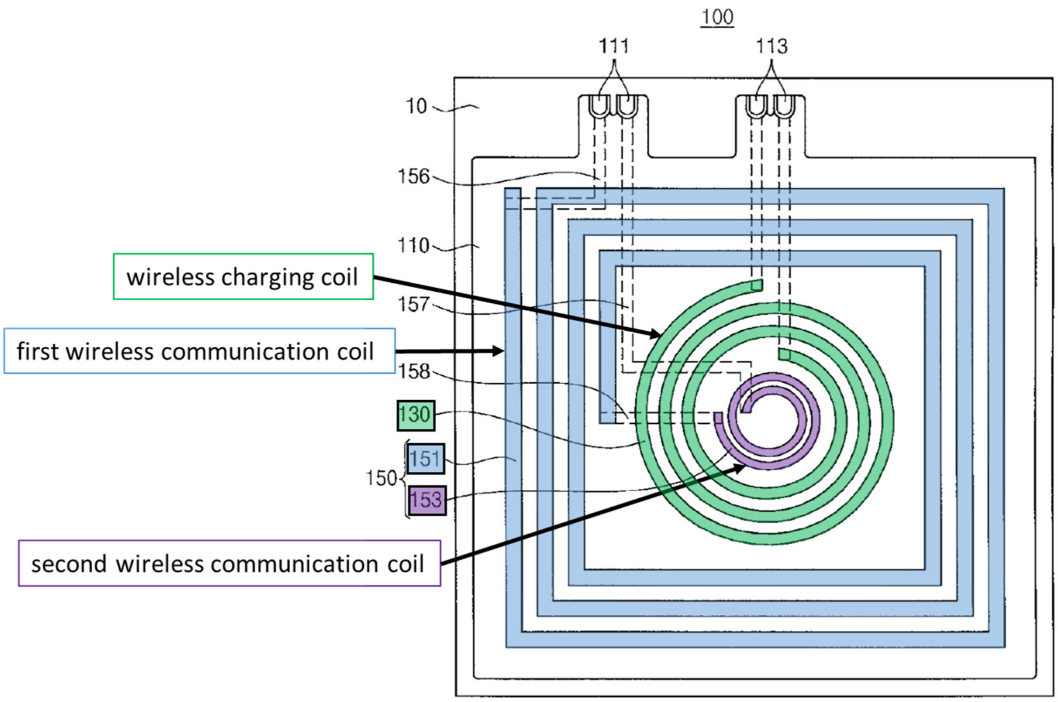
55. Therefore, Kim discloses "a wireless charging antenna comprising a wireless charging coil."

d) 1[c]: wherein the wireless charging coil is disposed inside the first wireless communication coil, and the second wireless communication coil is disposed inside the wireless charging coil,

56. Kim discloses this feature. For instance, as I discussed above for claim elements 1[a] and 1[b], Sections IX.A.1(b)-(c), Kim discloses a first loop antenna pattern 151 ("first wireless communication coil") that surrounds a non-contact power receiving coil unit 130 ("wireless charging coil"), and a second loop antenna pattern 153 ("second wireless communication coil") disposed inside the non-contact power receiving coil unit 130. (Ex-1005, ¶[0031].)

57. Annotated figure 1 below shows non-contact power receiving coil unit 130 ("wireless charging coil") (green) disposed inside a first loop antenna pattern

151 ("first wireless communication coil") (blue), and a second loop antenna pattern 153 ("second wireless communication coil") (purple) disposed inside the non-contact power receiving coil unit 130 (green). (*Id.*, ¶[0031], FIG. 1.)



(*Id.*, FIG. 1 (annotated).)

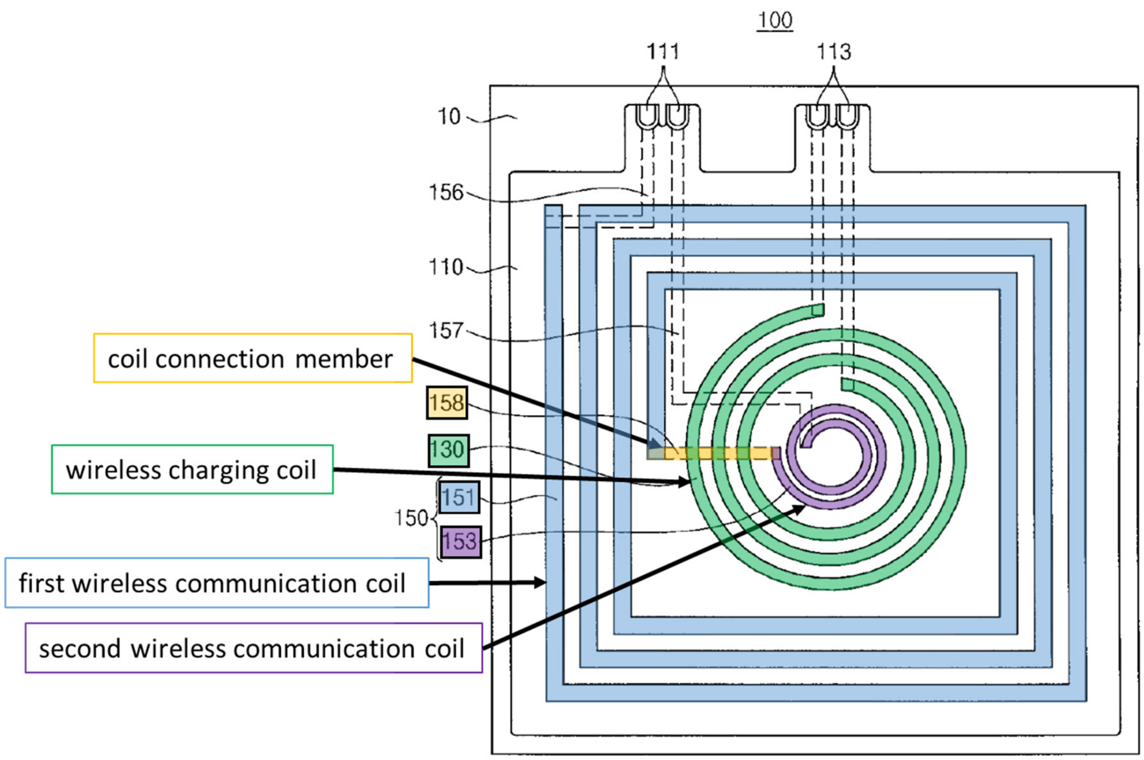
58. Therefore, Kim discloses that "the wireless charging coil is disposed inside the first wireless communication coil, and the second wireless communication coil is disposed inside the wireless charging coil."

e) 1[d]: wherein the wireless communication antenna further comprises a coil connection member traversing the wireless charging coil so as to interconnect the first wireless communication coil and the second wireless communication coil,

59. Kim discloses this feature. For instance, as I discussed above with respect to claim element 1[a], Kim discloses a loop antenna unit 150 ("wireless

communication antenna") comprising a first loop antenna pattern 151 ("first wireless communication coil") and a second loop antenna pattern 153 ("second wireless communication coil"). (Section IX.A.1(b); Ex-1005, ¶[0031], FIGs. 1, 2.) Kim further discloses that the loop antenna unit 150 comprises second connection line 158 ("coil connection member") that "interconnects the first and second loop antenna patterns (151, 153)" by traversing the wireless charging coil 130. (Ex-1005, ¶¶[0031], [0032] ("[T]he loop antenna unit (150) may further comprise … a second connection line (158)"), [0035] ("[t]he second connection line (158) interconnects the first and second loop antenna patterns (151, 153)"), FIG. 1); Section IX.A.1(b).)

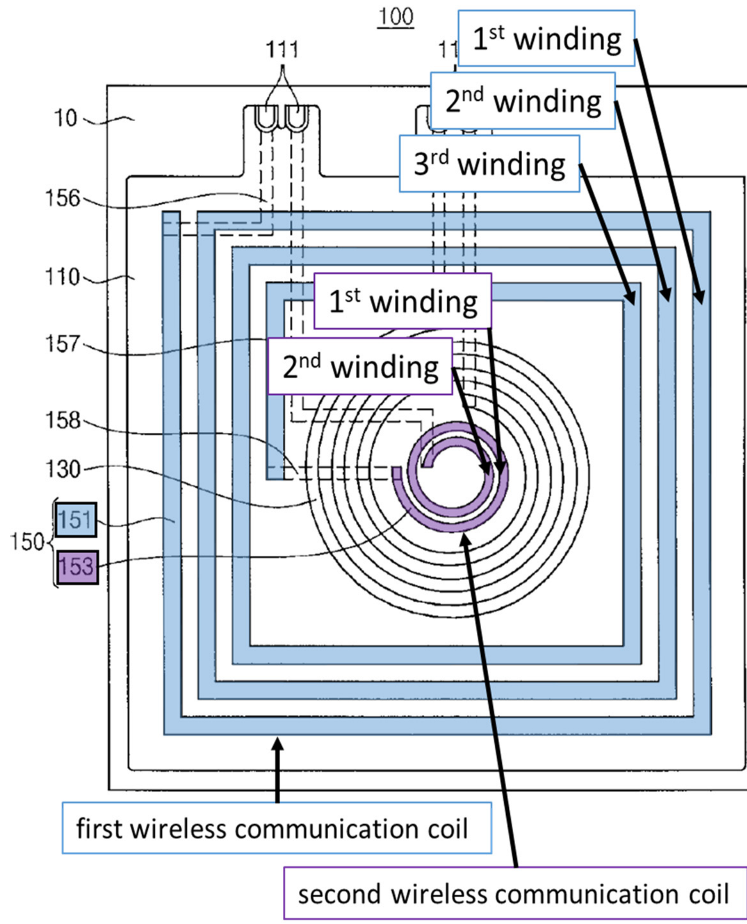
60. Kim shows the coil connection member in figure 1, annotated below, where the second connection line 158 ("coil connection member") (yellow) is disclosed traversing the wireless charging coil 130 so as to interconnect the first loop antenna pattern 151 ("first wireless communication coil") with the second loop antenna pattern 153 ("second wireless communication coil"). Therefore, Kim discloses a wireless communication antenna comprising "a coil connection member traversing the wireless charging coil so as to interconnect the first wireless communication coil and the second wireless communication coil."



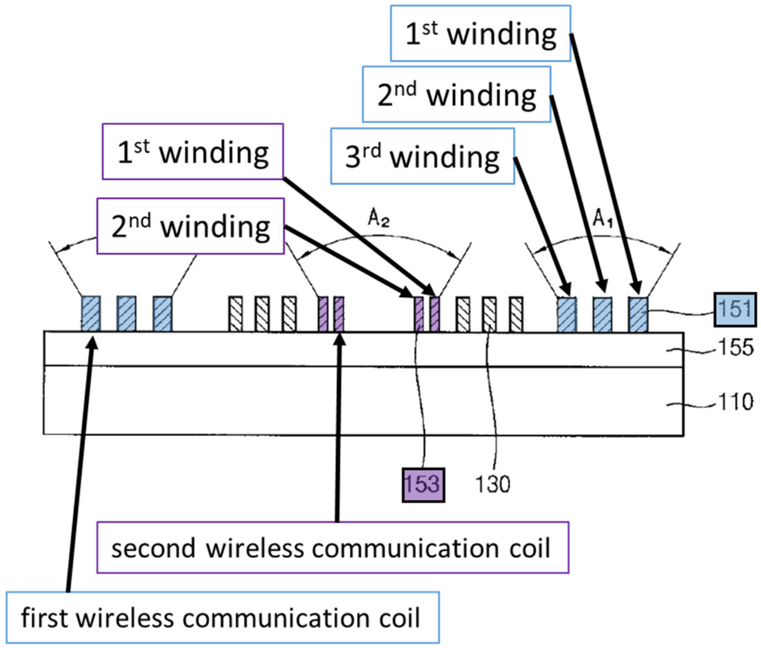
(Ex-1005, FIG. 1 (annotated).)

f) 1[e]: wherein a number of windings of the second wireless communication coil is less than a number of windings of the first wireless communication coil, and

61. Kim discloses this feature. For instance, Kim discloses a second loop antenna pattern 153 ("second wireless communication coil") with two windings and a first loop antenna pattern 151 ("first wireless communication coil") with three windings. (Ex-1005, FIG. 1.) Two windings is less than three windings. Kim's figures 1 and 2 are annotated below to further identify the respective number of windings in each of coils 151 and 153.



(Ex-1005, FIG. 1 (annotated).)

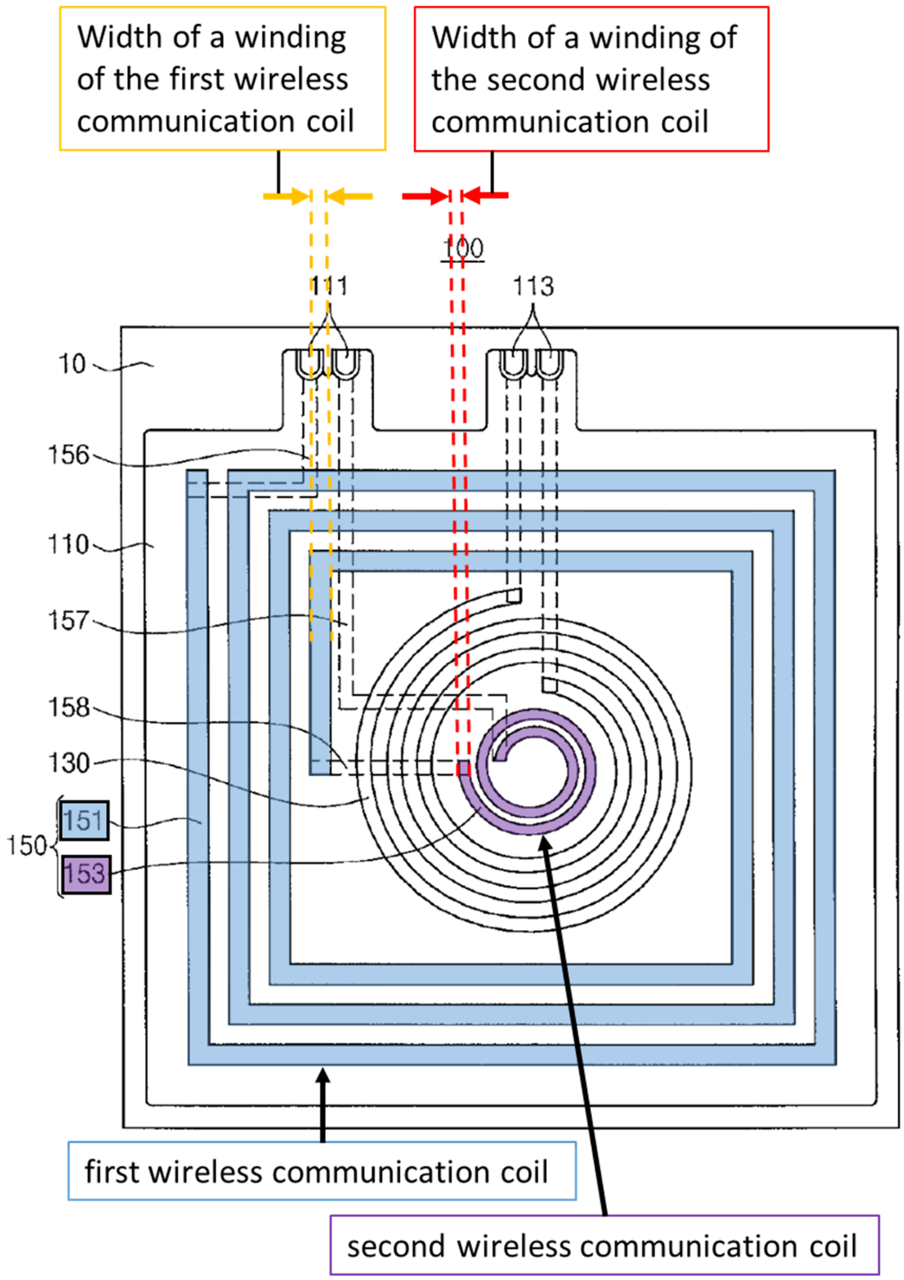


(Ex-1005, FIG. 2 (annotated).)

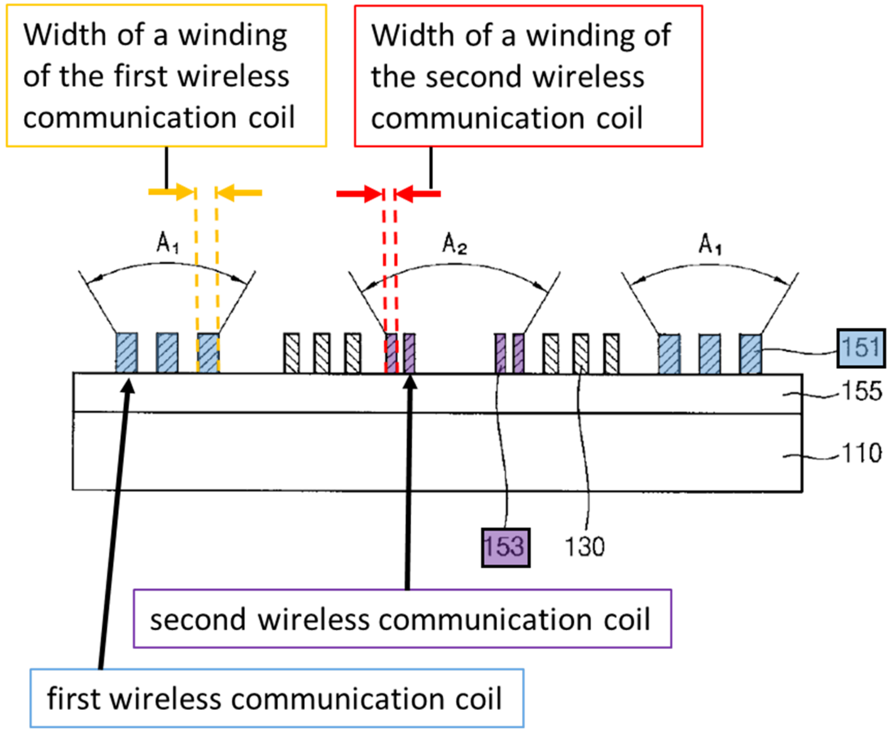
g) 1[f]: wherein a width of a winding of the second wireless communication coil is less than a width of a winding of the first communication coil.

62. Kim discloses this feature. For instance, Kim discloses that a width of a winding of second loop antenna pattern 153 (the "second wireless communication coil") is less than a width of a winding of the first loop antenna pattern 151 (the "first communication coil"). (Ex-1005, FIGs. 1, 2.). Kim's figures, which are annotated below, show a width of a winding (i.e., the outermost winding) of the second loop antenna pattern 153 ("second wireless communication coil") that is less than the width of a winding (i.e., the innermost winding) of the first loop antenna pattern 151 (the "first communication coil") (blue). Kim's figures 1 and 2 below both show the

three coils (151, 130, and 153) having the same relative widths: coil 151 wider than coil 130, and coil 130 wider than coil 153. (*Id*., FIGs. 1, 2.)



(*Id*., FIG. 1 (annotated).)



(*Id*., FIG. 2 (annotated).)

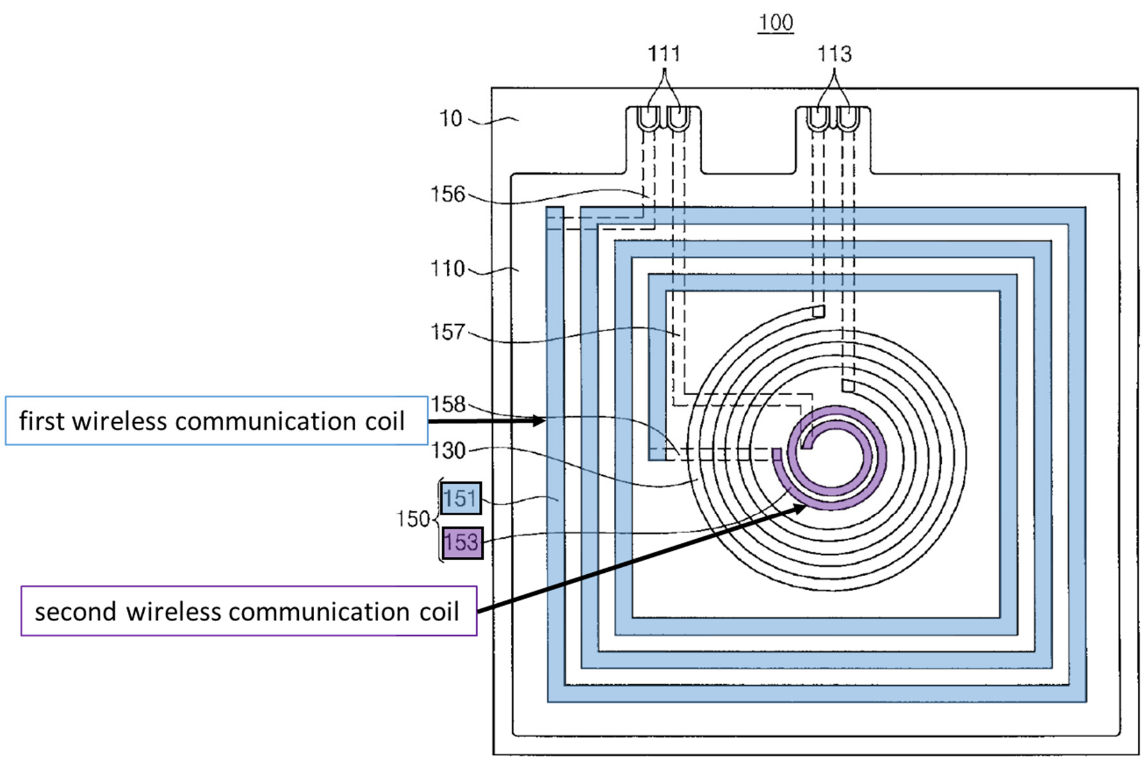
63. Kim's figures, annotated above, consistently show the three coils (151, 130, and 153) having the different relative widths that are the same in both figures: the windings of coil 151 are wider than the windings of coil 130, and the windings of coil 130 are wider than the windings of coil 153. (Ex-1005, FIGs. 1, 2.) Kim's consistent representations of those relative widths would have indicated to a person of ordinary skill in the art that the different relative widths in Kim's figures are intentional.

64. Therefore, Kim discloses that "a width of a winding of the second wireless communication coil is less than a width of a winding of the first communication coil."

2. Claim 2

a) The wireless antenna according to claim 1, wherein the first wireless communication coil and the second wireless communication coil have different shapes.

65. Kim discloses these features. For instance, Kim discloses a first loop antenna pattern 151 ("the first wireless communication coil") having a substantially rectangular shape, and a second loop antenna pattern 153 ("the second wireless communication coil") having a substantially circular shape (i.e., different shapes). (Ex-1005, FIG. 1.) Annotated figure 1 below demonstrates the substantially rectangular shape of the first loop antenna pattern 151 (blue) and the substantially circular shape of the second loop antenna pattern 153 (purple).

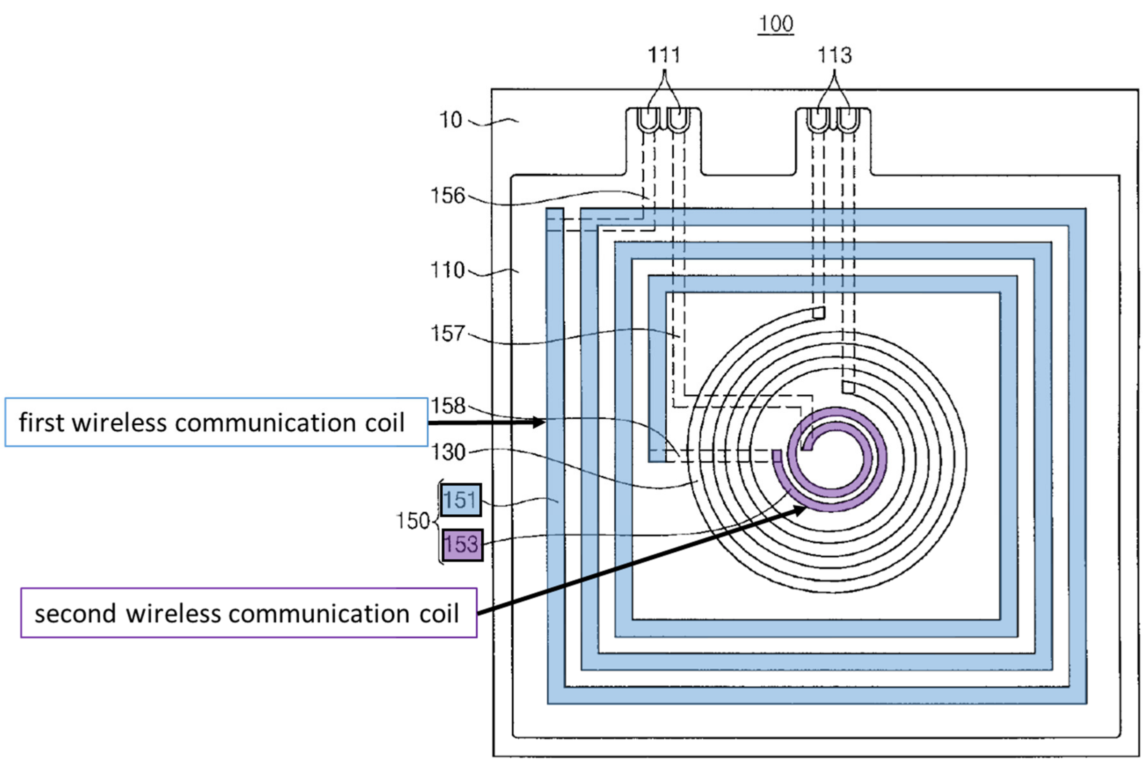


(*Id.*, FIG. 1 (annotated).)

3. Claim 3

a) The wireless antenna according to claim 2, wherein a shape of the first wireless communication coil is a polygonal loop pattern, and wherein a shape of the second wireless communication coil is a circular loop pattern.

66. Kim discloses these features. For instance, Kim discloses a first loop antenna pattern 151 ("first wireless communication coil") having a rectangular ("polygonal") shape with a loop pattern, and second loop antenna pattern 153 ("second wireless communication coil") having a circular shape with a loop pattern. (Ex-1005, FIG. 1; Section IX.A.2(a).)

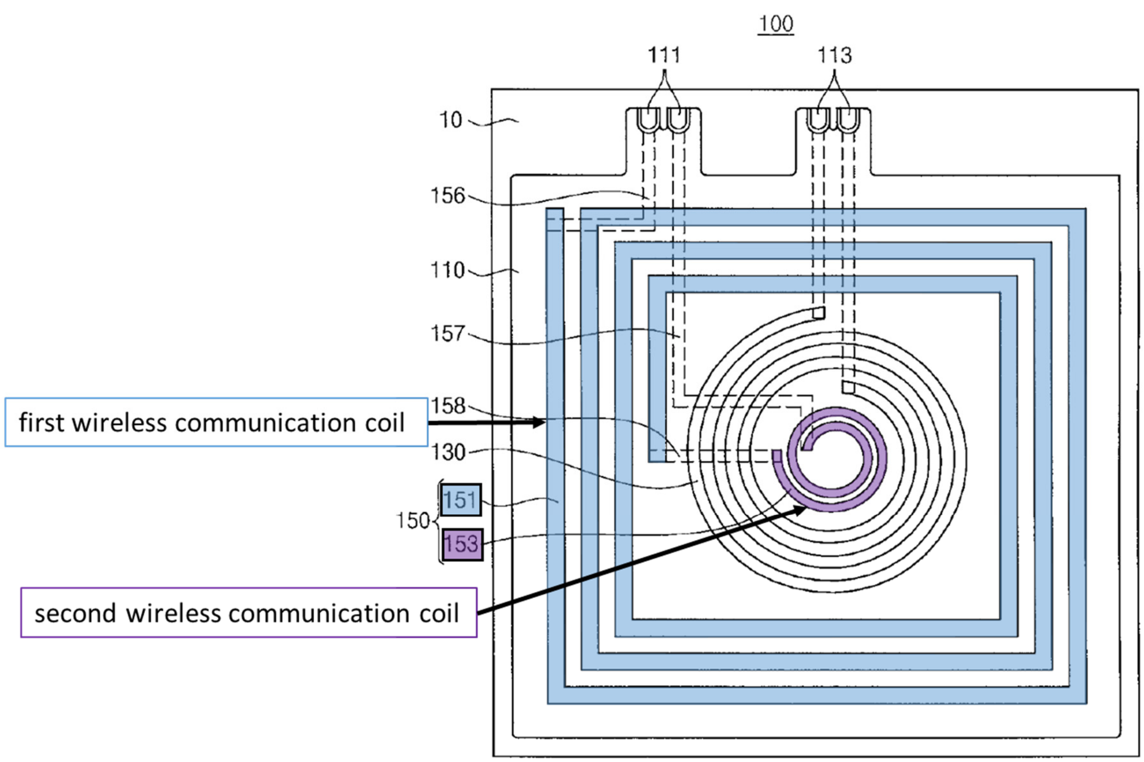


(*Id.*, FIG. 1 (annotated).)

4. Claim 4

a) The wireless antenna according to claim 1, wherein the first wireless communication coil and the second wireless communication coil have different curvatures.

67. Kim discloses these features. For instance, Kim discloses a first loop antenna pattern 151 ("the first wireless communication coil") having a substantially rectangular shape, and a second loop antenna pattern 153 ("the second wireless communication coil") having a substantially circular shape. (Ex-1005, FIG. 1; Section IX.A.2-3.) A rectangular shape and a circular shape have different curvatures.

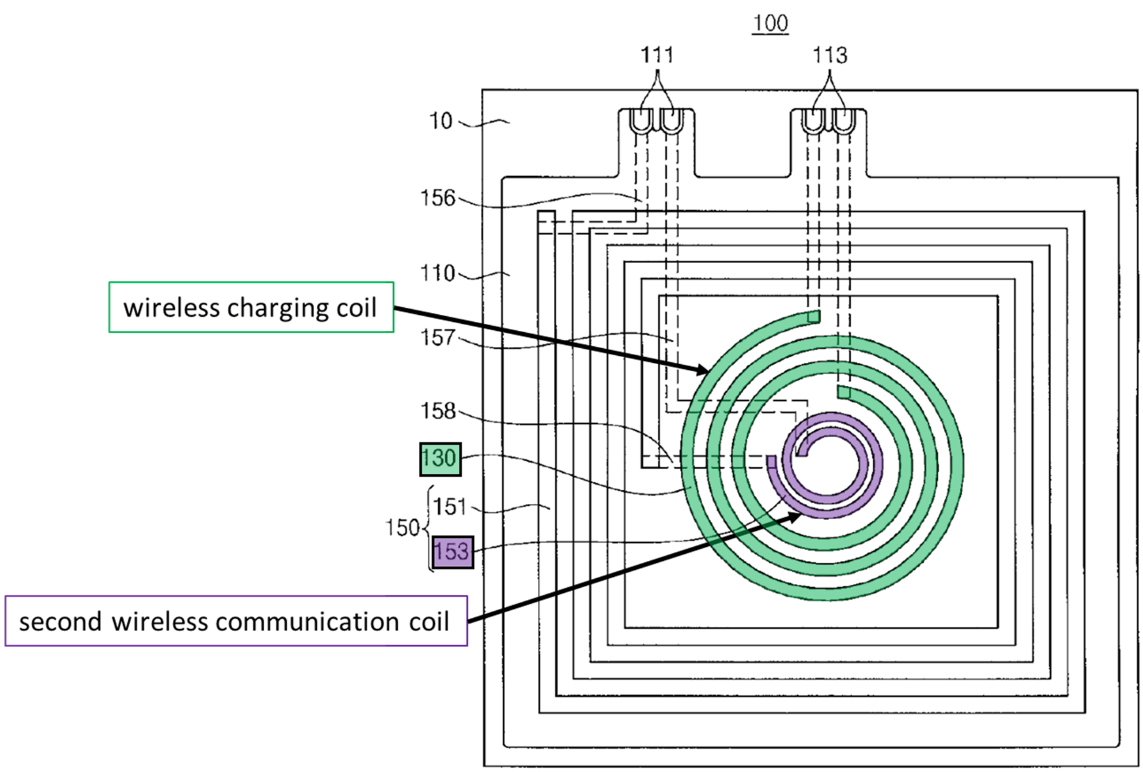


(Ex-1005, FIG. 1 (annotated).)

5. Claim 5

a) The wireless antenna according to claim 1, wherein the wireless charging coil and the second wireless communication coil have corresponding curvatures.

68. Kim discloses these features. For instance, Kim discloses that the contactless electric power receiving coil section 130 ("wireless charging coil") and the second loop antenna pattern 153 ("the second wireless communication coil") have corresponding circular shapes. (Ex-1005, FIG. 1.) Kim's figure 1, annotated below, shows the circular wireless charging coil 130 (green) surrounding the circular second wireless communication coil 153 (purple), and how their curvatures correspond.



(Ex-1005, FIG. 1 (annotated).)

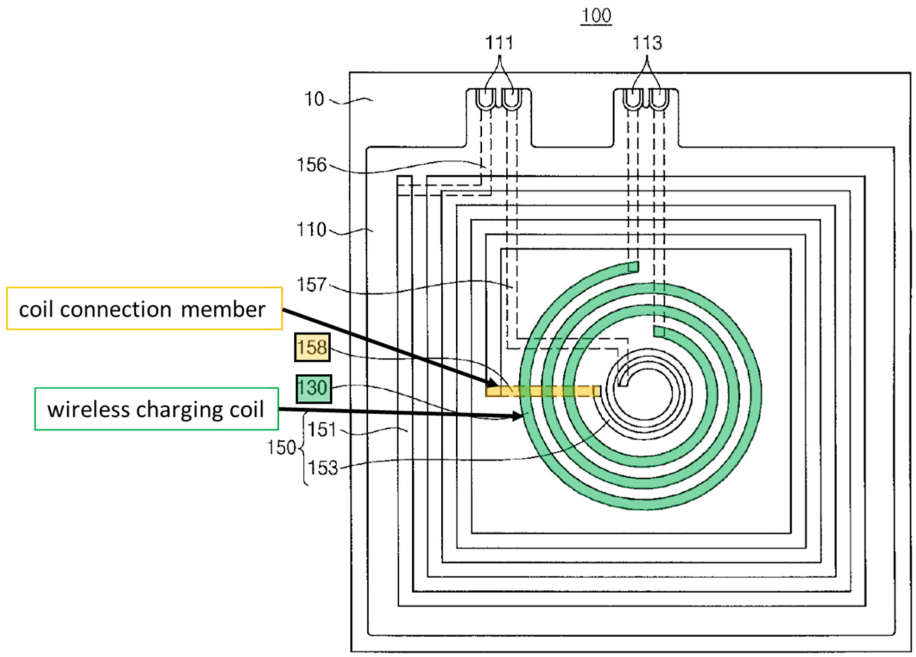
6. Claim 9

a) The wireless antenna according to claim 1, wherein the coil connection member is insulated from the wireless charging coil.

69. Kim discloses this feature. Kim's second connection line 158 ("the coil connection member"), annotated below in figure 1, is discussed above for claim 1[d]. (Section IX.A.1(e); Ex-1005, FIG. 1.) For instance, Kim discloses that "the loop antenna unit may comprise a flexible substrate having the first and second loop patterns formed on one surface thereof . . . and a second connection line [("coil connection member")] formed on the other surface of the flexible substrate and electrically connecting the first and second loop antenna patterns to each other." (Ex-1005, ¶[0013], FIG. 1; *see also id.* ¶[0018] ("Furthermore, as first and second loop antenna patterns are formed on one surface of the flexible substrate and a connection line for interconnecting the first and second loop antenna patterns is provided on the other surface of the flexible substrate, the first and second loop antenna patterns can be stably connected to each other.").)

70. Kim further discloses that the flexible substrate is insulating. For example, Kim discloses that interconnects between the antenna patterns (on the one side of the substrate) and connection lines (on opposite side of the substrate) are formed with contact vias "formed by penetrating the flexible substrate." (*Id.*, ¶[0035]). The contact vias would be unnecessary if the substrate were not insulating.

Kim further discloses the coil connection member 158 traversing the wireless charging coil 130 on the opposite side of the substrate. (*Id.*, ¶¶[0013], [0018], FIG. 1.) As such, the connection member is insulated from the wireless charging coil.



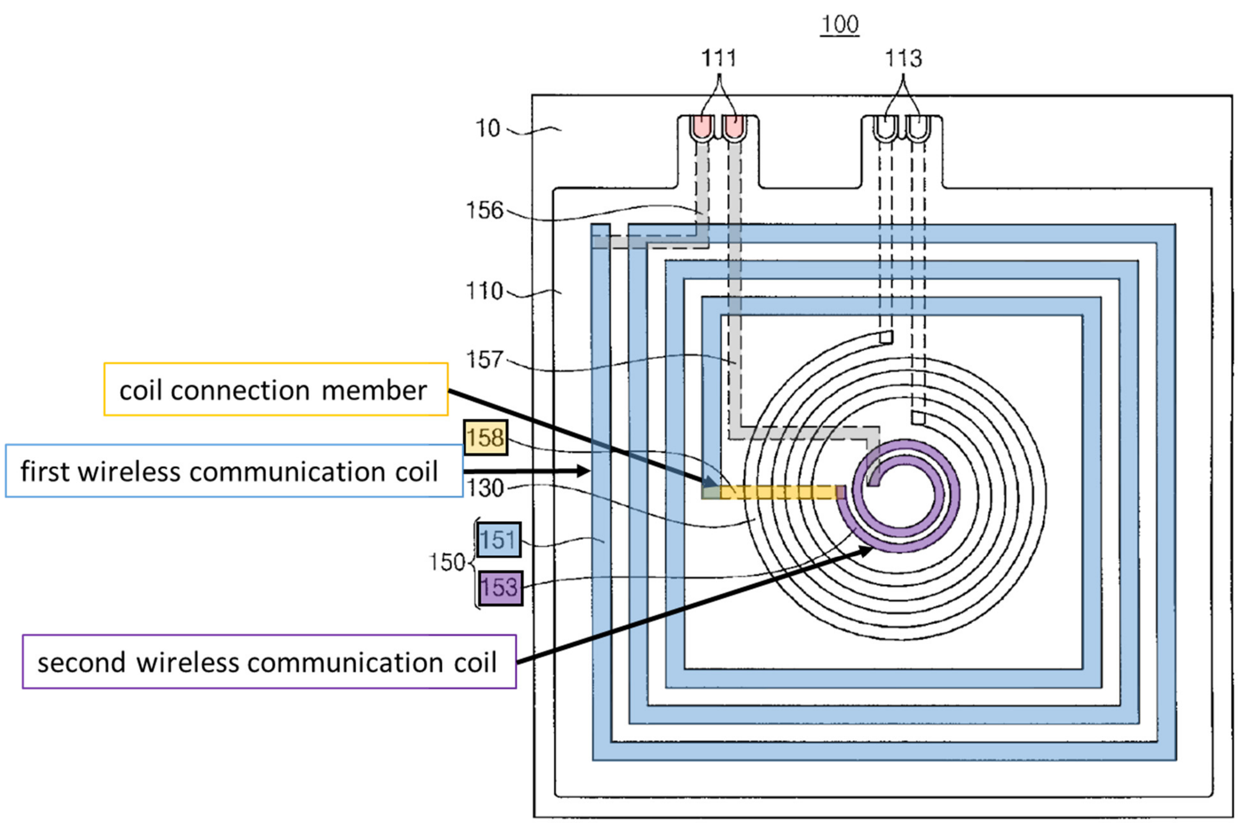
(*Id.*, FIG. 1 (annotated).)

7. Claim 10

a) 10[a]: The wireless antenna according to claim 1, wherein the first wireless communication coil and the second wireless communication coil are connected to each other in series, and

71. Kim discloses this feature. For instance, as I discussed above in Section IX.A.1(e) for claim 1, Kim discloses a **single** connection line 158 ("coil connection member") which interconnects a first loop antenna pattern 151 ("first wireless communication coil") and a second loop antenna pattern 153 ("second wireless communication coil"). (Section IX.A.1(e); Ex-1005, ¶¶[0032], [0035].) The

opposite ends of the first and second communication coils (151, 153)—that is, those ends not connected to the coil connection member 158—are each connected to a contact pad 111, creating a single current path through the coils 151, 153. (Ex-1005, ¶[0030] ("The loop antenna unit (150) is electrically connected to the terminals for near field communication (111)."); ¶[0034] ("The first connection lines (15[6], 157) connect the first and second antenna patterns (151, 153) to pads for near field communication (111), respectively."), FIG. 1.)



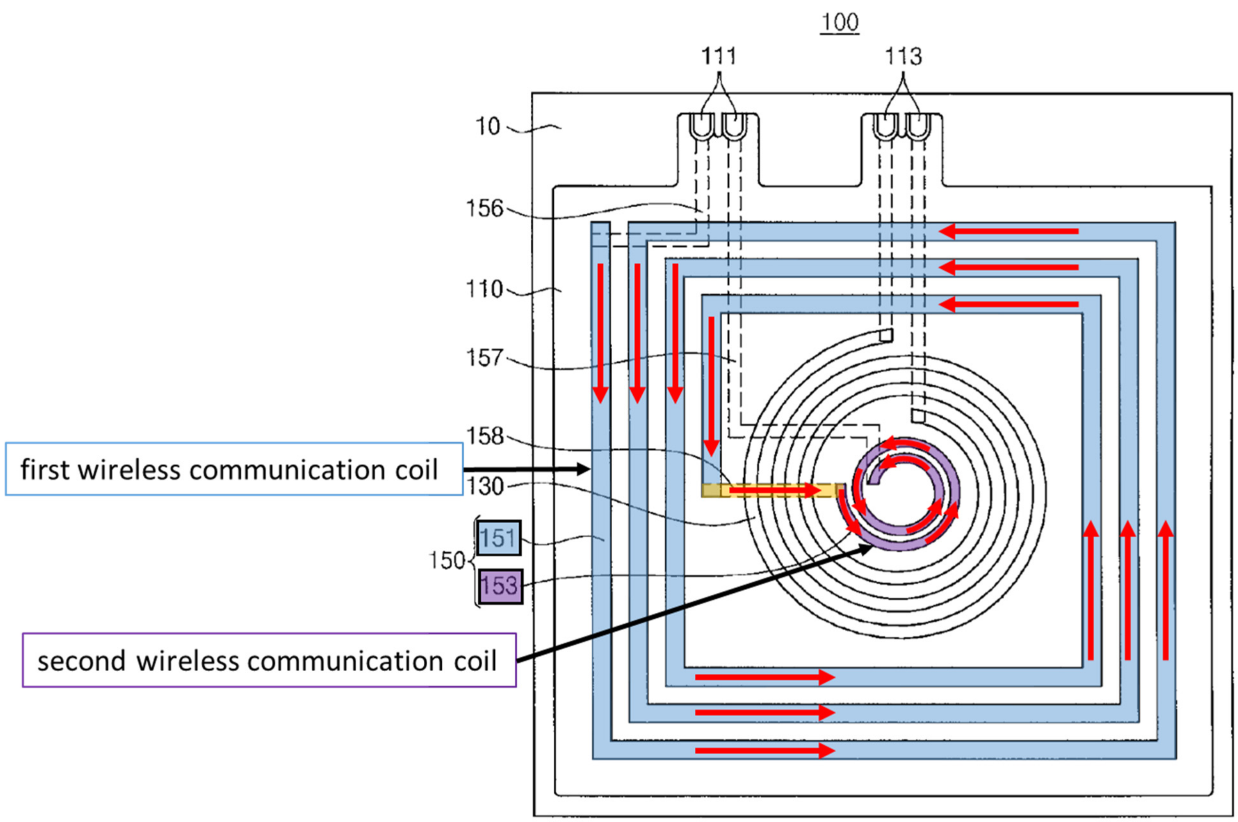
(Id., FIG. 1 (annotated).)

72. Kim's figure 1 is annotated above to highlight the series connection formed by connection line 158 ("coil connection member") (orange) connecting the

first loop antenna pattern 151 (“first wireless communication coil”) (blue) and the second loop antenna pattern 153 (“second wireless communication coil “) (purple). It is readily apparent that there are no other connections between the coils in Figure 1. A person of ordinary skill in the art would have therefore understood that Kim discloses the first wireless communication coil (151) is connected in series with the second wireless communication coil (153).

b) 10[b]: wherein the first wireless communication coil and the second wireless communication coil are wound so as to have a same rotational direction of current.

73. Kim discloses this feature. For instance, Kim discloses the first wireless communication coil 151 is wound in the same direction (counterclockwise) as the second wireless communication coil 153 (Ex-1005, FIG. 1), and the first and second wireless communication coils 151, 153 are connected in series (Section IX.A.7(a)). As such, current flowing through coils 151 and 153 would have the same current rotation direction.



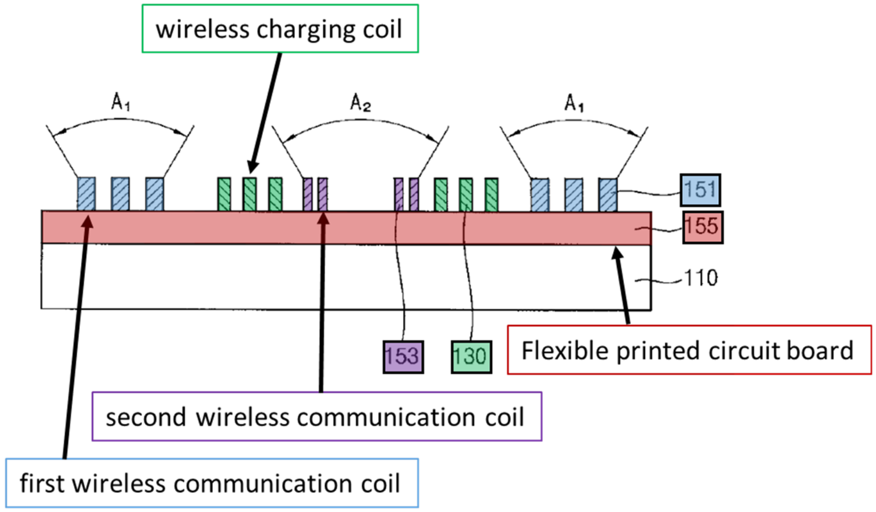
(*Id*., FIG. 1 (annotated).)

74. Kim's figure 1 is annotated above, illustrating the direction of current flow in the first and second wireless communication coils 151, 153 with red arrows. Depending on the polarity, the current may flow in the opposite direction as the arrows, but it will always flow in the same direction in both coils. However, as illustrated and explained above, regardless of whether the current flows in the direction of the arrows or against them, all of the current in both coils will flow in the same direction because they are wound in the same direction and are connected in series.

8. Claim 11

a) The wireless antenna according to claim 1, wherein the wireless communication antenna and the wireless charging antenna are formed on a flexible printed circuit board.

75. Kim discloses this feature. For instance, Kim discloses that the loop antenna unit 150 ("wireless communication antenna") may further comprise a flexible substrate 155, and that the first and second loop antenna patterns 151, 153 of the wireless communication antenna are formed on one surface of the flexible substrate 155. (Section IX.A.1(b); Ex-1005, ¶¶[0013], [0018] ("[A]s first and second loop antenna patterns are formed on one surface of the flexible substrate and a connection line for interconnecting the first and second loop antenna patterns is provided on the other surface of the flexible substrate, the first and second loop antenna patterns can be stably connected to each other."), [0032]-[0033], [0034] ("[T]he first connection lines (156, 157) may be connected to the first and second loop antenna patterns (151, 153) through contact vias (not shown) formed by penetrating the flexible substrate (155)."), FIG. 2.) Annotated figure 2 below illustrates the wireless communication antenna 151, 153 and the wireless charging antenna 130 formed on one surface of the flexible substrate 155. (Ex-1005, FIG. 2.)



(*Id.*, FIG. 2 (annotated).)

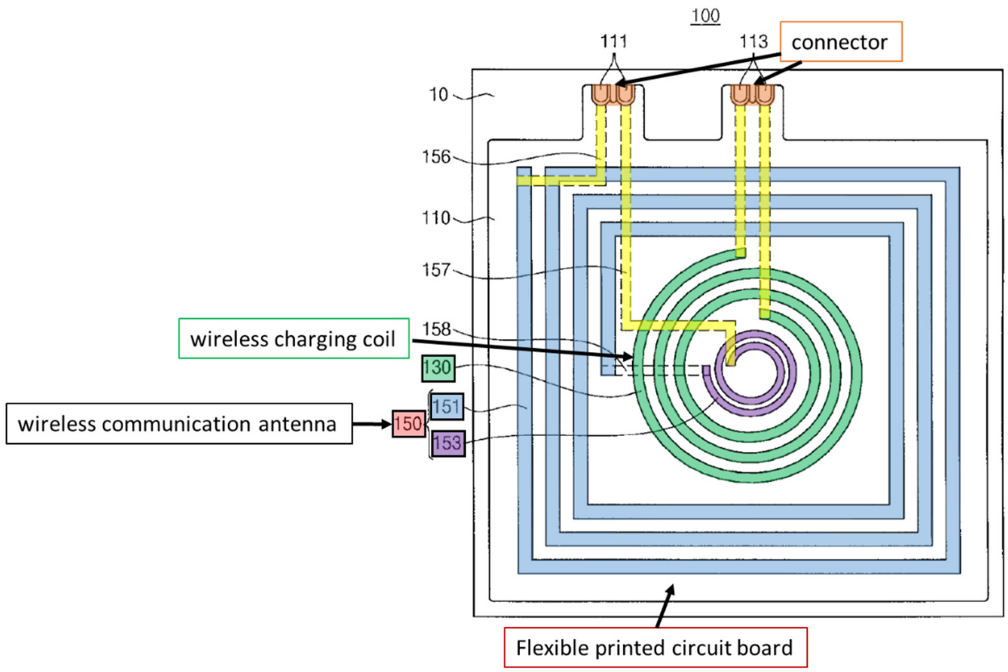
76. A person of ordinary skill in the art would have understood Kim's flexible substrate 155 was a flexible printed circuit board. For example, Kim discloses that "the flexible substrate (155) may be made of a flexible material," and that it "may comprise, for example, a heat-resistant polymer resin, that is, an ethylene-based resin or a polyimide-based resin." (*Id.*, ¶[0033].) These properties describe a flexible printed circuit board. For instance, Kim's substrate 155 is "flexible," and ethylene and polyimide were well-known flexible printed circuit board substrate materials at the time of the alleged invention. (*See*, *e.g.* Ex-1012, 1:42-51 (describing "a method for making a flexible printed circuit board (FPCB)" including "a flexible base 11" where "the base 11 is made from flexible material, such as **polyimide** (PI), poly**ethylene** terephthalate (PET), or poly**ethylene** naphthalate (PEN).") (emphasis added)). A person of ordinary skill in the art would have also understood Kim's flexible substrate 155 to describe a flexible printed

circuit board because (1) it is flexible and has coil traces (i.e., inductor circuitry) on it, and (2) at the time of the alleged invention, flexible printed circuit board was a common substrate on which wireless charging and communication coils were formed. (*See*, *e.g.*, Ex-1013, 17:32-39 ("A dual antenna 40 that performs both the NFC function and the wireless charging function is preferably implemented by using a flexible printed circuit board (FPCB).").)

9. Claim 12

a) The wireless antenna according to claim 11, wherein the flexible printed circuit board further comprises a connector connected to the wireless communication antenna and to the wireless charging antenna.

77. Kim discloses this feature. For instance, Kim discloses that the non-contact power receiving coil unit 130 ("the wireless charging coil") and the loop antenna unit 150 ("wireless communication antenna") are connected to terminals 113 and 111, respectively. (Ex-1005, ¶¶[0028] ("The non-contact **power receiving coil unit (130)** is a part of a WPC (wireless power charger) and **is connected to charging terminals (113)**, which allows it to charge the battery (10) in a non-contact manner.") (emphasis added), [0030] ("The **loop antenna unit (150) is electrically connected to the terminals for near field communication (111)**.") (emphasis added), [0034], FIG. 1.) As I explained below, terminals 113 and 111 are disposed on the flexible printed circuit board ("flexible printed circuit board comprises a connector"). The terminals 111 and 113, collectively, are a connector.

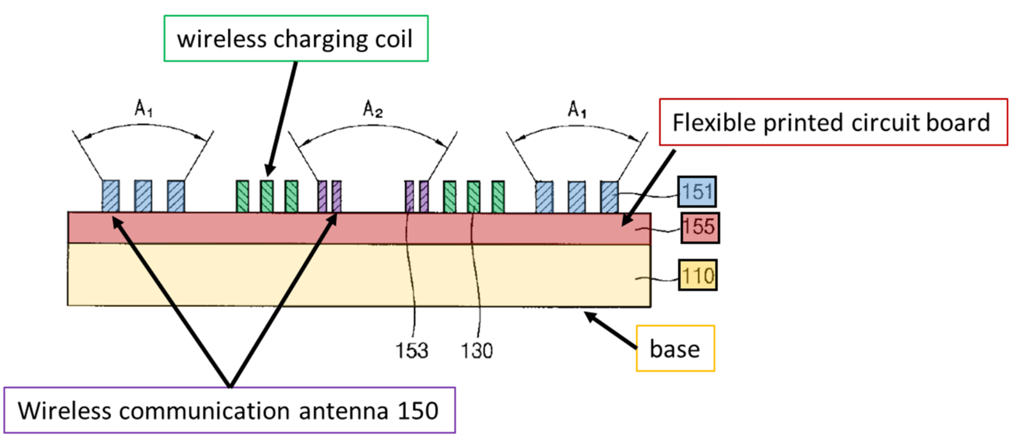


(*Id*., FIG. 1 (annotated) (dashed lines indicating connection lines on the opposite surface of the flexible substrate from the coils).)

78. A person of ordinary skill in the art would have understood Kim's terminals 111, 113, are disposed on the flexible printed circuit board because the connection lines 156, 157 (connecting the first and second antenna patterns 151, 153 to terminals 111) are formed on the opposite side of the flexible substrate 155 from the first and second antenna patterns 151, 153. (*See*, *e.g.*, *id*., ¶¶[0013] ("first connection lines formed on the other surface of the flexible substrate and electrically connecting the first and second loop antenna patterns to pads for near field communication, respectively"), [0033] ("The first and second loop antenna patterns (151, 153) are formed on one surface of the flexible substrate (155)"), [0034] (The first connection lines (156, 157) are formed on the other surface of the flexible

substrate (155).”), [0035], FIG. 1.) Kim’s Figure 1 shows the connection lines on the back opposite side of the flexible printed circuit board 155, indicating they are on the opposite side with dashed lines. Because those dashed connection lines are on the flexible printed circuit board, and they extend to the terminals 111, 113 (“connector”) as shown in Figure 1, above, flexible printed circuit board also extends to the connector. (*Id.*, FIG. 1.)

79. Furthermore, although Kim’s figure 1 shows base 110 (on the flexible printed circuit board), and not flexible printed circuit board 155, annotated figure 2 below, which is a cross-section of figure 1, shows base 110 is coextensive with the flexible printed circuit board 155. (*Id.*, FIGs. 1, 2.) Accordingly, because the connectors are on base 110, they are also on flexible printed circuit board 155. (*Id.*) Therefore, Kim discloses that “the flexible printed circuit board comprises a connector connected to the wireless communication antenna and to the wireless charging antenna.”

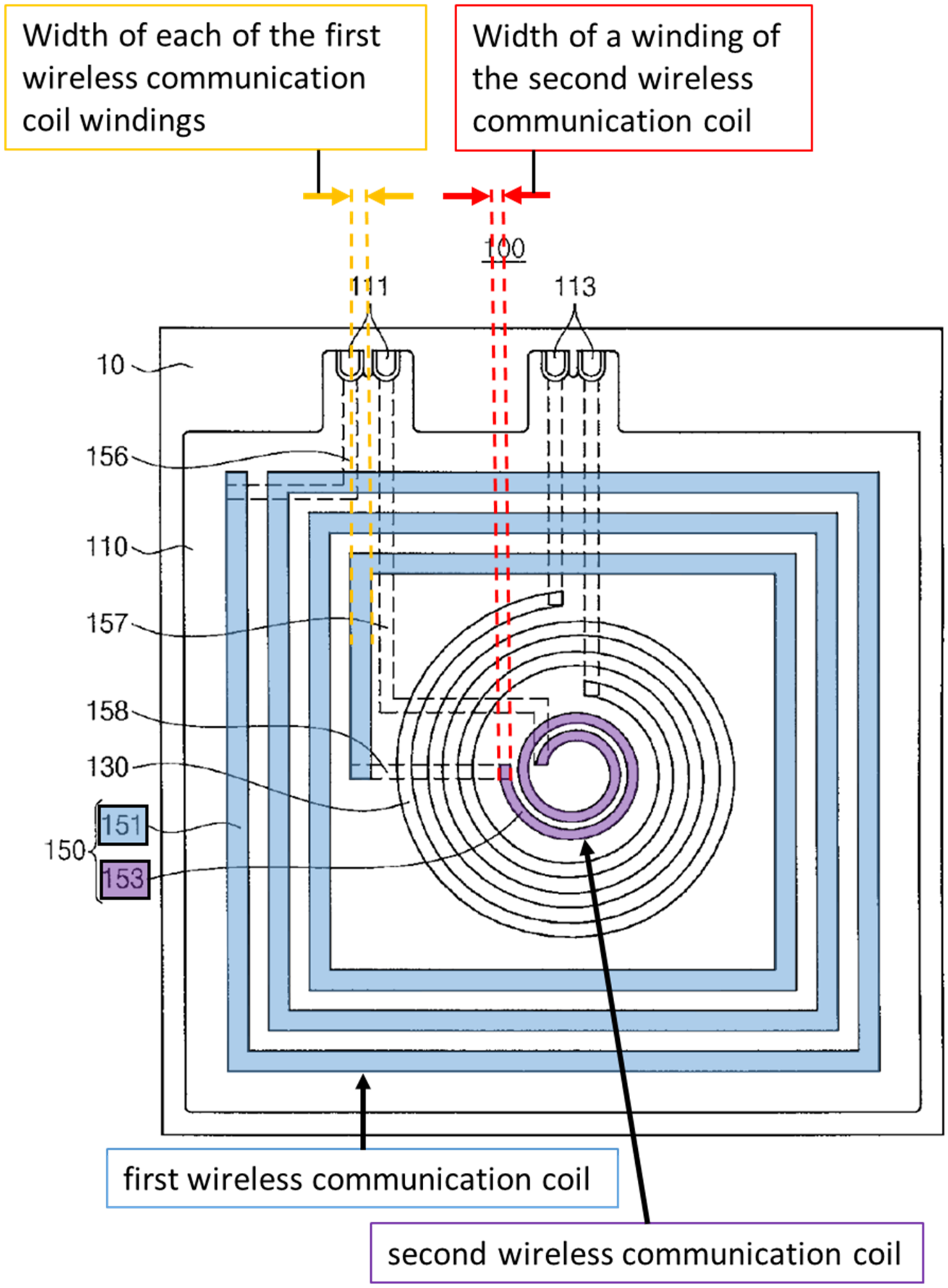


(*Id.*, FIG. 2 (annotated).)

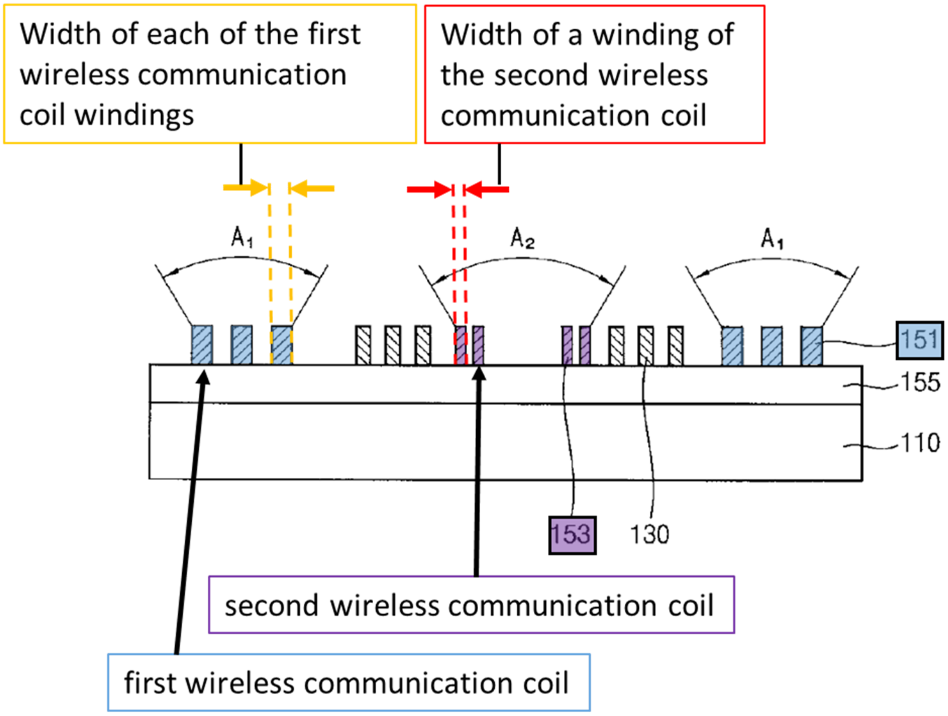
10. Claim 50

a) The wireless antenna according to claim 1, wherein each of the windings of the first communication coil has a width that is greater than the width of the winding of the second wireless communication coil.

80. Kim discloses this feature. For instance, as I discussed for claim element 1[f], Kim discloses that a width of a winding of the first loop antenna pattern 151 (the "first communication coil") is greater than a width of a winding of second loop antenna pattern 153 (the "second wireless communication coil"). (Section IX.A.1(g); Ex-1005, FIGs. 1, 2.) Each of the windings of Kim's first loop antenna pattern 151 is the same width (greater than the width of the winding of the second loop antenna pattern 153), as shown in annotated Figures 1 and 2, below. (Ex-1005, FIGs. 1, 2.)



(Ex-1005, FIG. 1 (annotated).)



(Ex-1005, FIG. 2 (annotated).)

B. Kim in Combination with Shostak Discloses or Suggests the Features of Claims 6, 17-22, 25-29, 34-39, 42-45, 51, and 52

1. Claim 6

a) The wireless antenna according to claim 1, wherein the number of windings of the second wireless communication coil is one.

81. Kim in combination with Shostak discloses or suggests this feature. As I discussed above in Section IX.A.1(b), Kim discloses a second wireless communication coil. (Section IX.A.1(b); Ex-1005, ¶[0031].) Although Kim's second wireless communication coil 153 has two windings, a person of ordinary skill in the art would have had good reason to configure Kim's second wireless communication coil to have one winding in view of Shostak.

82. Shostak, which is in the same field as Kim, discloses the same general antenna structure as Kim—a two-part communication antenna with a wireless charging antenna placed in between the communication coils (Ex-1006, 4:34-40 ("The example antenna apparatus 204 includes two different antennas 302 and 304."), 4:55-59 ("The antenna 304 is one continuous loop that includes multiple portions 314, 316, and 318. The portion 314 is positioned about the outer periphery 306 of the antenna 302."), 5:5-6 ("The portion 316 is positioned within the inner boundary 308 of the antenna 302."), FIGs. 3, 11)—and further discloses that the second (interior) wireless communication coil has one winding (*id.*, 9:55-66, 10:4-12, 10:18-25, FIGs. 9, 10). For instance, Shostak discloses that "[t]he portion 316 [of the wireless communication coil 504] forms a single loop as illustrated [in Figure 9]." (*Id.*, 10:12.)

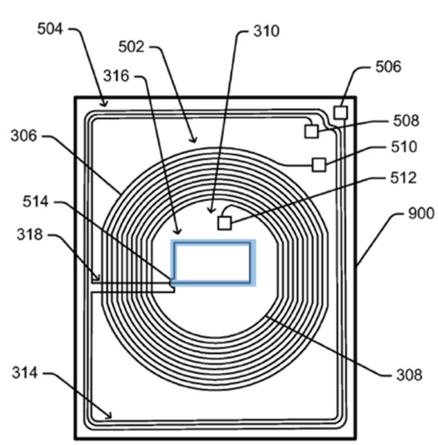


FIG. 9

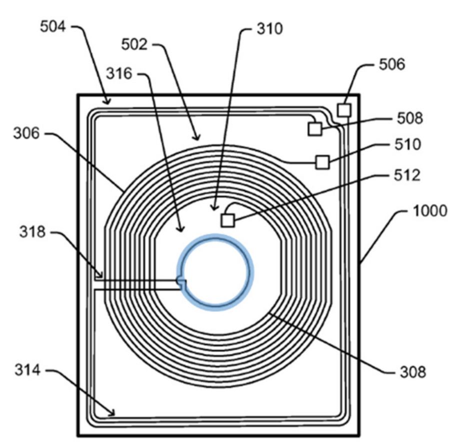


FIG. 10

(*Id.*, FIGs. 9, 10 (annotated).)

83. A person of ordinary skill in the art would have had reason to consider Shostak's teachings at least because the second communication coil in Kim and Shostak serve the same purpose: avoiding a dead zone in the center area of the antenna where the first (outer) communication antenna is unable to communicate with devices that are in the dead zone. (Ex-1005, ¶[0031] ("the second loop antenna pattern (153) can enable near field communication with an RFID tag adjacent to the location in the A2 region corresponding to the center portion of the base (110)"); Ex-1006, 10:41-52).

> Returning to FIG. 3, without the portion 314 of the antenna 304 being situated within the inner boundary 308 of the antenna 302, **a "dead zone" can be created in the center area 310**. Some devices with which communication with the computing device 102 may be desired may be small enough, or have antennas that are small enough, to effectively fit within this "dead zone". For example, the diameter of the center area 310 may be greater than the diameter of the other device or the antenna of the other device. **By extending the portion 314 of the antenna 304 into this "dead zone", the effects of the "dead zone" can be reduced** and communication with such other devices improved.

(Ex-1006, 10:41-52 (emphasis added).)

84. Thus, Shostak's teachings regarding the second communication coil are directly applicable to Kim, as they address the same known problem.

85. Having looked to Shostak, a person of ordinary skill in the art would have had reason to consider and implement Shostak's single-winding second wireless communication coil in Kim's communication antenna. Doing so would have been a matter of routine optimization the number of windings, well within such a person's grasp and technical ability.

86. The number of windings (also called "turns") in a communication antenna was known to effect the inductance, resistance, and recognition distance. (Ex-1011, ¶[0139] ("The number of turns is related to the inductance of the antenna, and as the number of turns increases, the inductance of the antenna increases, but due to the exponentially increasing resistance value, it has an adverse effect on the maximum recognition distance of the [NFC] antenna.")) Similarly, the '426 patent explains that routine optimization was conducted to identify the number of interior communication coil windings that would satisfy known wireless charging and communication standards, which led to a single winding in the second (interior) communication coil. (Ex-1001, 6:30-7:19.) It does not identify any unexpected result achieved by selecting a single winding. (*See generally* Ex-1001.)

87. Shostak's disclosure of antenna layouts having a single-turn second wireless communication coil confirms that a person of ordinary skill in the art could

have readily derived the claimed feature via routine optimization. In addition to disclosing the one-winding interior communication coils in Figures 9 and 10, Shostak also discloses antenna designs ranging between less than a full winding (Ex-1006, FIGs. 6-8) and two windings (*id.*, FIG. 5) like Kim. Thus, Shostak's disclosed range (less than 1 winding to 2 windings) overlaps the claimed range of one winding.

88. In my opinion, a person of ordinary skill in the art would have had reason to implement the second wireless communication coil with one winding because Shostak identifies the single-winding interior communication coils of Figures 9 and 10 as advantageously being wound in the same direction as the outer communication coils of those antenna layouts (unlike the coils of Figures 6-8 having less than one turn), such that the magnetic fields combine constructively, and "the radiated magnetic field can be greater due to the superposition of the fields from the two coils than if the orientation/direction of the coils in the two communication antenna portions were different." (*Id.*, 8:10-22, 10:18-25 ("Keeping the winding orientation the same allows the magnetic field generated by each of the portions 314 and 316 to combine constructively in the center area 310 of the antenna apparatus 500.").) This advantage would have given such a person a good reason to consider the single-winding coils disclosed by Shostak over its antenna layouts that lack that advantage. In addition, fewer windings would permit greater spacing between the

antenna coils, which would have had the advantage of reducing mutual inductance and interference between the coils. (Section IX.B.2(f).)

89. A person of ordinary skill in the art would have had a reasonable expectation of success in modifying the number of windings in Kim's communication coil 153 at least because such a person would have been well aware of the effects of varying the number of windings of an NFC coil like Kim's, and would have been capable of tuning that coil antenna for a particular application by selecting an appropriate number of windings. (*See, e.g.*, Ex-1011, ¶¶[0139], [0162] ("In the 13.56 MHz NFC antenna having a single-layer structure, the branched metal line inside increases the number of turns of the NFC antenna, the inductance [sic: inductance] value of the antenna can be changed by the number of turns (2 turns, 3 turns, 4 turns, and 5 turns)"), [0163], FIG. 20 (describing how inductance and resistance of an NFC coil changes with the number of windings).) Additionally, there is nothing particularly difficult about changing the number of coil windings in Kim's antenna, and a person of ordinary skill could readily make such changes. Therefore, it is my opinion that Kim in combination with Shostak discloses or suggests that "the number of windings of the second wireless communication coil is one."

2. Claim 17

a) 17[pre]: A wireless antenna comprising:

90. Kim discloses or suggests this feature for the reasons discussed for claim element 1[pre]. (Section IX.A.1(a).)

b) 17[a]: a wireless communication antenna comprising a first wireless communication coil and a second wireless communication coil; and

91. Kim discloses or suggests these features for the reasons discussed above for claim element 1[a]. (Section IX.A.1(b).)

c) 17[b]: a wireless charging antenna comprising a wireless charging coil,

92. Kim discloses or suggests this feature for the reasons discussed above for claim element 1[b]. (Section IX.A.1(c).)

d) 17[c]: wherein the wireless charging coil is disposed inside the first wireless communication coil, and the second wireless communication coil is disposed inside the wireless charging coil,

93. Kim discloses or suggests these features for the reasons discussed above for claim element 1[c]. (Section IX.A.1(d).)

e) 17[d]: wherein a number of windings of the second wireless communication coil is less than a number of windings of the first wireless communication coil,

94. Kim discloses or suggests this feature for the reasons discussed above for claim element 1[e]. (Section IX.A.1(f).)

f) 17[e]: wherein a minimum distance between the second wireless communication coil and the wireless charging coil is greater than a minimum distance between the first wireless communication coil and the wireless charging coil, and

95. Kim in combination with Shostak discloses or suggests this feature. As I discussed above in Sections IX.A.1(b)-(c), Kim discloses a first wireless communication coil 151, a second wireless communication coil 153, and a wireless charging coil 130. (Sections IX.A.1(b)-(c); Ex-1005, ¶[0031].) Although Kim does not explicitly disclose that a minimum distance between the second wireless communication coil 153 and the wireless charging coil 130 is greater than a minimum distance between the first wireless communication coil 151 and the wireless charging coil 130, Shostak discloses this feature, and, in view of Shostak, a person of skill in the art would have had good reason to implement it in Kim's antenna.

96. For instance, Shostak discloses a minimum distance between the second (inner) wireless communication coil 316 and the wireless charging coil 502 is greater than a minimum distance between the first (outer) wireless communication coil 314 and the wireless charging coil 502. (Ex-1006, FIGs. 9, 10.)

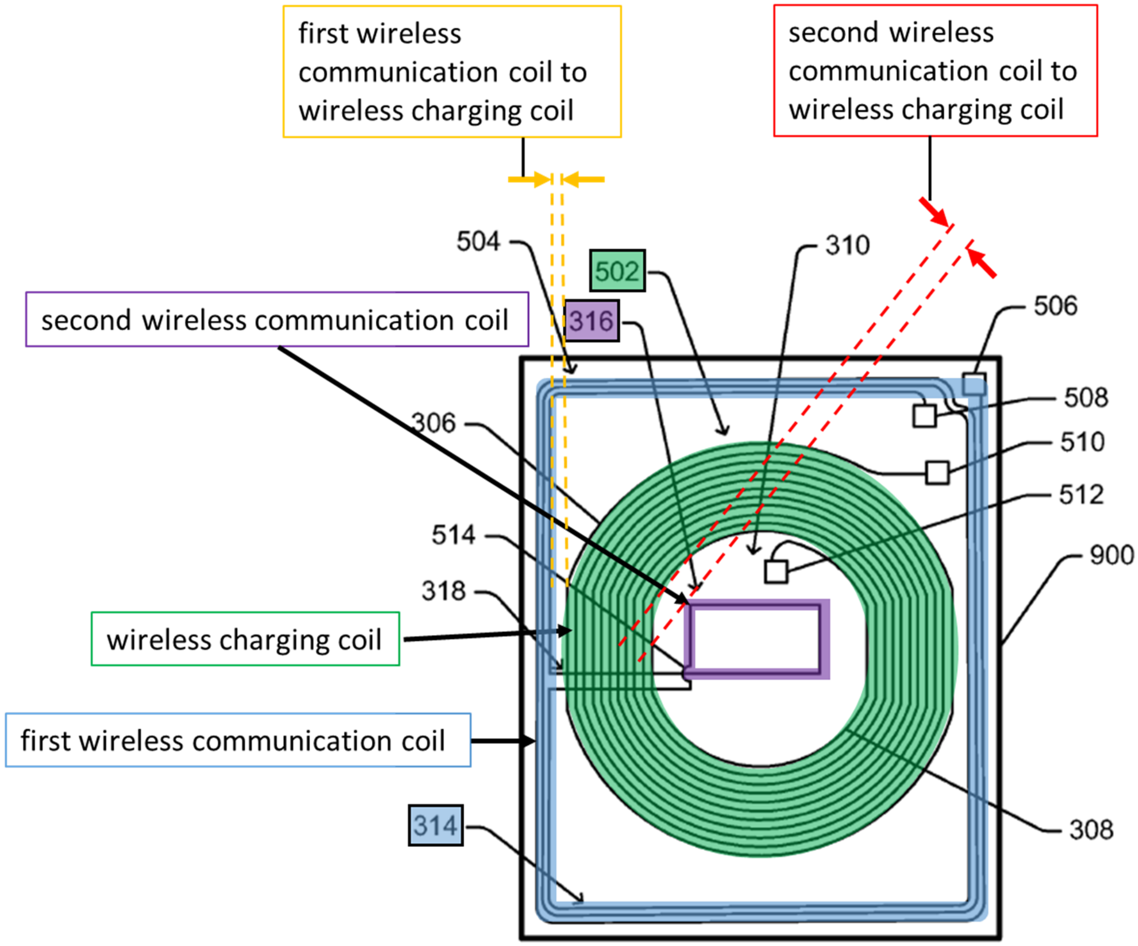


FIG. 9

(*Id*., FIG. 9 (annotated).)

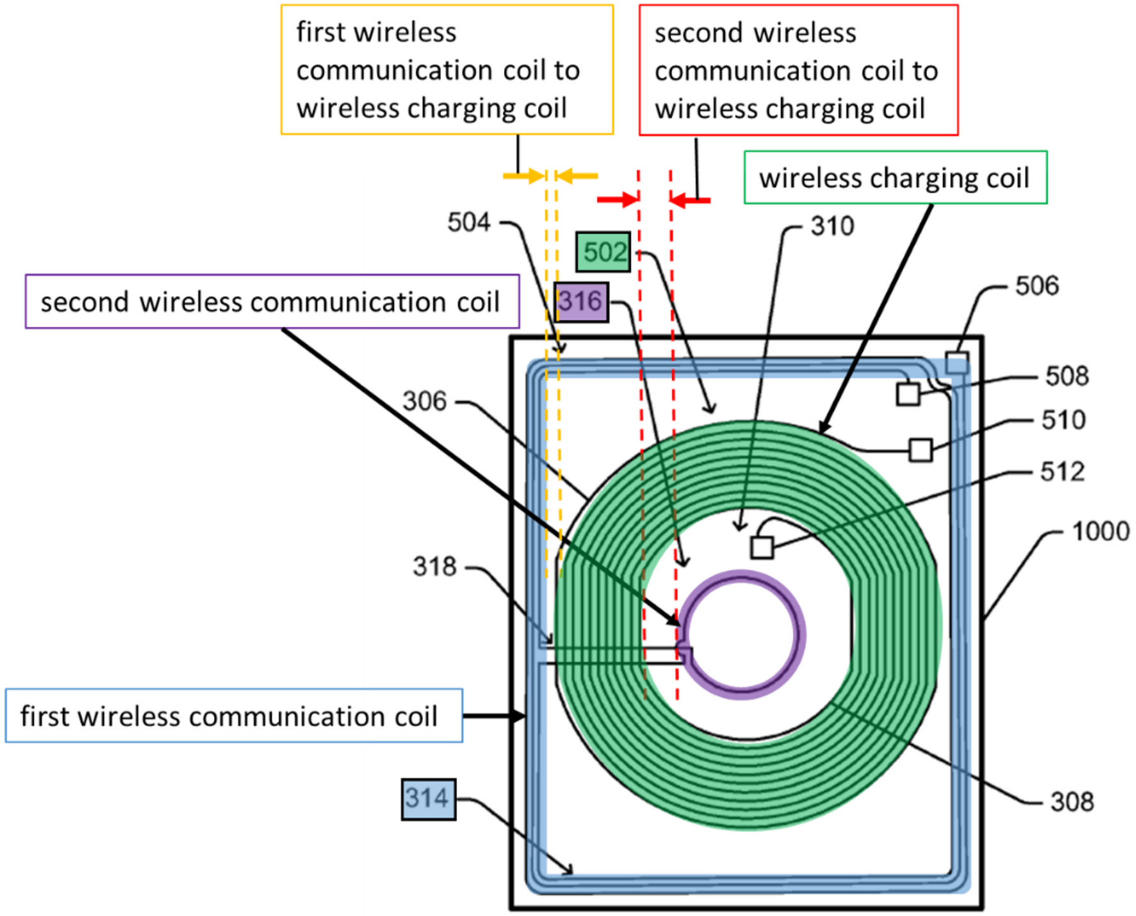


FIG. 10

(*Id*., FIG. 10 (annotated).)

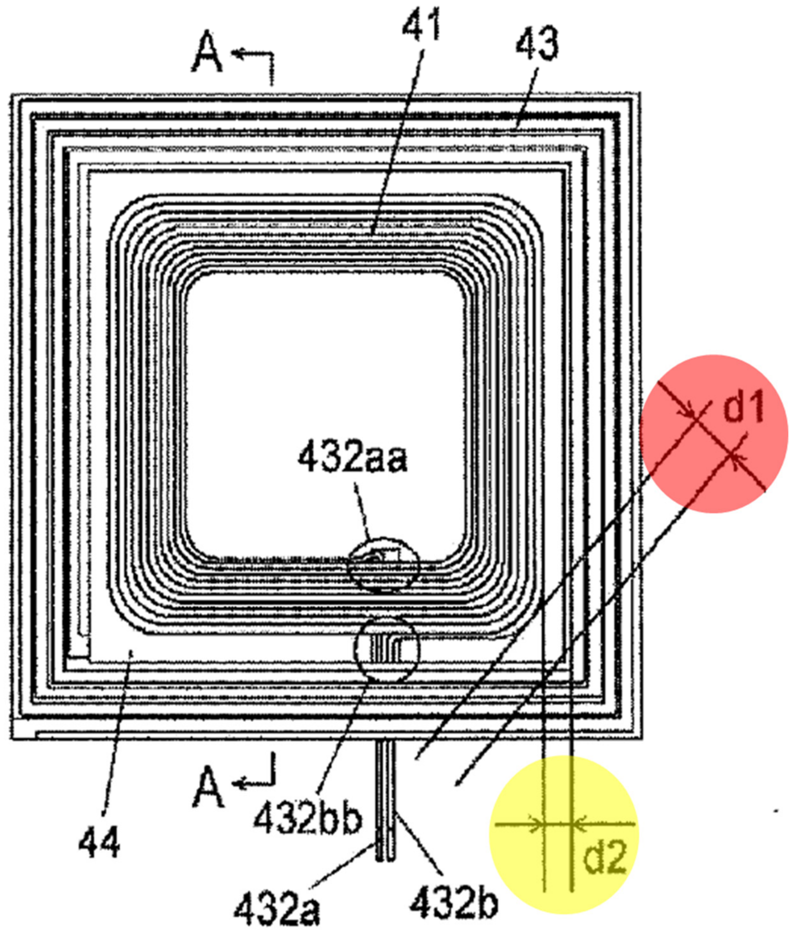
97. As I discussed above in Section IX.B.1(a), Shostak discloses the same general antenna structure as Kim—a two-part communication antenna 314, 316 with a wireless charging antenna 502 (the antenna 302 of FIG. 3) placed in between the communication coils. (*Id*., 4:34-40, 4:55-58, 5:5-6, 7:20-50, FIGs. 3, 9, 10.) Shostak discloses that "a separation is maintained" between the second wireless

communication coil 316 and the wireless charging coil 302 (502 in FIGs. 9, 10), and between the first wireless communication coil 314 and the wireless charging coil 302 (502 in FIGs. 9, 10). (*Id*., 5:33-41.) Shostak explains that the separation distances between the first and second communication coils and the wireless charging coil influences the mutual coupling between the wireless communication and wireless charging coils. (*Id*.) Maintaining appropriate separation prevents magnetic fields between the coils from interfering with one another. (*Id*.) Shostak further discloses that "this separation is at least approximately 2 millimeters, although other amounts of separation can alternatively be used." (*Id*., 5:39-41.) In fact, Shostak discloses using different separation distances between each of the communication coils and the wireless charging coil, as I noted above. (*Id.*, FIGs. 9, 10.)

98. The separation distance is merely a design choice, and person of ordinary skill in the art would have understood the benefits of using a minimum distance between the second (inner) wireless communication coil and the wireless charging coil that is greater than a minimum distance between the first (outer) wireless communication coil and the wireless charging coil, and therefore would have had good reason to implement that feature in the Kim-Shostak antenna. For example, in addition to Shostak's disclosure that selecting an appropriate separation prevents magnetic fields between the coils from interfering with each other—a well-

understood design consideration (Ex-1026, ¶¶[0049]-[0077])—such a skilled person would have understood that the magnetic fields are more concentrated in areas where the coil windings curve less gradually (e.g., in corners or where coil winding turns have a smaller diameter). (Ex-1010, 19:18-20:17, FIG. 8A.) Koyonagai teaches, for instance, that the separation distance between a charging coil 41 and an NFC coil 43 can be smaller along straight sides (d2) where the coil curves gradually (a large radius of the curve ("R")) than in the corners (d1) where R is small, because magnetic flux is concentrated where R is smaller. (*Id.*, 10:26-27, 19:18-67; FIG. 8a.)

FIG. 8A



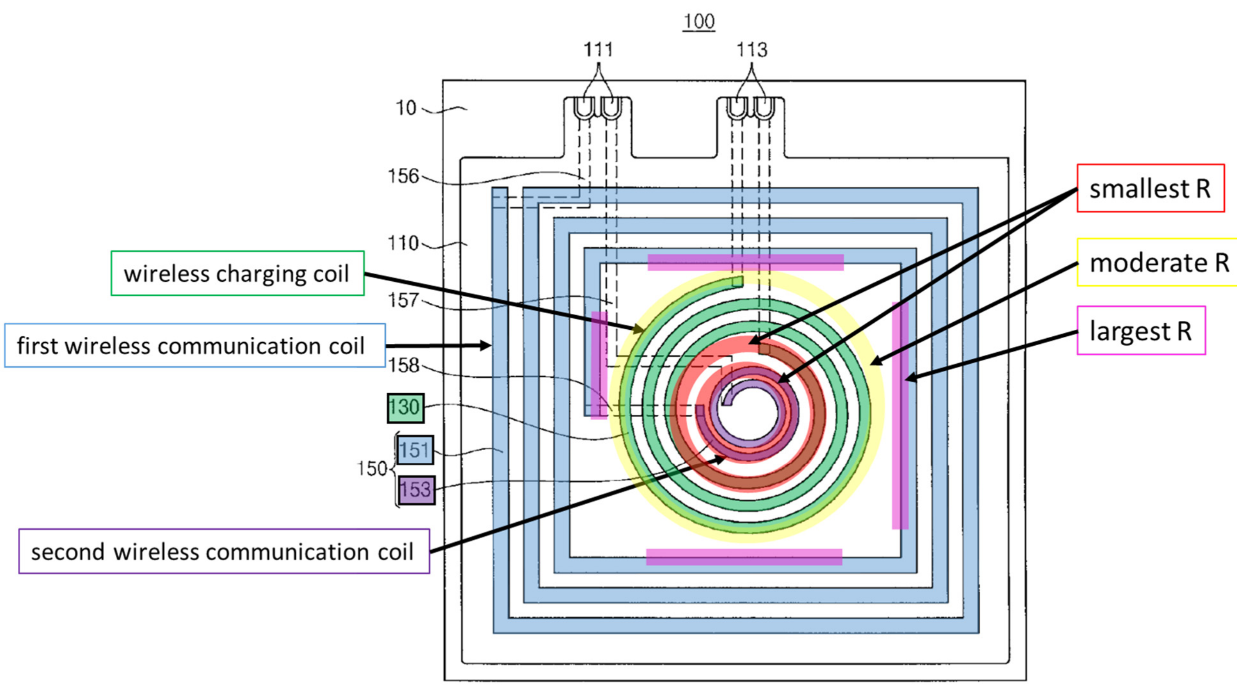
(*Id*., FIG. 8A.)

99. Koyanagi teaches that the antenna can be reduced in size by bringing the portions where flux is less concentrated close together (e.g., where R is large) (d2), but that the separation distance where R is small (d1) should be greater so that "a favorable balance can be achieved between a reduction in size, improvement of power transmission efficiency, and improvement of communication efficiency." (*Id*., 19:34-67.)

100. Shostak's disclosure that a minimum distance between the second (inner) wireless communication coil 316 and the wireless charging coil 502 is greater than a minimum distance between the first (outer) wireless communication coil 314 and the wireless charging coil 502 is consistent with Koyanagi's teachings. For instance, in FIG. 9, Shostak's wireless charging coil 502 is spaced further from the four corners of the inner communication coil 316, where R is small and flux is concentrated, than it is from the straight sides of the outer communication coil 314, where R is large and flux is less concentrated. (Ex-1006, FIG. 9, 10.) Similarly, in FIG. 10, the round inner communication 316 has a smaller R than the outer turns of the wireless charging coil 502, and is accordingly spaced further apart from the wireless charging coil than the straight sides of outer communication coil 314 that have a large R. (*Id.*)

101. Applying these teachings to Kim's antenna, a person of ordinary skill in the art would have had good reason to implement Shostak's relative spacing between the three coils. For example, such a skilled person would have understood that magnetic flux is more concentrated around second loop antenna pattern 153 ("second wireless communication coil") because it has a small R, and therefore it should be spaced further from the wireless charging coil 130 than the first loop antenna pattern 151 ("first wireless communication coil"), which—like Shostak—has straight sides in the area adjacent to the wireless charging coil such that flux is

not concentrated in those areas.[3] Using this spacing would achieve "a favorable balance ... between a reduction in size, improvement of power transmission efficiency, and improvement of communication efficiency" in Kim's antenna. (Ex-1010, 19:34-67.)



(Ex-1005, FIG. 1 (annotated to show the relative R where the coils are near each other: smallest R (red); moderate R (yellow), and the largest R (magenta).)

102. Furthermore, given that there are only three possible configurations—(1) the communication coils are equally spaced from the wireless charging coil, (2) the first communication coil is spaced further from the charging coil than the second communication coil, or (3) the second communication coil is spaced further from

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[3] The relative R is depicted in annotated Figure 1, below. (*Id.*)

the charging coil than the first communication coil—even without Shostak's disclosure of the optimal configuration or Koyanagi's teachings regarding why a person of ordinary skill in the art should select that configuration, such a skilled person would have had good reason to try the three options and select the best one for their application.

103. A person of ordinary skill in the art would have had a reasonable expectation of success. Such a person would have understood the impacts of adjusting the relative spacing between the coils, as I discussed above. It would have been well within such a person's ability to make such changes to Kim's antenna at least because there is nothing particularly complicated or difficult about adjusting the relative spacing between adjacent coils.

g) 17[f]: wherein a width of a winding of the second wireless communication coil is less than a width of a winding of the first communication coil.

104. Kim discloses or suggests this feature for the reasons discussed above for claim element 1[f]. (Section IX.A.1(g).)

3. Claim 18

a) The wireless antenna according to claim 17, wherein the first wireless communication coil and the second wireless communication coil have different shapes.

105. Kim discloses or suggests this feature for the reasons discussed above for claim 2. (Section IX.A.2(a).)

4. Claim 19

a) The wireless antenna according to claim 18, wherein a shape of the first wireless communication coil is a polygonal loop pattern, and wherein a shape of the second wireless communication coil is a circular loop pattern.

106. Kim discloses or suggests these features for the reasons discussed above for claim 3. (Section IX.A.3(a).)

5. Claim 20

a) The wireless antenna according to claim 17, wherein the first wireless communication coil and the second wireless communication coil have different curvatures.

107. Kim discloses or suggests this feature for the reasons discussed above for claim 4. (Section IX.A.4(a).)

6. Claim 21

a) The wireless antenna according to claim 17, wherein the wireless charging coil and the second wireless communication coil have corresponding curvatures.

108. Kim discloses or suggests this feature for the reasons discussed above for claim 5. (Section IX.A.5(a).)

7. Claim 22

a) The wireless antenna according to claim 17, wherein the number of windings of the second wireless communication coil is one.

109. Kim in combination with Shostak discloses or suggests this feature for the reasons discussed above for claim 6. (Section IX.B.1(a).)

8. Claim 25

a) The wireless antenna according to claim 17, wherein the wireless communication antenna further comprises a coil connection member traversing the wireless charging coil so as to interconnect the first wireless communication coil and the second wireless communication coil.

110. Kim discloses or suggests this feature for the reasons discussed above for claim element 1[d]. (Section IX.A.1(e).)

9. Claim 26

a) The wireless antenna according to claim 25, wherein the coil connection member is insulated from the wireless charging coil.

111. Kim discloses or suggests this feature for the reasons discussed above for claim 9. (Section IX.A.6(a).)

10. Claim 27

a) The wireless antenna according to claim 17, wherein the first wireless communication coil and the second wireless communication coil are connected to each other in series, and

112. Kim in discloses or suggests this feature for the reasons discussed above for claim element 10[a]. (Section IX.A.7(a).)

b) wherein the first wireless communication coil and the second wireless communication coil are wound in a same rotational direction of current.

113. Kim discloses or suggests this feature for the reasons discussed above for claim element 10[b]. (Section IX.A.7(b).)

11. Claim 28

a) The wireless antenna according to claim 17, wherein the wireless communication antenna and the wireless charging antenna are formed on a flexible printed circuit board.

114. Kim discloses or suggests this feature for the reasons discussed above for claim 11. (Section IX.A.8(a).)

12. Claim 29

a) The wireless antenna according to claim 28, wherein the flexible printed circuit board further comprises a connector connected to both the wireless communication antenna and the wireless charging antenna.

115. Kim discloses or suggests this feature for the reasons discussed above for claim 12. (Section IX.A.9(a).)

13. Claim 34

a) 34[pre]: A wireless antenna comprising:

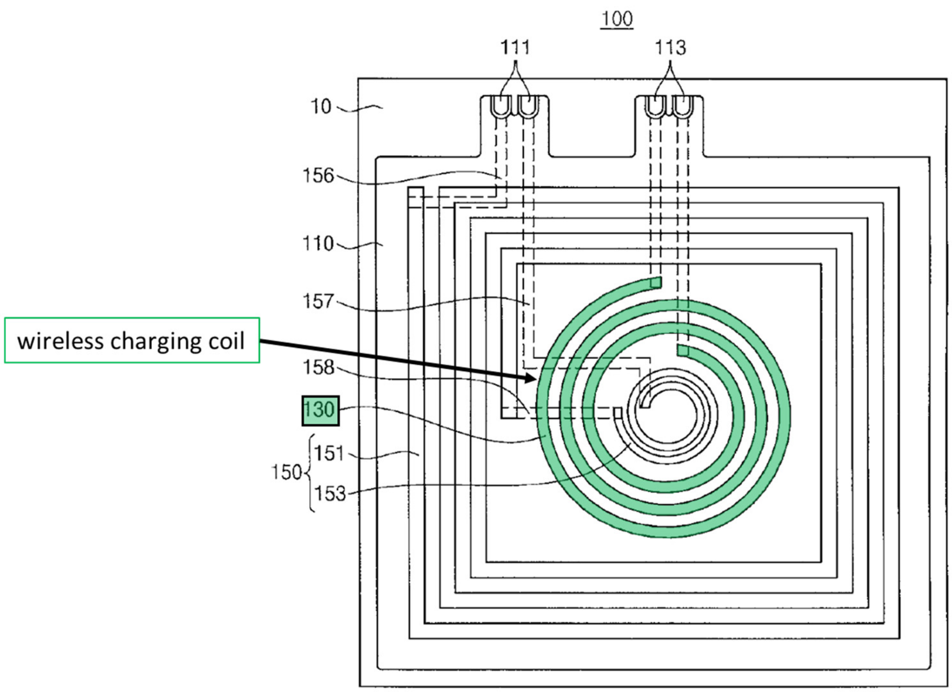
116. In my opinion, Kim discloses or suggests this feature for the reasons discussed for claim element 1[pre]. (Section IX.A.1(a).)

b) 34[a]: a wireless communication antenna comprising a first wireless communication coil having a polygonal loop pattern and a second wireless communication coil having a circular loop pattern; and

117. Kim discloses or suggests this feature for the reasons discussed for claim 3. (Section IX.A.3(a).)

c) 34[b]: a wireless charging antenna comprising a wireless charging coil having a circular loop pattern,

118. Kim discloses this feature. For instance, Kim discloses a non-contact power receiving coil unit 130 ("wireless charging antenna comprising a wireless charging coil") with a circular loop pattern (i.e., a spiral-shaped coil). (Section IX.A.5(a); Ex-1005, ¶[0028], FIG. 1.)



(Ex-1005, FIG. 1 (annotated).)

d) 34[c]: wherein the wireless charging coil is disposed inside the first wireless communication coil, and the second wireless communication coil is disposed inside the wireless charging coil,

119. Kim discloses or suggests this feature for the reasons discussed for claim element 1[c]. (Section IX.A.1(d).)

e) 34[d]: wherein the wireless communication antenna further comprises a coil connection member traversing the wireless charging coil so as to interconnect the first wireless communication coil and the second wireless communication coil,

120. Kim discloses or suggests this feature for the reasons discussed for claim element 1[d]. (Section IX.A.1(e).)

f) 34[e]: wherein a minimum distance between the second wireless communication coil and the wireless charging coil is greater than a minimum distance between the first wireless communication coil and the wireless charging coil, and

121. Kim in combination with Shostak discloses or suggests this feature for the reasons discussed for claim element 17[e]. (Section IX.B.2(f).)

g) 34[f]: wherein a width of a winding of the second wireless communication coil is less than a width of a winding of the first communication coil.

122. Kim discloses or suggests this feature for the reasons discussed for claim element 1[f]. (Section IX.A.1(g).)

14. Claim 35

a) The wireless antenna according to claim 34, wherein the first wireless communication coil and the second wireless communication coil have different curvatures.

123. Kim discloses or suggests this feature for the reasons discussed for claim 4. (Section IX.A.4(a).)

15. Claim 36

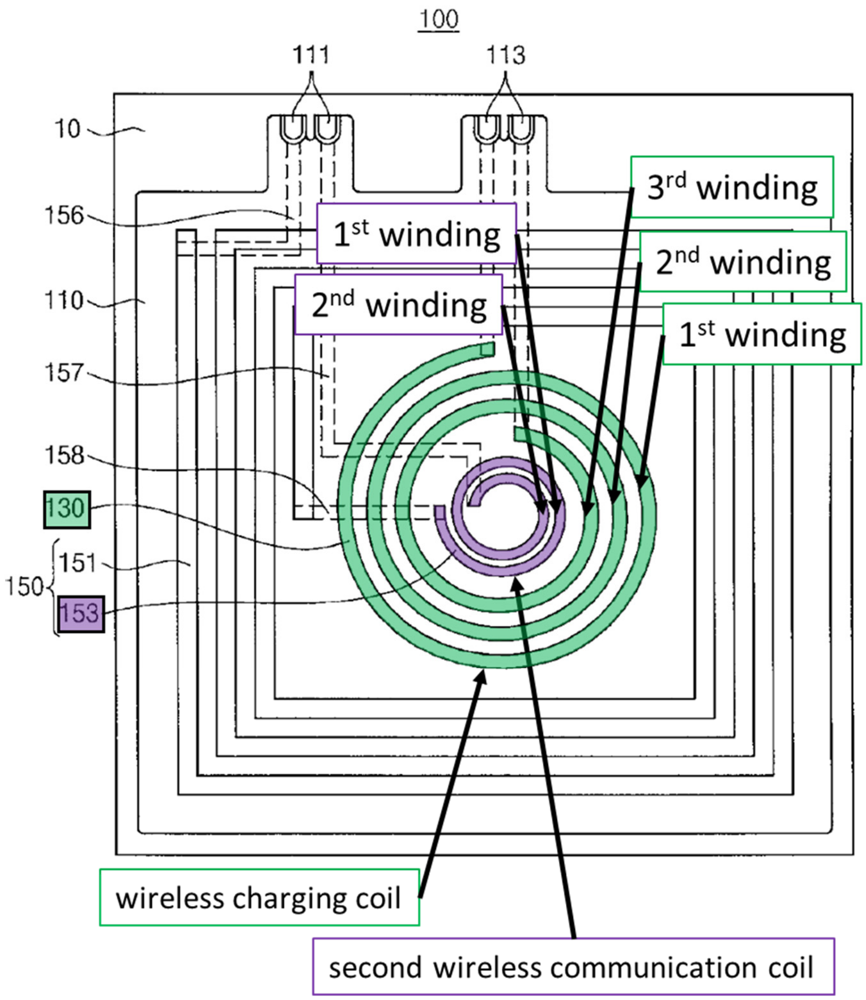
a) The wireless antenna according to claim 34, wherein the wireless charging coil and the second wireless communication coil have corresponding curvatures.

124. Kim discloses or suggests this feature for the reasons discussed for claim 5. (Section IX.A.5(a).)

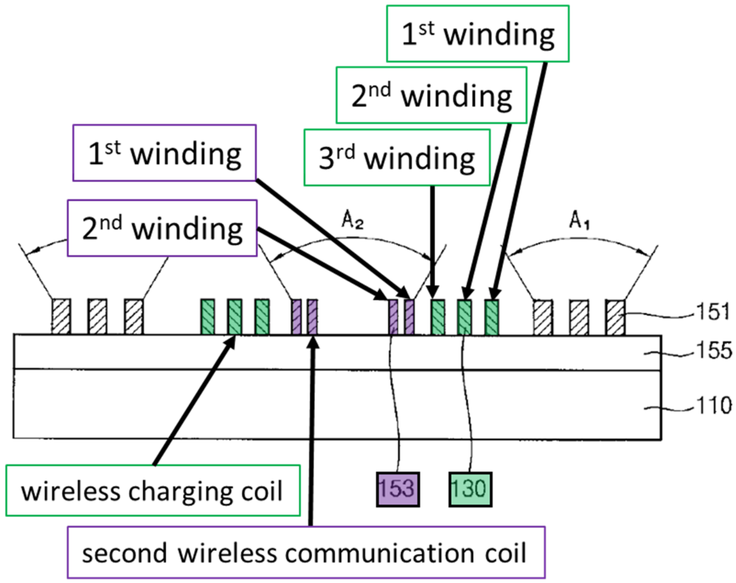
16. Claim 37

a) The wireless antenna according to claim 34, wherein a number of windings of the wireless charging coil is different from a number of windings of the second wireless communication coil.

125. Kim discloses or suggests this feature. For instance, Kim discloses that the non-contact power receiving coil unit 130 ("wireless charging coil") has three windings, and the second loop antenna pattern 153 ("the second wireless communication coil") has two windings. (Ex-1005, FIGs. 1, 2.) Three windings is a different number of windings than two windings. Annotated figures 1 and 2 below identify the respective number of windings in each coil.



(*Id*., FIG. 1 (annotated).)



(*Id.*, FIG. 2 (annotated).)

17. Claim 38

a) The wireless antenna according to claim 34, wherein a number of windings of the second wireless communication coil is one.

126. Kim in combination with Shostak discloses or suggests this feature for the reasons discussed for claim 6. (Section IX.B.1(a).)

18. Claim 39

a) The wireless antenna according to claim 34, wherein a number of windings of the second wireless communication coil is less than a number of windings of the wireless charging coil.

127. Kim discloses or suggests this feature for the reasons discussed for claim 37. (Section IX.B.16(a).) As I discussed, Kim discloses that the non-contact power receiving coil unit 130 ("wireless charging coil") has three windings, and the second loop antenna pattern 153 ("the second wireless communication coil") has

two windings. (Ex-1005, FIG. 1; Section IX.B.16(a).) Two windings is less than three windings.

19. Claim 42

a) The wireless antenna according to claim 34, wherein the coil connection member is insulated from the wireless charging coil.

128. Kim discloses or suggests this feature for the reasons discussed for claim 9. (Section IX.A.6(a).)

20. Claim 43

a) The wireless antenna according to claim 34, wherein the first wireless communication coil and the second wireless communication coil are connected to each other in series, and

129. Kim discloses or suggests this feature for the reasons discussed for claim element 10[a]. (Section IX.A.7(a).)

b) wherein the first wireless communication coil and the second wireless communication coil are wound so as to have a same rotational direction of current.

130. Kim discloses or suggests this feature for the reasons discussed for claim element 10[b]. (Section IX.A.7(b).)

21. Claim 44

a) The wireless antenna according to claim 34, wherein the wireless communication antenna and the wireless charging antenna are formed on a flexible printed circuit board.

131. Kim discloses or suggests this feature for the reasons discussed for claim 11. (Section IX.A.8(a).)

22. Claim 45

a) The wireless antenna according to claim 44, wherein the flexible printed circuit board further comprises a connector connected to both the wireless communication antenna and the wireless charging antenna.

132. Kim discloses or suggests this feature for the reasons discussed for claim 12. (Section IX.A.9(a).)

23. Claim 51

a) The wireless antenna according to claim 17, wherein each of the windings of the first communication coil has a width that is greater than the width of the winding of the second wireless communication coil.

133. Kim discloses or suggests this feature for the reasons discussed for claim 50. (Section IX.A.10(a).)

24. Claim 52

a) The wireless antenna according to claim 34, wherein each of the windings of the first communication coil has a width that is greater than the width of the winding of the second wireless communication coil.

134. Kim discloses or suggests this feature for the reasons discussed for claim 50. (Section IX.A.10(a).)

C. Kim in Combination with Kim ’681 Discloses or Suggests the Features of Claims 7 and 8

1. Claim 7

a) The wireless antenna according to claim 1, wherein a number of windings of the wireless charging coil is greater than the number of windings of the first wireless communication coil.

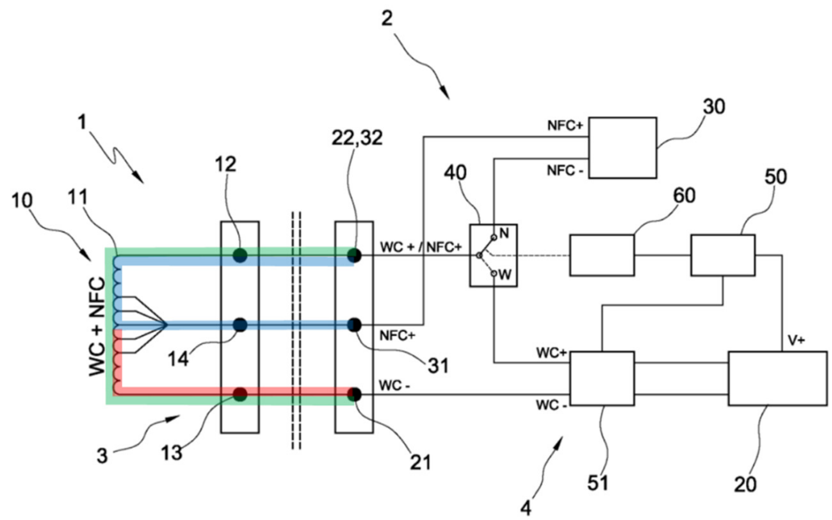
135. Kim in combination with Kim ’681 discloses or suggests this feature. As I discussed above in Sections IX.A.1(a)-(c), Kim discloses a wireless antenna including non-contact power receiving coil unit 130 (“wireless charging coil”) and first loop antenna pattern 151 (“first wireless communication coil”). (Sections IX.A.1(a)-(c); Ex-1005, ¶¶[0026], [0031].) Kim does not explicitly disclose that non-contact power receiving coil unit 130 has a greater number of windings than loop antenna pattern 151, but Kim ’681 discloses that a wireless charging coil may have more windings than a wireless communication coil. Thus, in my opinion, a person of ordinary skill in the art would have had good reason to combine the teachings of Kim and Kim ’681 to implement Kim’s antenna having a greater number of windings of the wireless charging coil than the number of windings of the first wireless communication coil.

136. Kim ’681, like Kim, relates to an antenna for wireless charging and near field wireless communication. (Ex-1007, ¶[0001].) Therefore, a person of ordinary skill in the art implementing Kim’s antenna would have had reason to look to Kim ’681. Kim ’681 describes a single-coil antenna capable of both wireless charging

and near-field communication, where a portion of the coil antenna is used for near-field wireless communication, and the entire coil antenna is used for wireless charging. (*Id*., Abstract, ¶¶[0019]-[0021], [0044]-[0046].)

137. Kim ’681 teaches that all windings of coil antenna 10 (between terminal 12 and terminal 13; path highlighted green in figure 2 below) are used for wireless charging. (*Id*., ¶[0046] (“[T]he coil unit (11) between the first terminal (12) and the second terminal (13) is formed to have a characteristic of generating an induced electromotive force of a frequency (300 kHz) for relatively long **non-contact charging**”) (emphasis added), ¶[0059].) However, only a subset of the coil windings (between terminal 12 and 14; path highlighted blue) are used for wireless communication. (*Id.* (“[T]he coil unit (11) between the first terminal (12) and the third terminal (14) generates an induced electromotive force of a relatively short frequency (13.56 MHz) for **NFC**.”) (emphasis added), ¶[0060].)

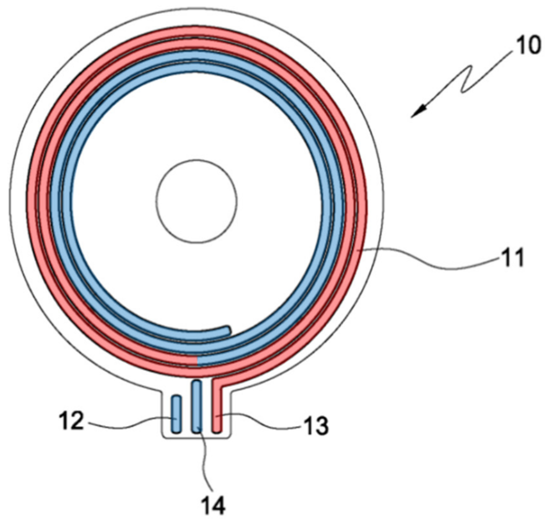
Fig. 2



(*Id*., FIG. 2 (annotated).)

138. Kim '681's coil antenna unit 10 is illustrated below in annotated Figure 1. As annotated, the coil antenna is divided into red and blue sections to illustrate how only the portion between terminals 12 and 14 (blue section)—fewer than all windings—are used for wireless communication, whereas the portion between terminals 12 and 13 (red and blue sections together)—all windings—are used for wireless charging. (*Id*., ¶¶[0044]-[0046].) Note that the highlighting in annotated figure 1, below, is not intended to represent the precise division of the coil windings used for communication versus charging. Instead, it generally illustrates Kim '681's teaching that a portion of the coil is used for communication (blue), and the entire coil is used for wireless charging (blue and red together).

Fig. 1

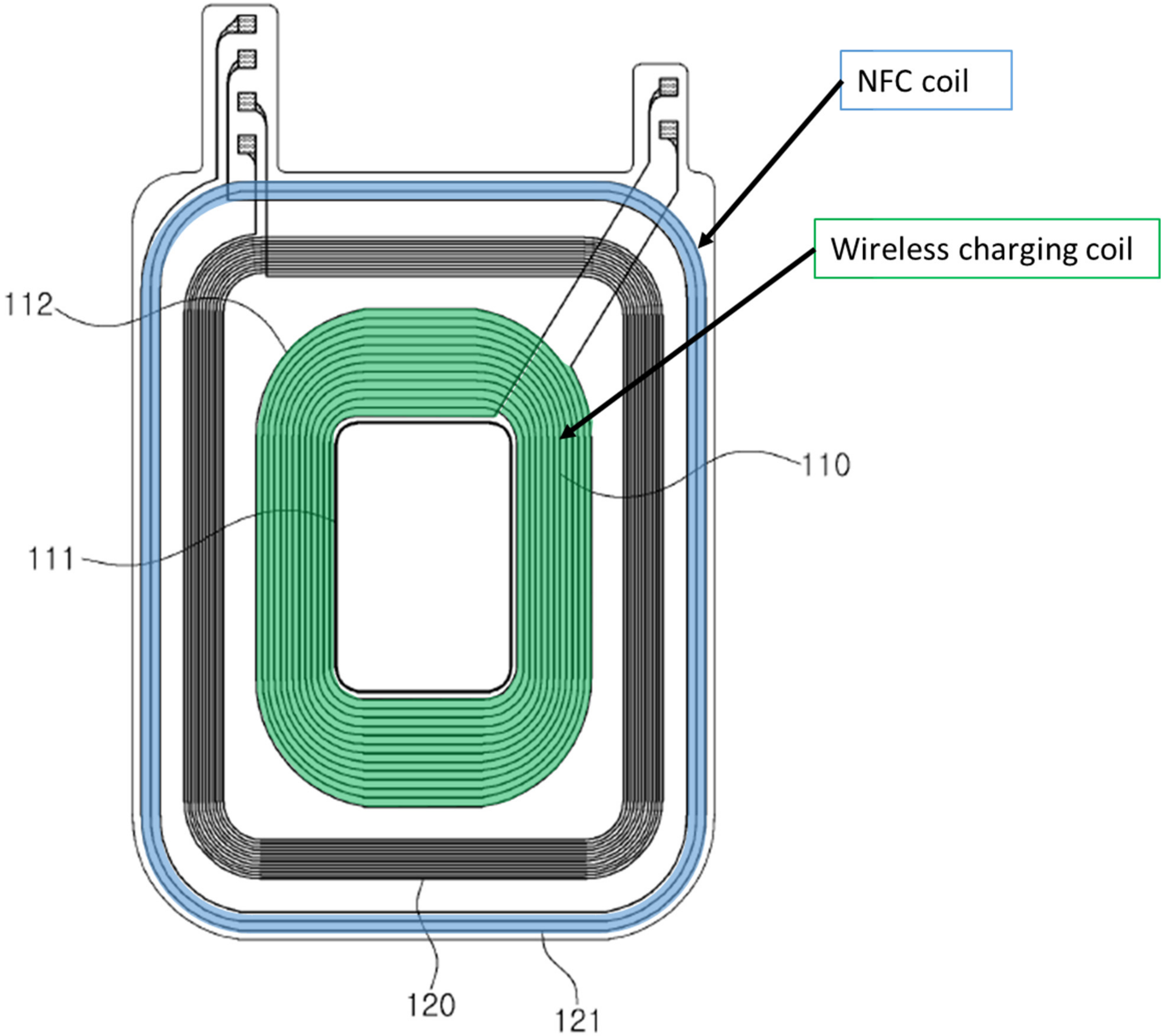


(*Id*., FIG. 1 (annotated).)

139. A person of ordinary skill in the art would have had good reason to modify Kim's antenna based on Kim '681 such that the wireless charging coil has more windings than the first wireless communication coil. As taught by Kim '681, using a greater number of coil windings for wireless charging than for wireless communication ensures that the antenna functions properly (e.g., is able to generate an induced electromotive force) during both near field communication and wireless charging. (*Id*., ¶[0046].) Although Kim '681 concerns using different sections of the same coil, a person of ordinary skill in the art would have understood that its teachings regarding the respective number of coil windings needed for charging and communication are equally applicable to two different coils.

140. In fact, it was well-understood at the time of the filing of the patent that a wireless charging coil may have more windings than a near-field communication

coil like Kim and Kim '681's communication coils. (Ex-1025, ¶¶[0018], [0101], [0102] ("For example, the number of windings of the inside first wireless communications coil 120 is larger than that of the outermost second [NFC] wireless communications coil 121, and the number of windings of the inside power receiving coil 110 is larger than that of the first wireless communications coil 120."), FIG. 11; Ex-1006, FIGs. 5-10; Ex-1009, FIGs. 3, 18-20, 25; Ex-1018, FIGs. 3-6; Ex-1024, FIGs. 3, 4.)



(Ex-1025, FIG. 11 (annotated) (showing wireless charging coil 110 with 13 windings and NFC coil 121 with three windings).)

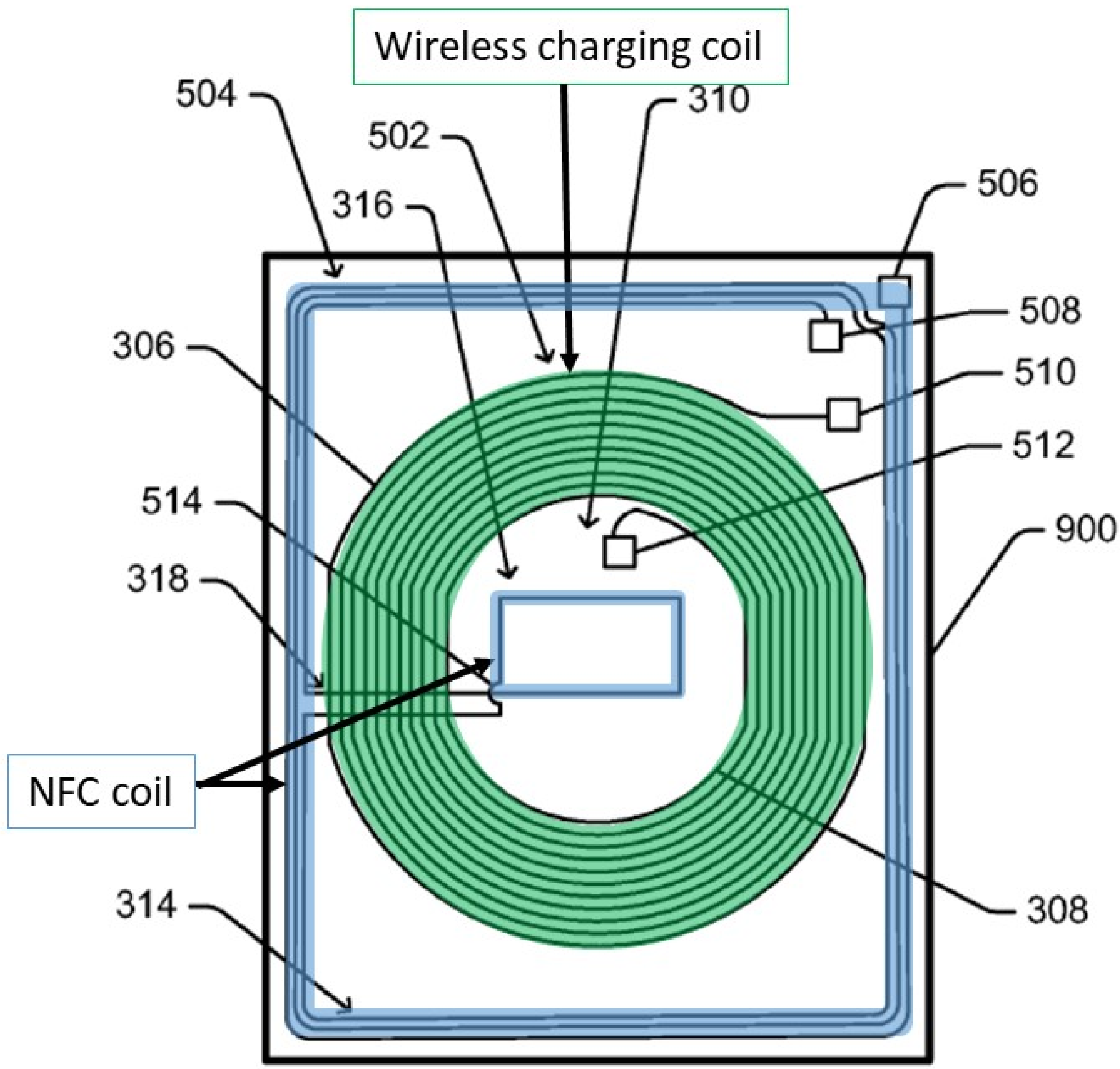


FIG. 9

(Ex-1006, FIG. 9 (annotated) (showing wireless charging coil 306 with 11 windings, and two-part NFC coil 504 (comprising 314, 316) with 4 total windings—3 outside the charging coil and 1 inside the charging coil); *see also id*. 1:58-61, 5:10-19, 5:45-

56, 9:58-66 ("The antenna apparatus 900 includes a wireless charging antenna that is the wireless charging coil 502 having the outer periphery 306 (e.g., the outer loop of the wireless charging coil 502) and the inner boundary 308 (e.g., the inner loop of the wireless charging 502). The antenna apparatus 900 also includes a wireless communication antenna that is the wireless communication coil 504 (e.g., the antenna 304 of FIG. 3) including portions 314, 316, and 318.").)

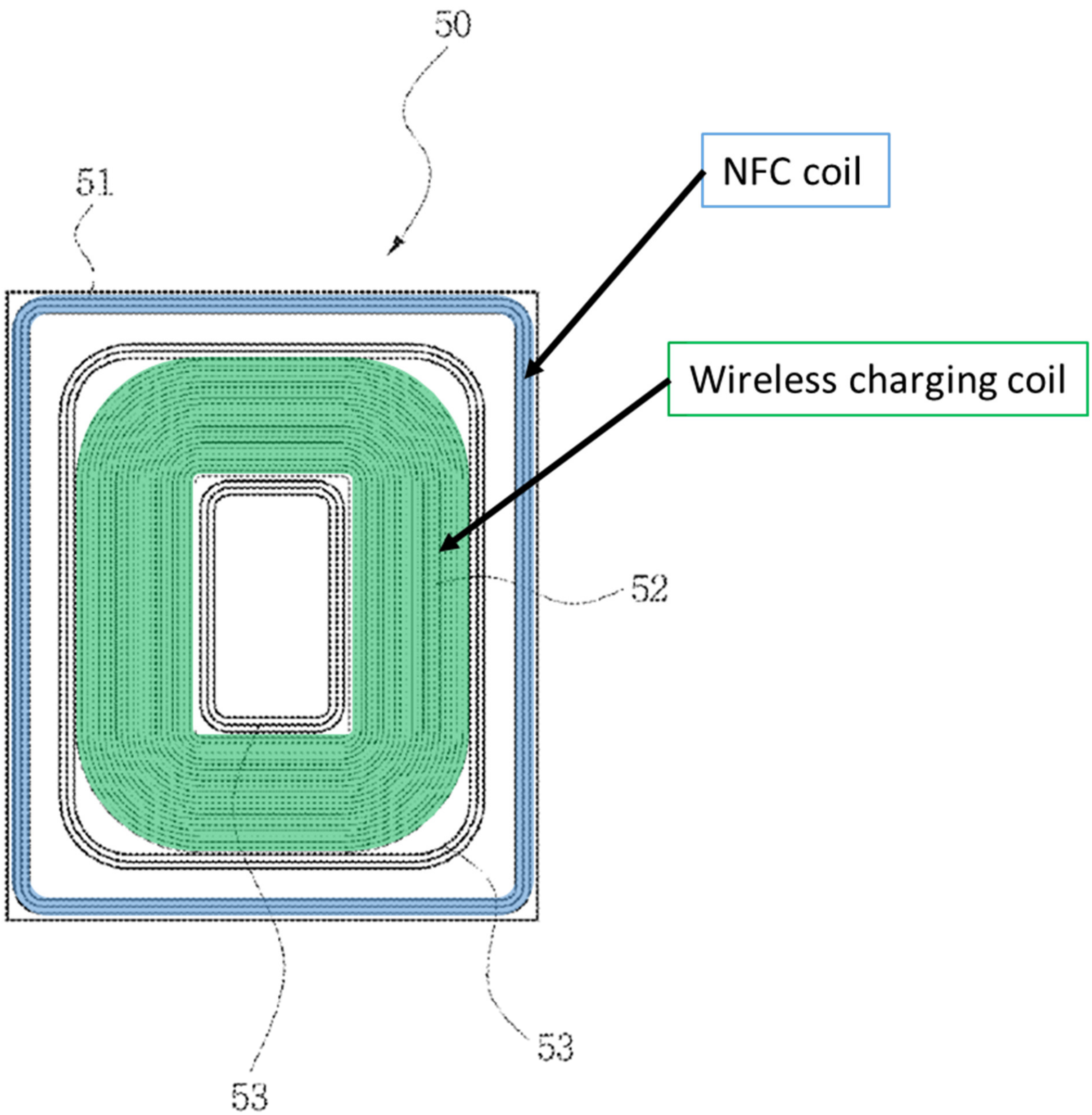


Fig. 3

(Ex-1009, FIG. 3 (annotated) (showing wireless charging coil 52 with approximately 20 windings and NFC coil 51 with 3 windings); *see also id*. 2:51-61, 5:54-56 ("as shown in FIG. 3a, the NFC coil 51 is provided at the outermost side to be the largest coil, and the WPC coil 52 [] are provided inside thereof.”).)

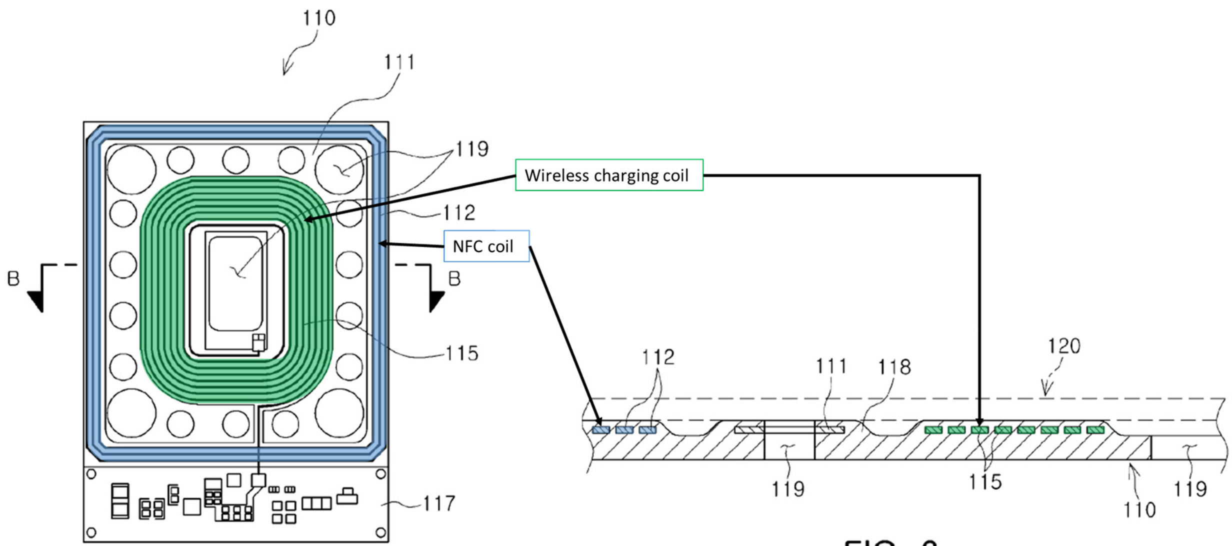
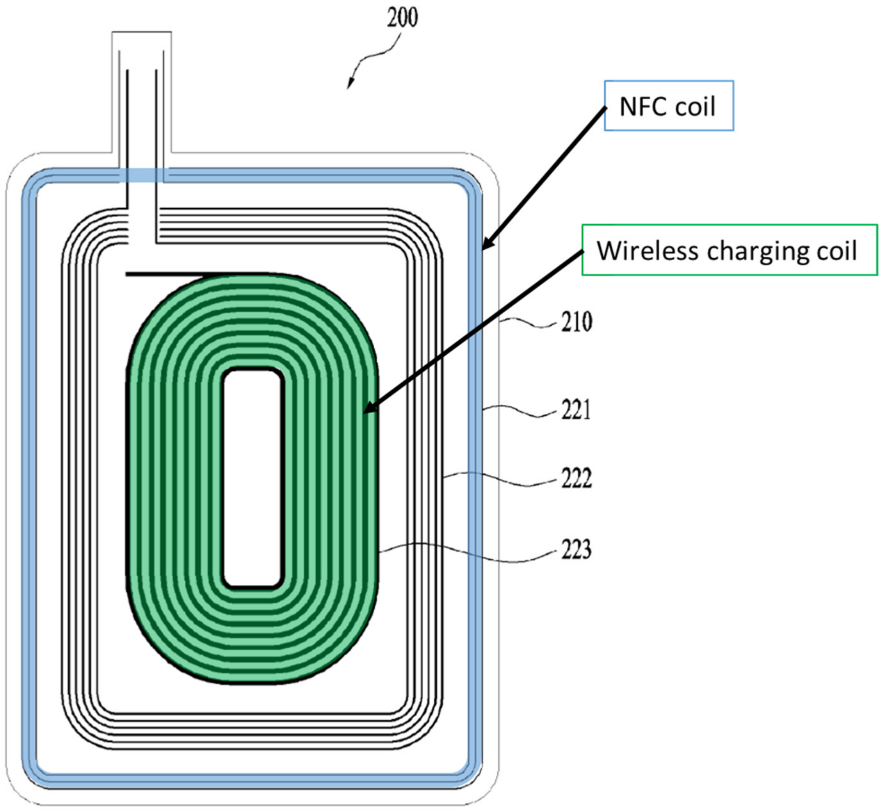


FIG. 5

FIG. 6

(Ex-1018, FIGs. 5-6 (annotated) (showing wireless charging coil 115 with 8 windings and NFC coil 112 with 3 windings), 5:45-49 (“The antenna 112 according to the present embodiment may be an antenna used in near field communications (NFC).”), 5:57-67 (“the coil pattern 115 for wireless charging”).)



(Ex-1024, FIG. 3 (showing wireless charging coil 223 with 9 windings and NFC coil 221 with 3 windings); *see also id*. 12:8-13 ("The first coil 221 may use NFC (Near Filed Communication)."), 13:4-10 ("The third coil 223 is arranged in the center of the coil arrangement area and used as an electric power receiving coil for wireless electric power receiving, i.e. wireless charging."), 14:5-9 ("The number of the first coil [(NFC coil)] windings is the smallest and the number of the third coil [(wireless charging coil)] windings is the largest.").)

141. Therefore, in view of Kim '681, a person of ordinary skill in the art would have had good reason to select an appropriate number of windings for the first wireless communication coil and the wireless charging coil, where the wireless

charging coil has more windings than the first wireless communication coil. Furthermore, Kim's first wireless communication coil 151 is part of its wireless communication antenna 150, which is for near field communication. (*See*, *e.g.*, Ex-1005, ¶[0030] ("loop antenna unit (150) enables near field communication").) In accordance with Kim '681's teachings that I discussed above, Kim's entire wireless communication antenna 150 (the "first wireless communication coil" 151 and the "second wireless communication coil" 153, combined) may have fewer windings than the wireless charging coil 130. Thus, a person of ordinary skill in the art would have understood that the first wireless communication coil, itself a portion of the wireless communication antenna, may have fewer windings than the wireless charging coil.

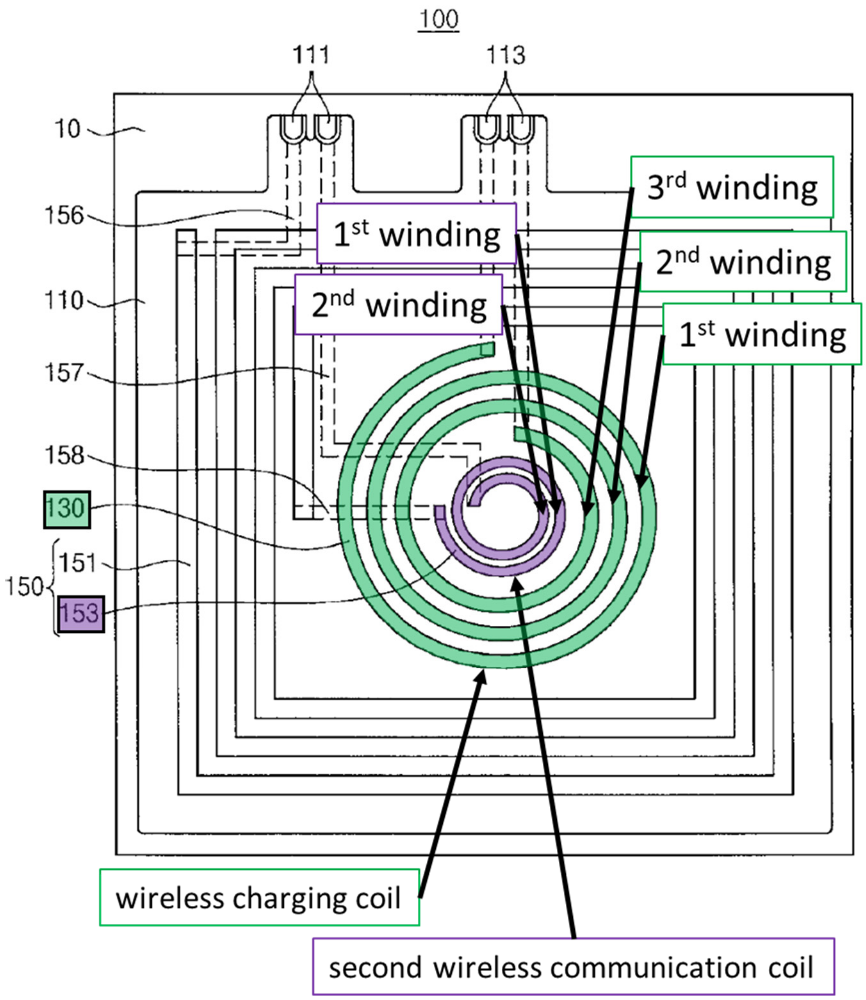
142. A person of ordinary skill in the art would have had a reasonable expectation of success in modifying the number of windings in Kim's coils at least because such a person would have been well aware of the effects of varying the number of windings of a wireless charging coil and an NFC coil, and would have been capable of tuning the antennas for those applications by selecting an appropriate number of windings. (*See, e.g.*, Ex-1011, ¶¶[0139], [0162]-[0163], FIG. 20 (describing how inductance and resistance of an NFC coil changes with the number of windings); Ex-1016, 1277-78 (describing how inductance of a wireless

charging coil changes with the number of windings).) Additionally, there is nothing particularly difficult about changing the number of coil windings in Kim's antennas.

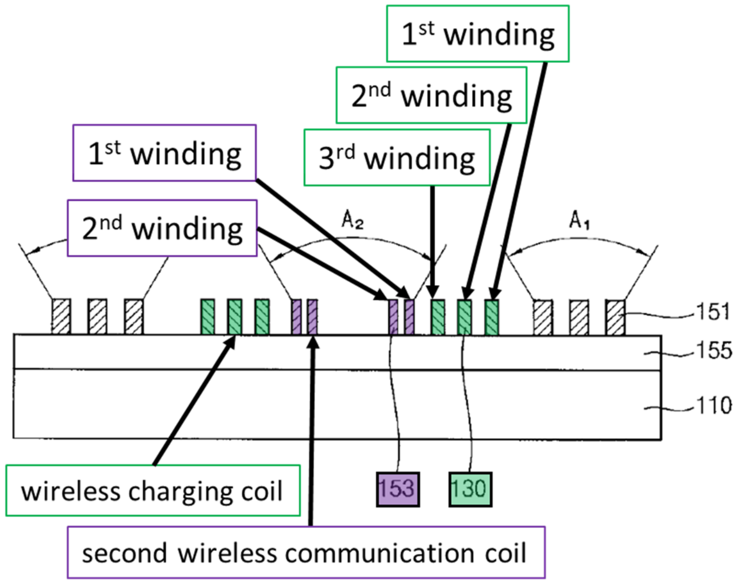
2. Claim 8

a) The wireless antenna according to claim 7, wherein the number of windings of the wireless charging coil is greater than the number of windings of the second wireless communication coil.

143. Kim discloses or suggests this feature. For instance, Kim discloses that the non-contact power receiving coil unit 130 ("wireless charging coil") has three windings, and the second loop antenna pattern 153 ("the second wireless communication coil") has two windings. (Ex-1005, FIGs. 1, 2.) Three windings is a greater number of windings than two windings. Annotated figures 1 and 2 below identify the respective number of windings in each coil.



(Ex-1005, FIG. 1 (annotated).)



(Ex-1005, FIG. 2 (annotated).)

D. Kim in Combination with An Discloses or Suggests the Features of Claims 12, 29, and 45

1. Claim 12

a) The wireless antenna according to claim 11, wherein the flexible printed circuit board further comprises a connector connected to the wireless communication antenna and to the wireless charging antenna.

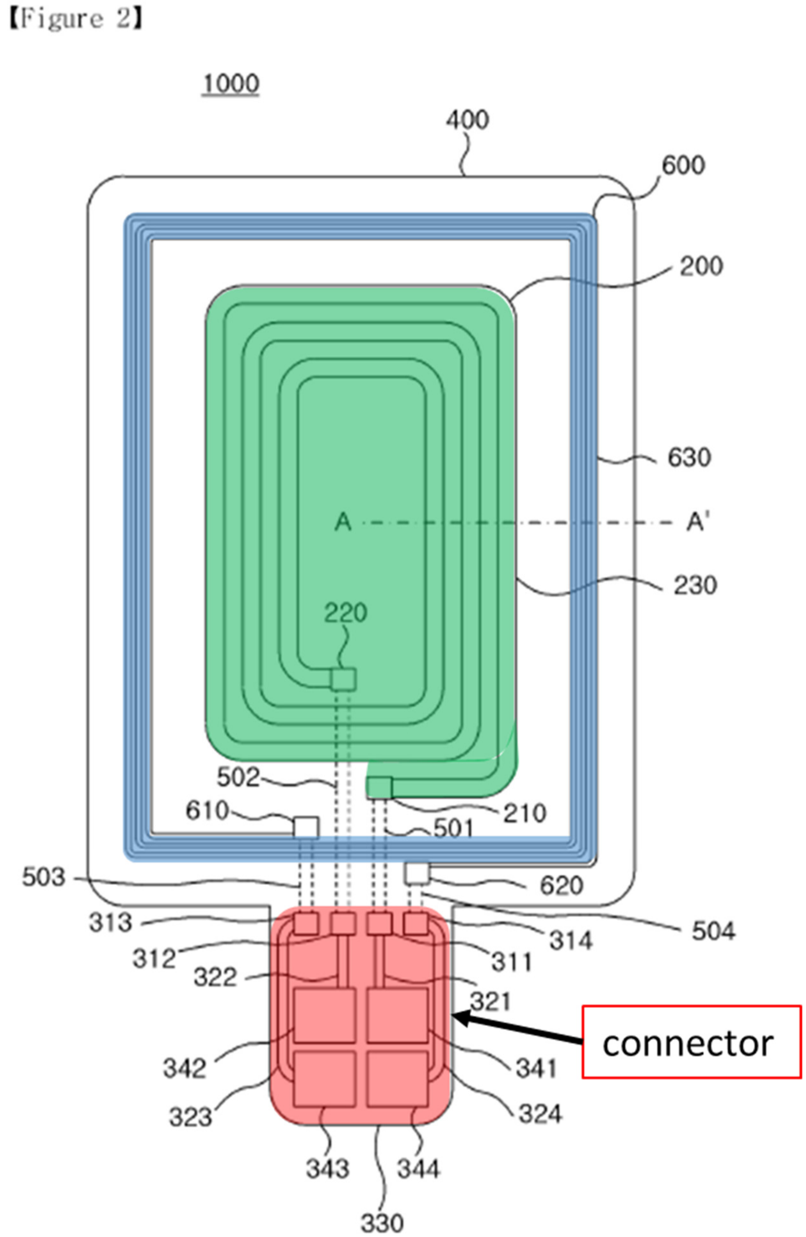
144. As I discussed above in Section IX.A.9(a), Kim discloses this feature. I have been asked to assume, however, that Kim does not disclose this feature. Under that assumption, it is my opinion that Kim in combination with An discloses or suggests this feature. An discloses an antenna having a connector disposed on a flexible printed circuit board that is connected to a wireless communication antenna and a wireless charging antenna, and, in view of An, a person of ordinary skill in the art would have had good reason to implement a similar connector in Kim's antenna.

145. Similar to Kim, An discloses an antenna assembly 1000 ("wireless antenna") including an inner antenna 200 which may be a wireless charging antenna and an outer antenna 600 which may be a near field communication antenna. (Ex-1008, ¶[6] ("[T]here is provided an antenna assembly including a substrate, and a wireless charge antenna pattern on the substrate."), ¶[7] ("The antenna assembly may further include a wireless communication antenna pattern formed on the substrate and provided at an outside of the wireless charge antenna pattern."), ¶¶[64]-[66], [70] ("The substrate 400 may include a printed circuit board (PCB), or a flexible printed circuit board (FPCB)."), [71]-[72], FIGs. 2, 3.)

146. An further discloses a substrate 330, which is a flexible printed circuit board, including contact portion 300 ("connector"), which may be integrally formed with the flexible printed circuit board 400 on which the charging and communication coils are disposed. (Ex-1008, ¶¶[70], [82]-[83], [85].) Connector 300 includes connection terminals 310, connection conductive wires 320, and contact terminals 340 ("connector") as a "conductive pattern" that is "formed on the substrate (330)." (*Id*., ¶¶[70], [82], [83] ("The substrate 330 may include a printed circuit board or a flexible circuit board."), FIG. 2.)

147. As shown in annotated figure 2 below, connection terminals 310 (first to fourth connection terminals 311 to 314), connection conductive wires 320 (including first to fourth connection conductive wires 321 to 324), and contact

terminals 340 (including first to fourth contact terminals 341 to 344) together form a connector, with contact terminals 343 and 344 connected to the wireless communication antenna 600 and contact terminals 341 and 342 connected to the wireless charging antenna 200. (*Id.*, ¶[76], FIG. 2.) The first to fourth contact terminals (341 to 344) are each electrically connected to the corresponding first to fourth connectors (311 to 314) through the first to fourth connection conductive lines (321 to 324). (*Id.*, ¶[81].)



(*Id.*, FIG. 2 (annotated).)

148. An "provides an antenna assembly including an antenna, wirelessly charged, having a thinned thickness." (*Id.*, ¶[5].) An explains that "the antenna assembly 1000 may be buried in a back cover of the terminal device," and "[w]hen the back cover of the terminal device is coupled to the terminal device, the antenna

assembly 1000 may be electrically connected to the terminal device through the contact part 300 of the antenna assembly 1000." (*Id.*, ¶[68].) An explains that "if a back cover of the terminal device is coupled to the terminal device," the wireless charge antenna 200 "may be electrically connected to the battery of the terminal device through the first and second contact terminals 341 and 342," and the wireless communication antenna 600 "may be electrically connected to the wireless communication module of the terminal device through the contact terminals 343 and 344" of the connector 300. (*Id.*, ¶[86].) Kim explains that its antenna, like An's, is typically "installed on the battery cover" of a mobile phone and thus would be connected to circuitry within the phone. (Ex-1005, ¶¶[0006] ("as the charging circuit to which the antenna is connected became miniaturized and incorporated into the body of the mobile phone, only the antenna (unit) remains on the battery cover"), [0009].) Therefore, An's connector 300 would perform the same function in Kim's antenna (facilitating a connection between the antenna and circuitry on other components in a mobile device) to achieve the same result (an electrical connection between the communication and charging coils and the mobile device).

149. A person of ordinary skill in the art would have had good reason to modify Kim's antenna with An's connector. Such a person would have had a reasonable expectation of success, as there is nothing particularly difficult or challenging about adding additional connection lines and terminals to Kim's

antenna, making it predictable and well within a such a person's skill. In fact, Kim's terminals 111 and 113 are the similar to An's first to connection terminals 311 to 314. Thus, to the extent Kim does not already disclose the claimed connector, a person of ordinary skill in the art would have only needed to add An's conductive lines 321 to 324, and contact terminals 341 to 344, or a similar structure to Kim's flexible printed circuit board to form a "connector," as disclosed by An.

150. A person of ordinary skill in the art would have had good reason to make such a modification. For instance, An discloses that the antenna assembly may be buried in the back cover of a device, and when coupled to the device, the contact terminals (i.e., the connector) make an electric connection to the device. (*Id.*, ¶[68].) A connector having all connection terminals located in the same place would make it easier to connect the antenna to the mobile device. An also explains that connecting antennas to its connector simplifies the antenna fabrication process. (*Id.*, ¶[12] ("[A]ccording to the embodiment, the inner terminal of the spiral antenna pattern is connected to the connector provided at the outside of the spiral antenna pattern through the conductive bridge, **so that the fabrication process of the antenna assembly can be simplified**.") (emphasis added).) Thus, such a skilled person would have appreciated the benefits of using An's connector, and had good reason to form a convenient single connector on Kim's flexible printed circuit board.

2. Claim 29

a) The wireless antenna according to claim 28, wherein the flexible printed circuit board further comprises a connector connected to both the wireless communication antenna and the wireless charging antenna.

151. Kim in view of An discloses or suggests this feature for the reasons discussed for claim 12. (Section IX.D.1.)

3. Claim 45

a) The wireless antenna according to claim 44, wherein the flexible printed circuit board further comprises a connector connected to both the wireless communication antenna and the wireless charging antenna.

152. Kim in view of An discloses or suggests this feature for the reasons discussed for claim 12. (Section IX.D.1.)

E. Kim in Combination with Shostak and Kim '681 Discloses or Suggests the Features of Claims 23, 24, 40, and 41

153. Claims 23, 24, 40, and 41 recite the same features recited in claims 7 and 8, the features of which, as I discussed above in Section IX.C, are discloses or suggested based on the combination of Kim and Kim '681. For the same reasons I discuss in section IX.C, the Kim-Shostak combination in further view of Kim '681 discloses or suggests the features of claims 23, 24, 40, and 41, because the inclusion of Shostak's teachings does not detract from the modification based on Kim '681.

1. Claim 23

a) The wireless antenna according to claim 17, wherein a number of windings of the wireless charging coil is greater than the number of windings of the first wireless communication coil.

154. Kim in combination with Kim '681 discloses or suggests this feature for the reasons discussed for claim 7. (Section IX.C.1(a).)

2. Claim 24

a) The wireless antenna according to claim 23, wherein the number of windings of the wireless charging coil is greater than the number of windings of the second wireless communication coil.

155. Kim in combination with Kim '681 discloses or suggests this feature for the reasons discussed for claim 8. (Section IX.C.2(a).)

3. Claim 40

a) The wireless antenna according to claim 39, wherein the number of windings of the wireless charging coil is greater than a number of windings of the first wireless communication coil.

156. Kim in combination with Kim '681 discloses or suggests this feature for the reasons discussed for claim 7. (Section IX.C.1(a).)

4. Claim 41

a) The wireless antenna according to claim 40, wherein the number of windings of the wireless charging coil is greater than the number of windings of the second wireless communication coil.

157. Kim in combination with Kim ’681 discloses or suggests this feature for the reasons discussed for claim 8. (Section IX.C.2(a).)

F. Shostak in Combination with Kim Discloses or Suggests the Features of Claims 1-12, 17-29, 34-45, and 50-52

1. Claim 1

a) 1[pre]: A wireless antenna comprising:

158. I have been asked to assume the preamble of claim 1 is limiting. Under that assumption, it is my opinion that Shostak discloses the features therein. For instance, Shostak discloses “antenna apparatus 900” (“wireless antenna”), which “includes a wireless charging antenna that is the wireless charging coil 502,” and “a wireless communication antenna that is the wireless communication coil 504 (e.g., the antenna 304 of FIG. 3) including portions 314, 316, and 318.” (Ex-1006, 9:55-66.) Annotated figure 9 below shows the wireless antenna 900 (red), wireless charging coil 502 (green), and wireless communication coil 504 (blue).

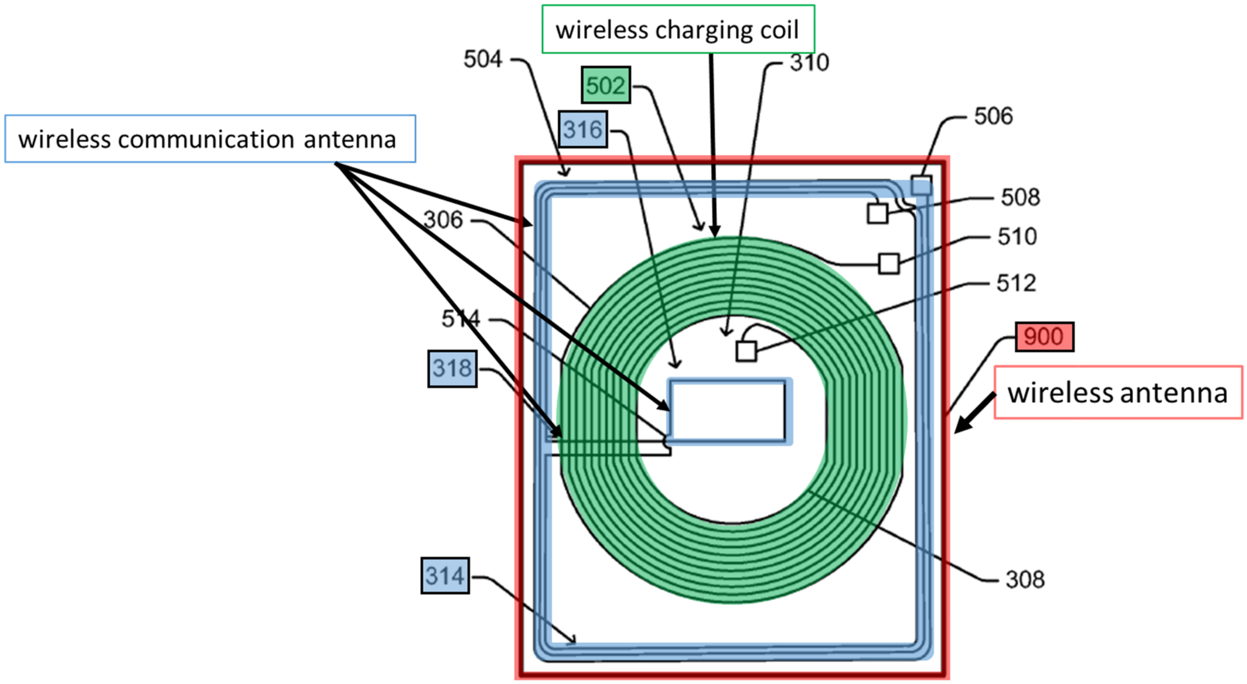


FIG. 9

(*Id.*, FIG. 9 (annotated).)

159. Shostak discloses a "computing device having multiple co-located antennas" which "supports both wireless communication (e.g., near field communication (NFC)) and wireless charging (WC)." (Ex-1006, 1:58-61.) Shostak further explains that "[e]ach antenna is a coil that is located at a particular area (e.g., a central area) of a housing of the computing device," and that a "first portion of a second coil of the multiple coils is positioned about the outer periphery of the first coil, a second portion of the second coil is positioned within the inner boundary of

the first coil, and a third portion of the second coil traverses the first coil and interconnects the first and second portions of the second coil." (*Id*., 2:11-22.)

b) 1[a]: a wireless communication antenna comprising a first wireless communication coil and a second wireless communication coil; and

160. Shostak discloses this feature. For instance, Shostak discloses "a wireless communication antenna that is the wireless communication coil 504" ("a wireless communication antenna"). (Ex-1006, 9:64-65, FIG. 9.) Shostak's wireless communication antenna includes an outer coil portion 314 ("first wireless communication coil"), an inner coil portion 316 ("second wireless communication coil"), and portion 318 which connects the outer and inner portions 314, 316. (*Id*., 9:55-66.) Annotated figure 9 below shows outer coil portion 314 ("first wireless communication coil") (blue) positioned around a wireless charging antenna 502 and inner coil portion 316 ("second wireless communication coil") (purple) disposed inside of wireless charging antenna 502.

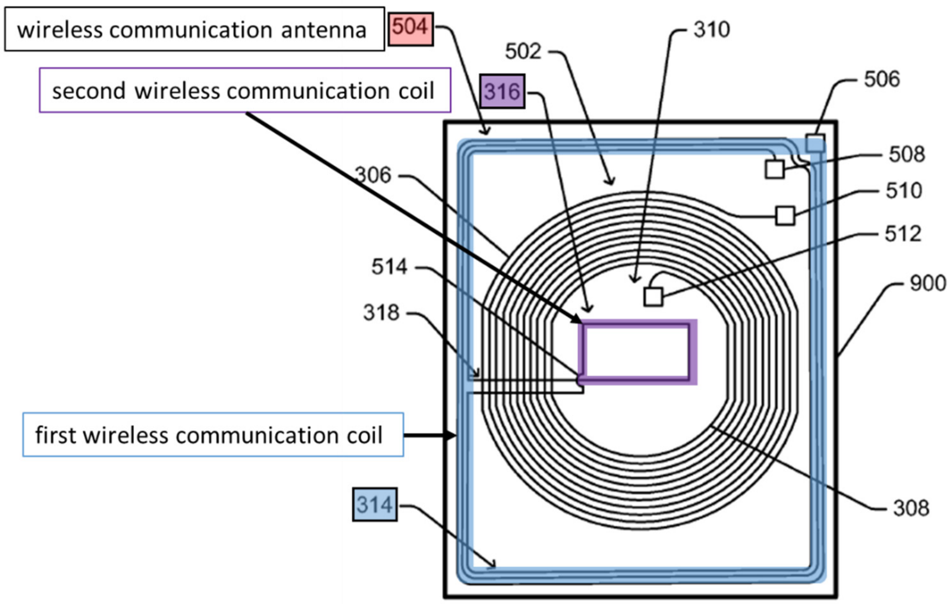


FIG. 9

(Ex-1006, FIG. 9 (annotated).)

c) 1[b]: a wireless charging antenna comprising a wireless charging coil,

161. Shostak discloses this feature. For instance, Shostak discloses "a wireless charging antenna that is the wireless charging coil 502." (Ex-1006, 9:58-60.) Annotated figure 9 below shows wireless charging coil 502.

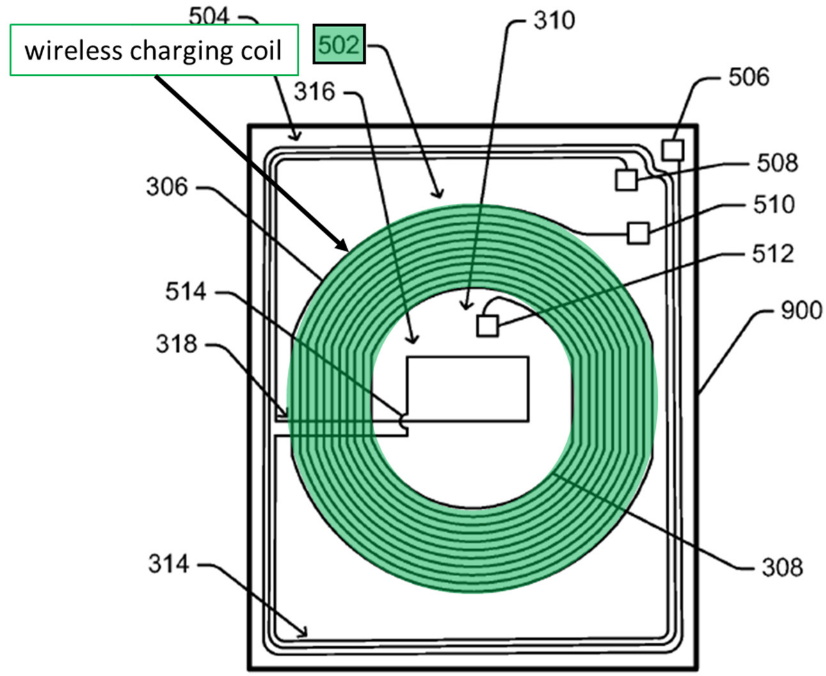


FIG. 9

(*Id.*, FIG. 9 (annotated).)

d) 1[c]: wherein the wireless charging coil is disposed inside the first wireless communication coil, and the second wireless communication coil is disposed inside the wireless charging coil,

162. Shostak discloses this feature. For instance, Shostak discloses "an example antenna apparatus 900 in which multiple antennas are co-located." (Ex-1006, 9:55-57, FIG. 9.) Shostak discloses that the wireless charging antenna 302 (502 in FIG. 9) ("wireless charging coil") is positioned between the outer portion 314 ("first wireless communication coil") and the inner portion 316 ("second wireless communication coil") of the wireless communication antenna 304. (*Id.*,

4:58-60, 5:5-6, 9:55-57, FIGs. 3, 9.) As shown in annotated figure 9 below, the wireless charging coil 502 (green) is disposed inside the first wireless communication coil 314 (blue), and the second wireless communication coil 316 (purple) is disposed inside the wireless charging coil. (*Id.*, FIG. 9.)

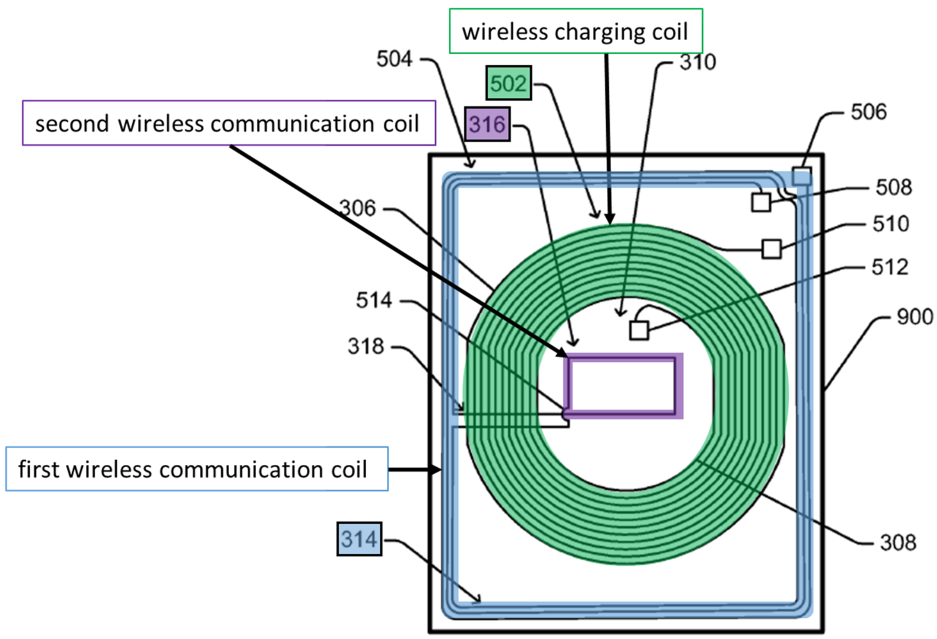


FIG. 9

(*Id.*, FIG. 9 (annotated).)

e) 1[d]: wherein the wireless communication antenna further comprises a coil connection member traversing the wireless charging coil so as to interconnect the first wireless communication coil and the second wireless communication coil,

163. Shostak discloses or suggests this feature. For example, as I discussed above for claim element 1[a], Section IX.F.1(b), Shostak discloses a wireless

communication antenna 504 comprising a first wireless communication coil 314 and a second wireless communication coil 316. With respect to figures 3 and 9, Shostak further discloses "portion 318" ("coil connection member") which "traverses the [wireless charging coil], interconnecting the portions 314 and 316 of the antenna 304" ("interconnect the first wireless communication coil and the second wireless communication coil.") (Ex-1006, 5:13-14; FIGs. 3, 9; *see also id.*, 4:34-40; 9:63-66 ("The antenna apparatus 900 also includes a wireless communication antenna that is the wireless communication coil 504 (e.g., the antenna 304 of FIG. 3) including portions 314, 316, and 318."), FIG. 4.)

164. Annotated figure 9 below shows the wireless communication antenna 504 comprising coil connection member 318 traversing the wireless charging coil 502 and interconnecting the first wireless communication coil 314 and second wireless communication coil 316 (purple).

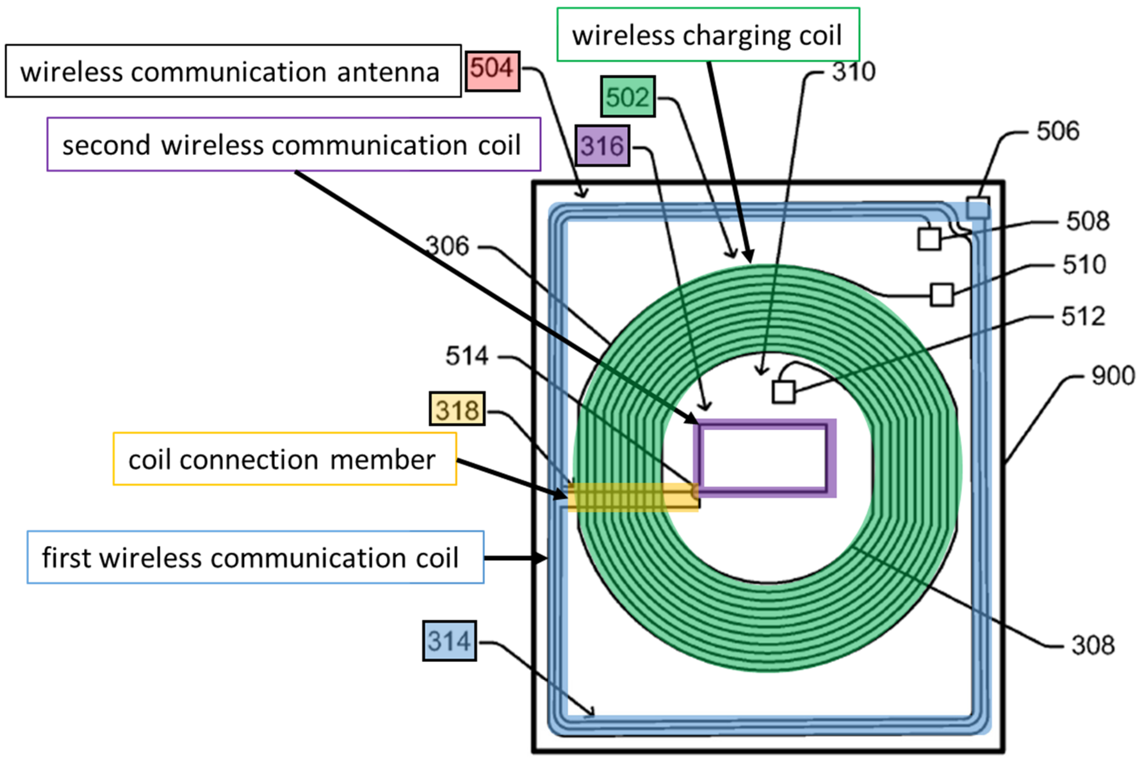


FIG. 9

(Ex-1006, FIG. 9 (annotated).)

f) 1[e]: wherein a number of windings of the second wireless communication coil is less than a number of windings of the first wireless communication coil, and

165. Shostak discloses or suggests this feature. For instance, Shostak discloses that wireless communication coil portion 316 ("the second wireless communication coil") has one winding, and wireless communication coil portion 314 ("the first wireless communication coil") has three windings. (Ex-1006, FIG.

9.) One windings is less windings than three windings. Figure 9, below, shows the respective number of windings in each coil.

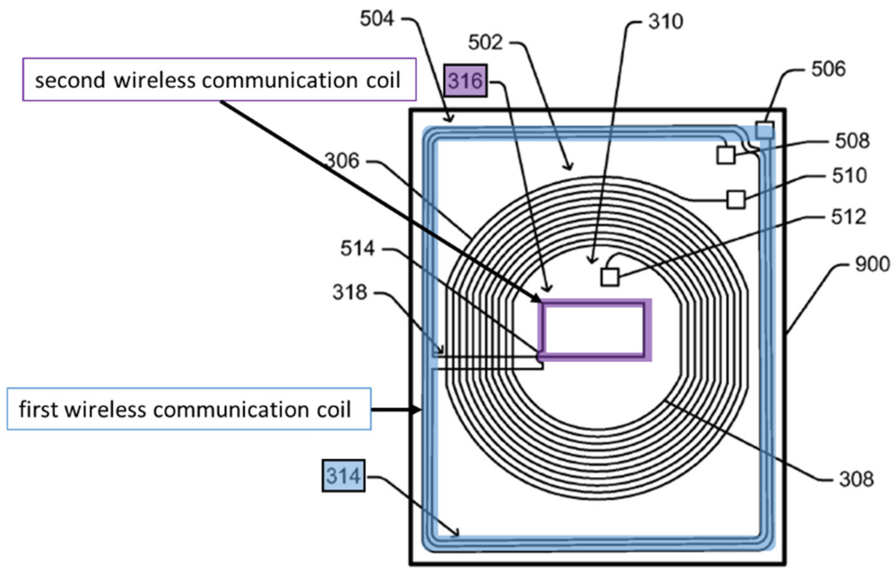


FIG. 9

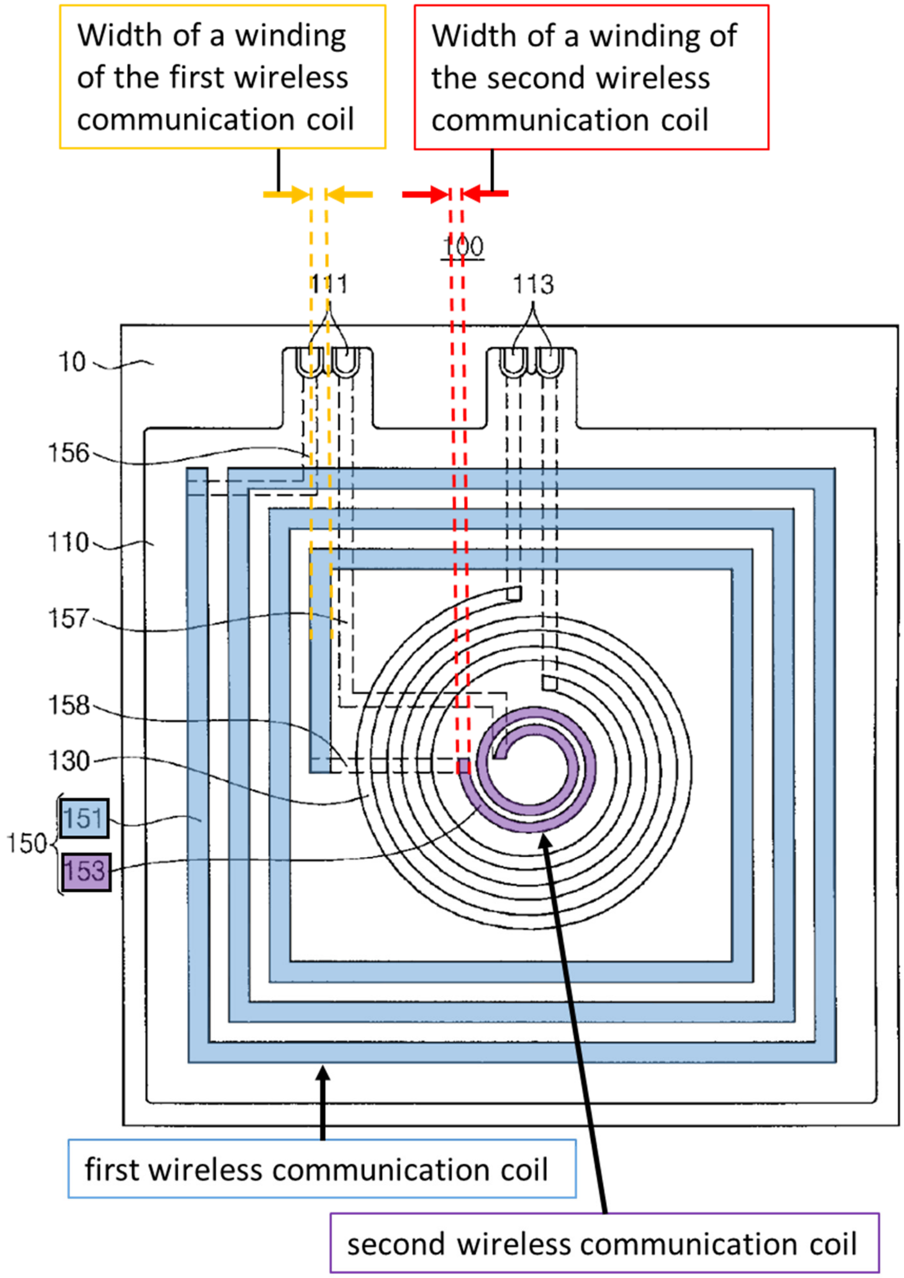
(Ex-1006, FIG. 9 (annotated).)

g) 1[f]: wherein a width of a winding of the second wireless communication coil is less than a width of a winding of the first communication coil.

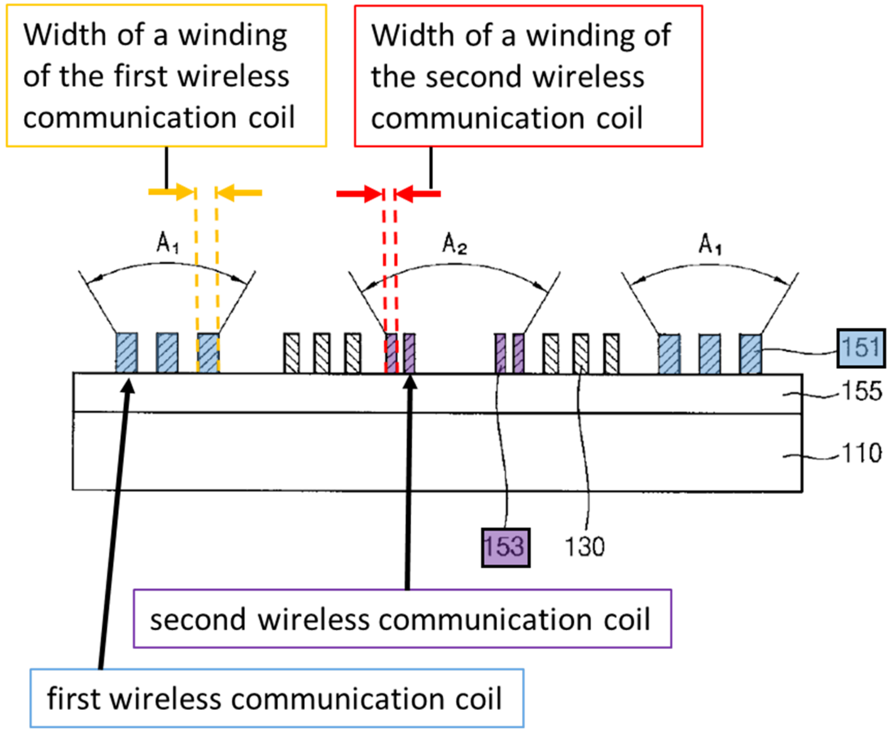
166. Shostak in combination with Kim discloses or suggests this feature. As I discussed for claim 1 in Section IX.A.1, Kim discloses a wireless antenna design similar to that of Shostak, having first and second wireless communication coils with a wireless charging coil disposed between the communication coils. (Sections IX.A.1(a)-(g).) Kim discloses, for example, that a width of a winding of second loop antenna pattern 153 (the "second wireless communication coil") is less than a width

of a winding of the first loop antenna pattern 151 (the "first communication coil"). (Ex-1005, FIGs. 1, 2; Section IX.A.1(g).)

167. As I discussed above in Section IX.A.1(g), Kim's figures consistently show the width of the windings of the second wireless communication coil as less than the width of the windings of the first wireless communication coil. (Section IX.A.1(e); Ex-1005, FIGs. 1, 2.) And as shown in Kim's figures 1 and 2, annotated below, the width of the outermost turn of the second wireless communication coil is less than the width of the innermost turn of the first wireless communication coil.



(Ex-1005, FIG. 1 (annotated).)



(*Id*., FIG. 2 (annotated).)

168. Shostak is silent on the relative widths of the first and second wireless communication coils. Therefore, a person of ordinary skill in the art would have looked to similar references in the same field, such as Kim, for further guidance on how to implement Shostak's antenna. Kim discloses or would have suggested to such a person to select a width of a winding of the first communication coil to be wider than a width of a winding of a second communication coil.

169. The '426 patent does not provide any explanation or rationale as to why one of the coils has a width of a winding that is greater than one of the other coils, nor identify any criticality associated with that feature. A person of ordinary skill in the art would have understood that selecting widths of the windings of the wireless

communication coils is nothing more than a design choice. Such a skilled person would have further understood that there are only three options for the relative winding widths of the first communication coil and the second communication coils: (1) same width; (2) the first communication coil having a width of a winding that is less than a width of a winding of the second communication coil; or (3) the second communication coil having a width of a winding that is less than a width of a winding of the first communication coil. Kim's disclosure of only one of these options—a winding of the first communication coil wider than a winding of the second communication coil—would have directed such a skilled person towards that option. Three options presents a finite number of predictable options. Having a narrower first communication coil winding is one of a finite number of possible alternatives, all of which would have worked and a person of ordinary skill in the art would have been encouraged to try.

170. For example, a person of ordinary skill in the art would have understood that a wider coil winding reduces the resistance of the coil, which is desirable in some applications. (Ex-1014, 871 ("As the width of the coil increases, R_S of the coil decreases. The coil with the biggest W achieved the smallest R_S.").) Such a person would have further understood that in some applications a high quality factor (Q) coil is desirable, where having a wider coil results in a higher Q. (*Id.*, 872, FIG. 8.) In addition, making the winding width of the second wireless communication coil

narrower in such a manner could have been used to realize the desired coil characteristics in a coil configuration in which other variables for the coil (e.g., trace spacing, coil dimensions, trace thickness) are constrained.

171. The relationship between coil width and coil properties was also well understood, and thus a person of ordinary skill in the art would have known that the width of the coil windings is one of a number of variables that can be manipulated to configure the performance of a coil by, for example, adjusting the inductance, resistance, and quality factor (Q) of the coil. (Ex-1015, ¶[0046] ("The width and the length of each antenna coil and the film thickness or the coating thickness for each antenna coil are set in accordance with the desired communication performance."); Ex-1016, 1276, 1281 (disclosing that the inductive parameters of an inductive coil formed on a printed circuit board vary with outermost radius, number of turns, **conductor width,** lamination thickness, and conductor thickness), 1279 (showing that the inductance of the coil varies with width); Ex-1014, 871 ("[C]oil geometry is an important parameter in the design of the spiral configuration of the printed coils. Values for R_S for 5-turn circular PSC's with different W and S, measured at different resonating frequencies are shown in Fig. 6.") (where "W" refers to the width of the coil windings), 872 ("[A]s shown in Fig. 8, **a change in width of the coil** from 163 to 313 μm, **resulted the [sic] change in Q** by approximately 50% at 20 MHz.") (emphasis added), FIGs. 6-9.)

172. A person of ordinary skill in the art would have had good reason to select a width of a winding of the first communication coil to be wider than a width of a winding of a second communication coil when implementing Shostak's antenna. For instance, Shostak's first and second wireless communication coils taken together are effectively a single coil inductor (with a gap between the outermost and innermost windings for the wireless charging coil). It was known long before the alleged invention in the '426 patent that a coil inductor can be made with windings that are narrower on the inside of the coil than at the outside. (*See generally*, Ex-1022.) Such a design has the advantages of saving space in small devices (such as the mobile devices Shostak's antenna is designed for), while maintaining substantially the same performance, including quality factor, inductance, and resistance as a coil where all traces are the width of the widest trace. (*Id.*, 2:38-59, FIG. 1.) Using an innermost communication coil with narrower traces that takes up less space would also have the added benefit of freeing up room to optimize the geometry of the antenna as a whole (e.g., spacing between the coils, width of the wireless charging coil windings, shape, etc.).

173. Therefore, in view of Kim and a skilled person's general understanding of the relationship between winding width and coil properties, and the advantages of a design where the inner coil winding(s) is narrower than the outermost winding(s), the skilled person would have had good reason to make a width of a winding of the

second wireless communication coil less than a width of a winding of the first communication coil.

174. A person of ordinary skill in the art would have had a reasonable expectation of success in implementing Shostak's antenna with a width of a winding of the coil portion 316 ("second wireless communication coil") that is less than a width of a winding of Shostak's coil portion 314 ("first wireless communication coil"). Such a skilled person would have understood the impact of the coil winding widths on antenna properties, and further understood how to implement coils with appropriate widths. Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success in the combination because of the similarities between Kim and Shostak's two-coil communication antennas, and given these similarities, relative dimensions that work in Kim's antenna would also be expected to work in Shostak's antenna. Additionally, there is nothing particularly difficult about selecting or changing the widths of the coil windings in Shostak's antenna, or implementing those widths, and doing so would be well within a skilled person's ability.

2. Claim 2

a) The wireless antenna according to claim 1, wherein the first wireless communication coil and the second wireless communication coil have different shapes.

175. Shostak discloses or suggests this feature. For instance, in figure 10, Shostak illustrates a variation of its figure 9 antenna where the wireless communication coil portion 314 ("the first wireless communication coil") has a substantially rectangular shape, and wireless communication coil portion 316 ("the second wireless communication coil") has a substantially circular shape (i.e., different shapes). (Ex-1006, 10:26-40 ("the portion 316 of the wireless communication coil 504 in the antenna apparatus 1000 forms a shape that is substantially circular"), FIG. 10.) Annotated figure 10 below illustrates different shapes of the outer portion 314 ("the first wireless communication coil") (blue) and inner portion 153 ("the second wireless communication coil") (purple) of the wireless communication coil.

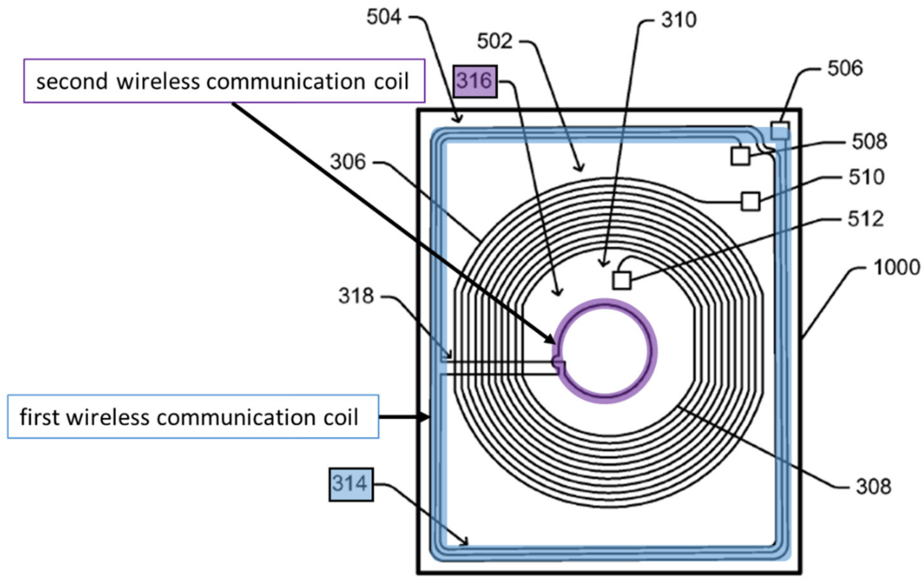


FIG. 10

(Ex-1006, FIG. 10 (annotated).)

176. Shostak further explains that the figure 10 antenna is "analogous to" the figure 9 antenna that I discussed above in Section IX.F.1(a)-(g) for claim 1, with the only difference being that figure 10 is used to illustrate that the antenna 316 in figure 9 "can form various other shapes" and is not limited to the rectangular loop illustrated in figure 9. (Ex-1006, 10:26-40.) In figure 10, the antenna portion 316 ("second wireless communication coil") is substantially circular.

> Although illustrated as a shape that is substantially rectangular, it should be noted that **the portion 316 can form various other shapes, such as shapes that are substantially circular**, shapes that are substantially

> elliptical, and so forth. For example, FIG. 10 illustrates an example antenna apparatus 1000 in which multiple antennas are co-located in accordance with one or more embodiments. **The antenna apparatus 1000 of FIG. 10 is analogous to the antenna apparatus 900 of FIG. 9**, however differs from the antenna apparatus 900 of FIG. 9 in the configuration of the portion 316 of the wireless communication coil 504. Rather than forming a shape that is substantially rectangular, **the portion 316 of the wireless communication coil 504 in the antenna apparatus 1000 forms a shape that is substantially circular** around the center of the center area 310.

(Ex-1006, 10:26-40 (emphasis added).)

3. Claim 3

a) The wireless antenna according to claim 2, wherein a shape of the first wireless communication coil is a polygonal loop pattern, and wherein a shape of the second wireless communication coil is a circular loop pattern.

177. Shostak discloses or suggests this feature. For instance, as shown in annotated figure 10 below, Shostak discloses that wireless communication coil portion 314 ("the first wireless communication coil") has a substantially rectangular ("polygonal") shape, disclosed as a loop pattern, and wireless communication coil portion 316 ("the second wireless communication coil") has a substantially circular shape, disclosed as a loop pattern. (Ex-1006, FIG. 10; Section IX.F.2(a).)

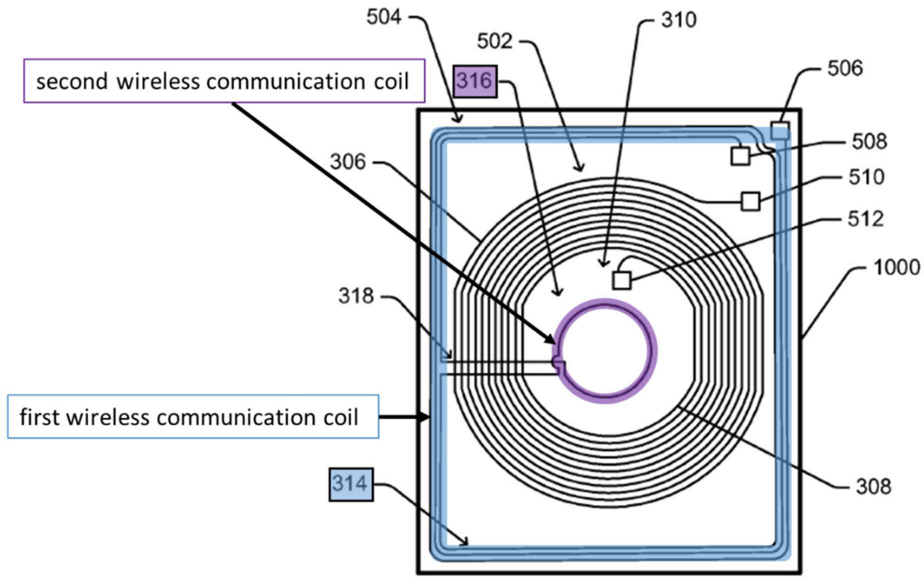


FIG. 10

(Ex-1006, FIG. 10 (annotated).)

4. Claim 4

a) The wireless antenna according to claim 1, wherein the first wireless communication coil and the second wireless communication coil have different curvatures.

178. Shostak discloses or suggests this feature. For instance, as I discussed for claim 2, Shostak discloses that wireless communication coil portion 314 ("the first wireless communication coil") has a substantially rectangular shape, and wireless communication coil portion 316 ("the second wireless communication coil") has a substantially circular shape. (Ex-1006, FIG. 10.) A rectangle and circle have different curvatures. Annotated figure 10 below illustrates different shapes of the outer portion 314 ("the first wireless communication coil") (blue) and inner

portion 153 ("the second wireless communication coil") (purple) of the wireless communication coil.

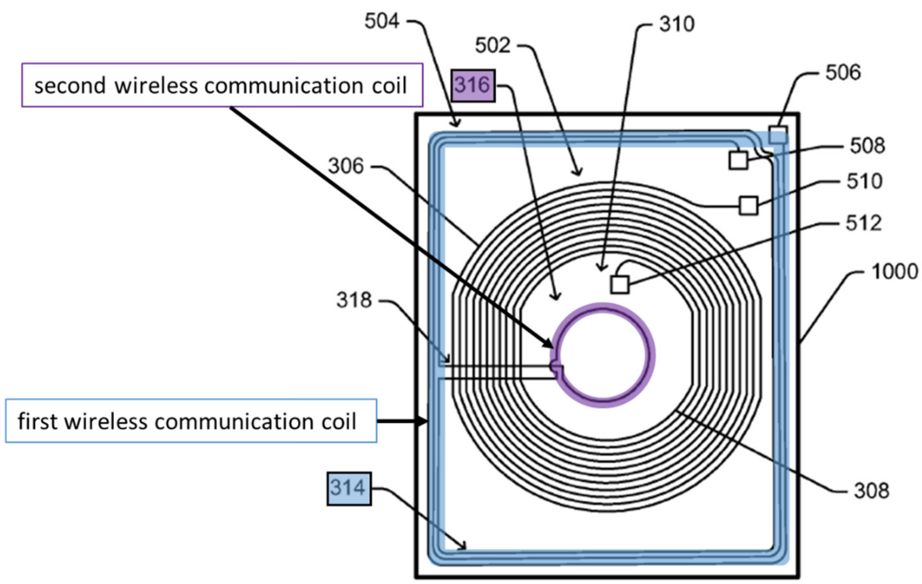


FIG. 10

(Ex-1006, FIG. 10 (annotated).)

5. Claim 5

a) The wireless antenna according to claim 1, wherein the wireless charging coil and the second wireless communication coil have corresponding curvatures.

179. Shostak discloses or suggests this feature. For example, Shostak discloses wireless charging coil 502 is circular, and shows its curvature corresponding to (e.g. having close similarity to) that of wireless communication coil portion 316 ("the second wireless communication coil"). (Ex-1006, FIG. 10.)

As shown below, wireless charging coil 502 and coil portion 316 are both substantially circular.

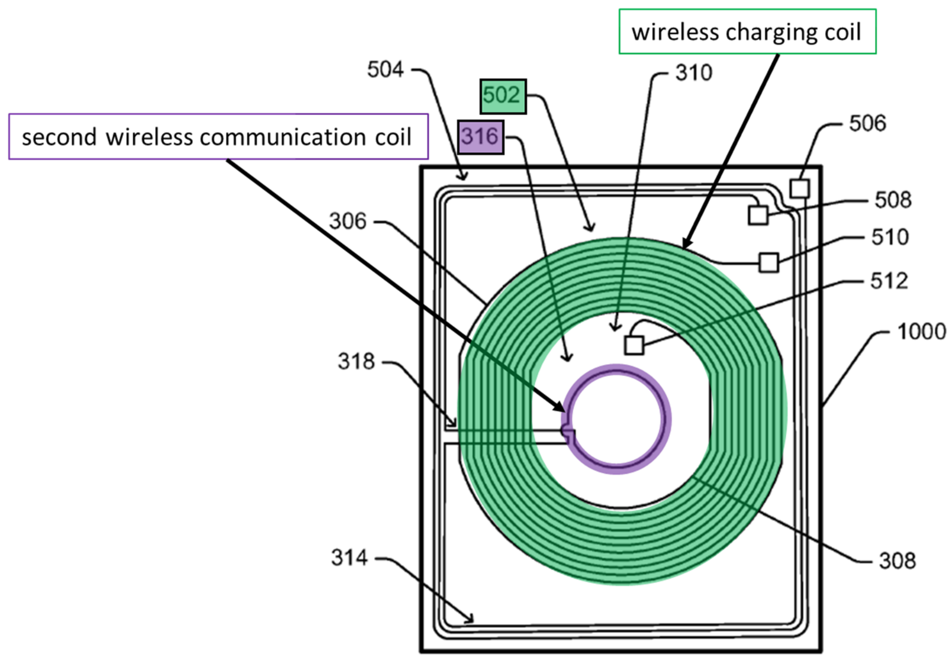


FIG. 10

(Ex-1006, FIG. 10 (annotated).)

6. Claim 6

a) The wireless antenna according to claim 1, wherein the number of windings of the second wireless communication coil is one.

180. Shostak in combination with Kim discloses this feature. For example, as I discussed above in Section IX.B.1(a), Shostak discloses that the interior portion of the wireless communication antenna 316 ("second wireless communication coil") has only one winding. (Section IX.B.1(a).) For instance, Shostak discloses that

"[t]he portion 316 [of the wireless communication coil 504] forms a single loop as illustrated [in Figure 9]." (Ex-1006, 10:4-12; FIG. 9.)

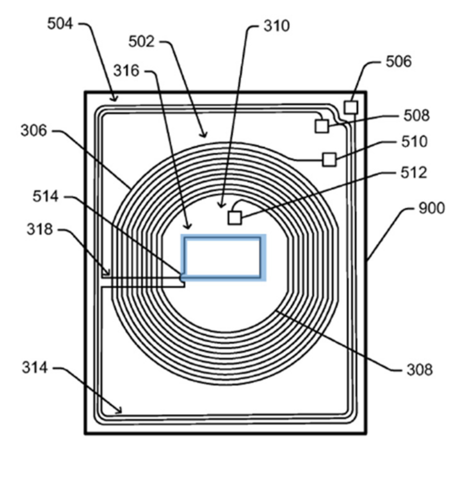


FIG. 9

(*Id*., FIG. 9 (annotated).)

7. Claim 7

a) The wireless antenna according to claim 1, wherein a number of windings of the wireless charging coil is greater than the number of windings of the first wireless communication coil.

181. Shostak discloses or suggests this feature. For example, Shostak discloses in Figure 9 (annotated below) the wireless charging coil 502 (green) has eleven windings and the first wireless communication coil 314 (blue) has three windings. Eleven windings is a greater number of windings than three windings.

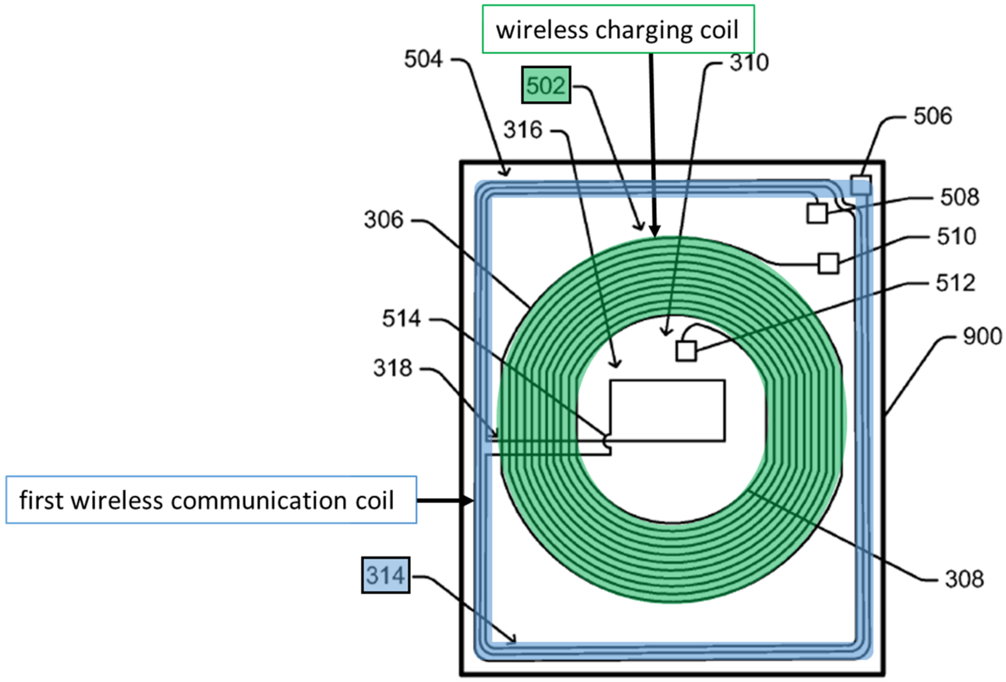


FIG. 9

(Ex-1006, FIG. 9 (annotated).)

8. Claim 8

a) The wireless antenna according to claim 7, wherein the number of windings of the wireless charging coil is greater than the number of windings of the second wireless communication coil.

182. Shostak discloses or suggests this feature. For example, as I discussed above in Sections IX.B.1(a), IX.F.6(a) and 7(a), Shostak discloses that the wireless charging coil has eleven windings and the second wireless communication coil has one winding. (Sections IX.B.1(a), IX.F.6(a) and 7(a); Ex-1006, FIG. 9.) Eleven winding is a greater number of windings than one winding.

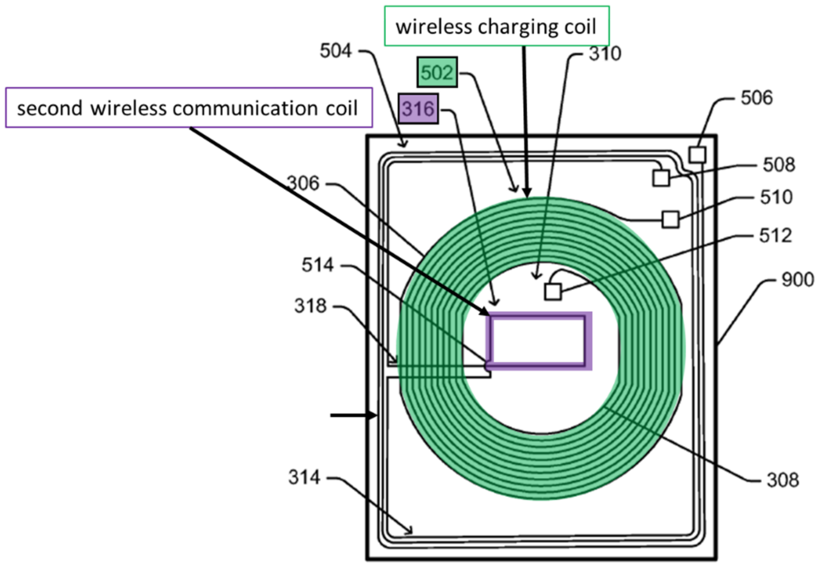


FIG. 9

(Ex-1006, FIG. 9.)

9. Claim 9

a) The wireless antenna according to claim 1, wherein the coil connection member is insulated from the wireless charging coil.

183. Shostak in combination with Kim discloses or suggest this feature. As I discussed above for claim limitation 1[d], Shostak discloses a coil connection member. (Section IX.F.1(e).)

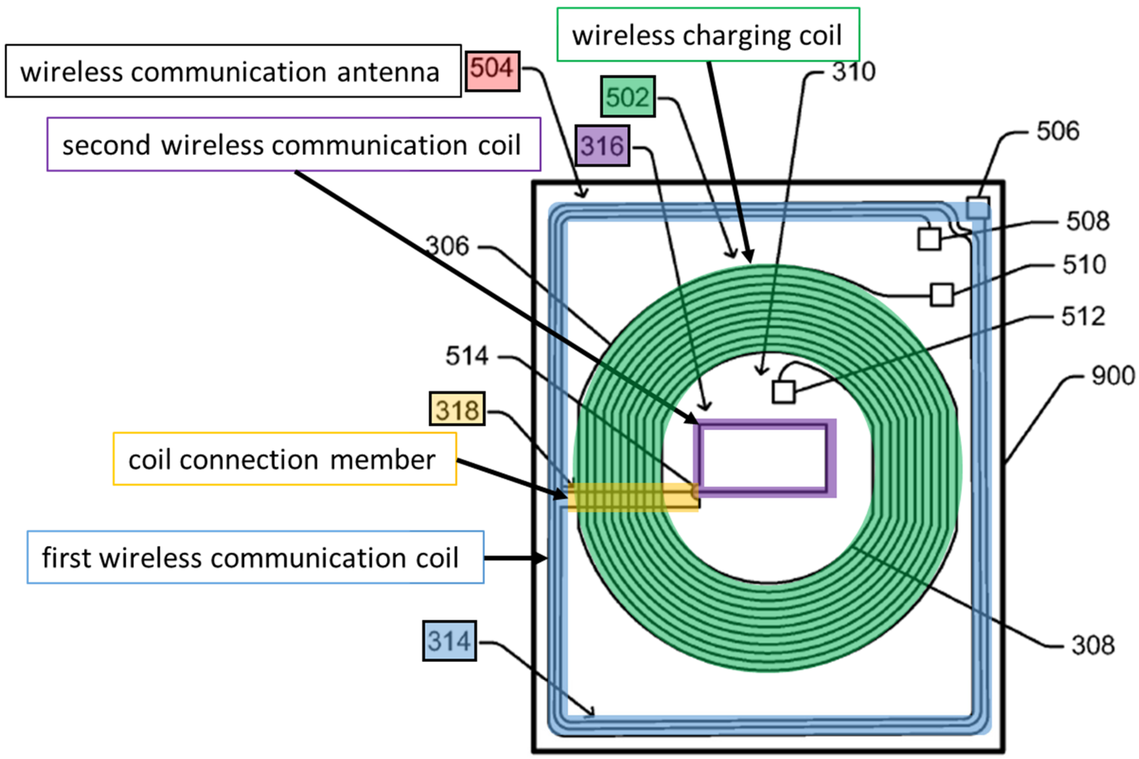


FIG. 9

(Ex-1006, FIG. 9 (annotated).)

184. Shostak also discloses that where the coil connection member 318 (labeled 418 in Figure 4, below) traverses the wireless charging coil, "[a] dielectric or shield material [(labeled 424 in Figure 4, below)] can be positioned between the portion 318 and the antenna 302 to prevent the portion 318 and antenna 302 from coming into physical contact with one another" ("the coil connection member is insulated from the wireless charging coil"). (Ex-1006, 5:13-32, FIG. 4.)

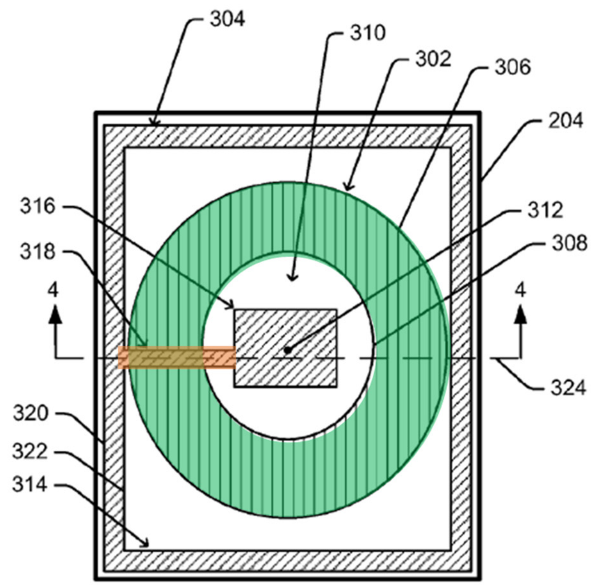


FIG. 3

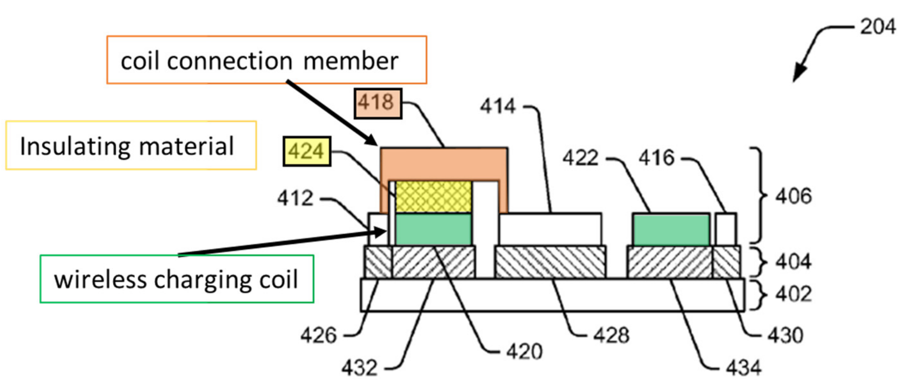


FIG. 4

(Ex-1006, FIGs. 3 (top, annotated), 4 (bottom, annotated).)

10. Claim 10

a) 10[a]: The wireless antenna according to claim 1, wherein the first wireless communication coil and the second wireless communication coil are connected to each other in series, and

185. Shostak discloses or suggests this feature. For instance, as I discussed above in Section IX.F.1(e) for claim element 1[d], Shostak discloses a coil connection member 318, which interconnects an outer coil portion 314 ("first wireless communication coil") to an inner coil portion 316 ("second wireless communication coil"). (Section IX.F.1(e).) Annotated figure 9 below shows that the coil connection member 318 connects the first wireless communication coil 314 and the second wireless communication coil 316 in series because the second communication coil is connected to the innermost turn of the first wireless communication coil, with a single current path through the second communication coil. (Ex-1006, FIG. 9.) A person of ordinary skill in the art would have thus understood Shostak discloses the first wireless communication coil (314) is connected in series with the second wireless communication coil (316).

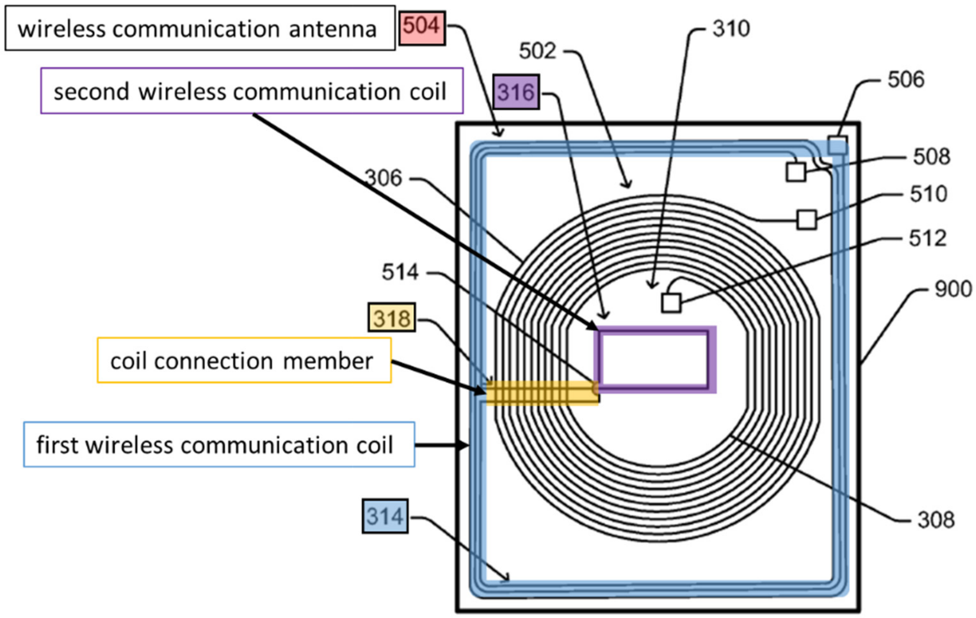


FIG. 9

(Ex-1006, FIG. 9 (annotated).)

b) 10[b]: wherein the first wireless communication coil and the second wireless communication coil are wound so as to have a same rotational direction of current.

186. Shostak discloses or suggests this feature. For instance, Shostak discloses that the first wireless communication coil 314 is wound in the same direction as the second wireless communication coil 316, and those coils are connected in series as I discussed above in Section IX.F.10(a) such that current flowing through the coils would rotate in the same direction. (Section IX.F.10(a); Ex-1006, FIG. 9.) Shostak further discloses that "the winding orientation (for example, clockwise or counterclockwise) of the portion 314 of the wireless

communication coil 504 and the portion 316 of the wireless communication coil 504 is kept the same in the example of FIG.9," and "[k]eeping the winding orientation the same allows the magnetic field generated by each of the portions 314 and 316 to combine constructively in the center area 310 of the antenna apparatus 900." (Ex-1006, 10:18-25.) Shostak teaches the rationale for winding the coils in the same direction with reference to its figure 5 antenna:

> By preserving the trace winding orientation/direction of the coils in the portions 314 and 316, the radiated magnetic field can be greater due to the superposition of the fields from the two coils than if the orientation/direction of the coils in the portions 314 and 316 were different.

(*Id.*, 8:10-22.)

11. Claim 11

a) The wireless antenna according to claim 1, wherein the wireless communication antenna and the wireless charging antenna are formed on a flexible printed circuit board.

187. Shostak in combination with Kim discloses or suggests this feature. For instance, Shostak discloses with reference to its example layout in figure 3, and the accompanying cross-section in figure 4, that wireless communication antenna 314 (labeled 412, 414, and 416 in figure 4), and wireless charging antenna 302 (420 and

422 in figure 4), are formed on base layer 402 ("flexible printed circuit board").[4] (Ex-1006, 4:34-36, 6:21-27, 6:43-50, FIGs. 3-4.) Shostak further discloses "base layer 402 can be any of a variety of … flexible sheets made of any of a variety of non-conductive materials." (*Id.*, 6:36-38.) A person of ordinary skill in the art would have understood from Shostak's disclosure of flexible sheets having circuitry for a wireless antenna disposed thereon that Shostak's flexible sheets were a flexible printed circuit board.

[4] The example layout in Shostak's figures 3 and 4 provides the general structure of Shostak's antenna apparatus, illustrating each coil as a shaded area, whereas figures 5-10 illustrate specific coil patterns "each of which is an example of the antenna apparatus." (Ex. 1006, 4:34-36, 6:21-25, 7:24-28, FIGs. 3-10.) Shostak uses a different numbering convention in figure 4—for instance, labeling each side of the circular wireless charging coil with different numbers—which is explained at Ex-1006, 6:42-50.

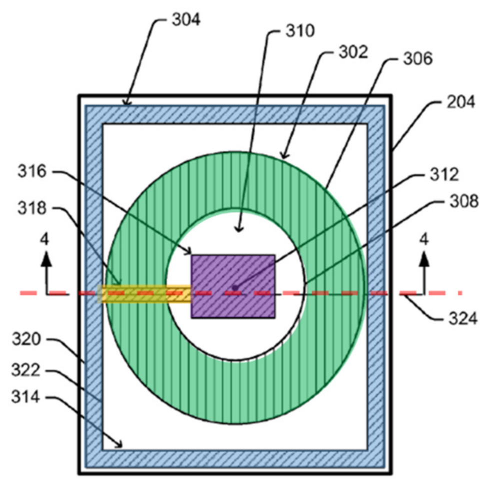


FIG. 3

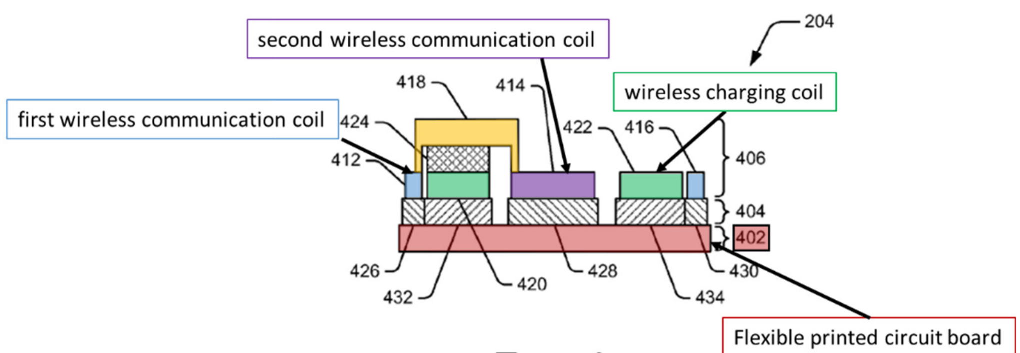


FIG. 4

(*Id*., FIGs. 3 (annotated), 4 (annotated).)

188. In the alternative to my analysis above, I have been asked to assume that Shostak does not disclose or suggest a flexible printed circuit board. Under that assumption, it is my opinion that a person of ordinary skill in the art would have had good reason to implement Shostak's wireless communication and charging coils on flexible printed circuit board in view of Kim. Kim, in the same field as Shostak, similarly discloses that "the loop antenna unit (150) may further comprise a flexible

substrate (155)," where the flexible substrate 155 is a flexible printed circuit board as I discussed above in Section IX.A.8(a). (Section IX.A.8(a).)

189. A person of ordinary skill in the art would have had good reason to use a flexible printed circuit board in Shostak's antenna, as disclosed by Kim, at least because it was well-known at the time of the alleged invention that flexible printed circuit boards provided multiple advantages. For example, flexible printed circuit boards enabled wireless coil antennas to "be significantly slim," capable of "attach[ing] to a structure such as the case of a cellular phone using simple attachment methods such as the use of double sided tape, whereby a manufacturing cost and process cost may be reduced," and "simply attached even to an electronic device having a curved shape." (Ex-1017, ¶¶[0067]-[0068]; *see also id.* ¶¶[0013] ("[I]n accordance with the recent trend towards thin devices, there is a need to develop a contactless power transmission device having a reduced thickness."), [0021] ("The flexible substrate may be a polyimide type flexible printed circuit board (FPCB)....".) Given these known benefits, a person of ordinary skill in the art would have had good reason to implement Shostak's flexible sheet as a flexible printed circuit board such that Shostak's wireless communication antenna and wireless charging antenna are formed on a flexible printed circuit board. Such a skilled person would have had a reasonable expectation of success because implementing Shostak's antennas on a flexible printed circuit board would have

involved nothing more than applying known techniques (flexible printed circuit board manufacturing and materials) to Shostak's antenna design in a routine way.

12. Claim 12

a) The wireless antenna according to claim 11, wherein the flexible printed circuit board further comprises a connector connected to the wireless communication antenna and to the wireless charging antenna.

190. Shostak discloses or suggests this feature. For instance, Shostak discloses that "antenna apparatus 900 also includes communication connector contacts 506 and 508 for coupling to a wireless communication circuit and wireless charging connector contacts 510 and 512 for coupling to a wireless charging circuit" (contacts 506, 508, 510, and 512 together form a "connector"). (Ex-1006, 9:66-10:3.) Annotated figure 9 below illustrates Shostak's wireless communication antenna 504 connected to connectors 510, 512 and wireless charging antenna 502 connected to connectors 506, 508.

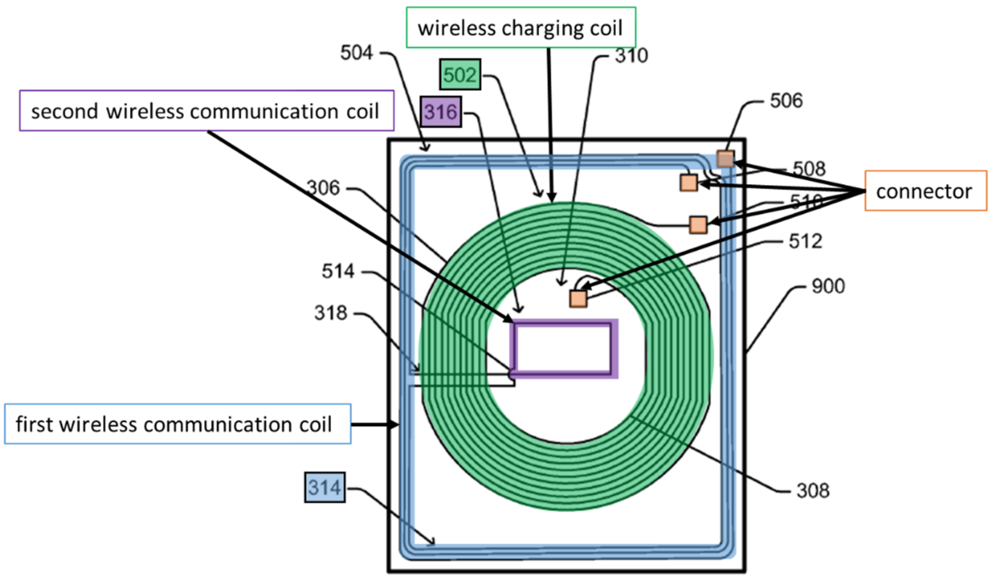


FIG. 9

(*Id*., FIG. 9 (annotated).)

191. As I discussed above in Section IX.F.10(a), the cross-section in annotated figure 4 below shows the flexible printed circuit board 402, which is depicted as spanning the entire antenna. (Section IX.F.10(a); Ex-1006, 6:25-26 ("The antenna apparatus 204 illustrated in FIG. 4 includes a base layer 402."), FIG. 4.) A person of ordinary skill in the art would thus have understood that the connector is on the antenna, and, as such, is disposed on the flexible printed circuit board.

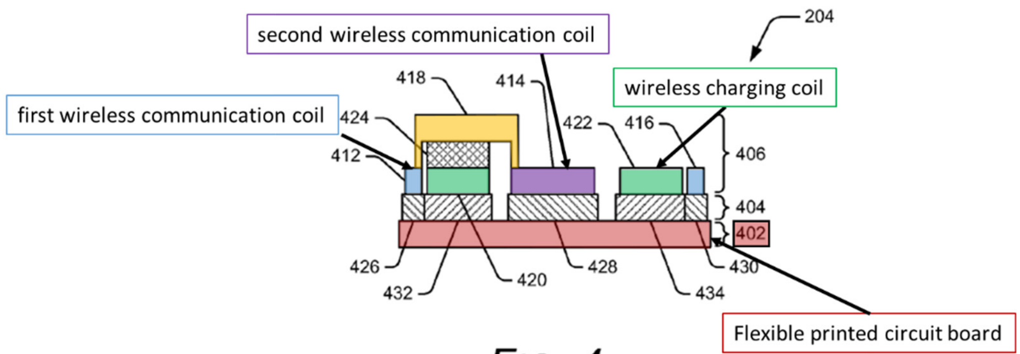


FIG. 4

(Ex-1006, FIG. 4 (annotated).)

13. Claim 17

a) 17[pre]: A wireless antenna comprising:

192. In my opinion, Shostak discloses or suggests this feature for the reasons discussed for claim element 1[pre]. (Section IX.F.1(a).)

b) 17[a]: a wireless communication antenna comprising a first wireless communication coil and a second wireless communication coil; and

193. Shostak discloses or suggests these features for the reasons discussed above for claim element 1[a]. (Section IX.F.1(b).)

c) 17[b]: a wireless charging antenna comprising a wireless charging coil,

194. Shostak discloses or suggests this feature for the reasons discussed above for claim element 1[b]. (Section IX.F.1(c).)

d) 17[c]: wherein the wireless charging coil is disposed inside the first wireless communication coil, and the second wireless communication coil is disposed inside the wireless charging coil,

195. Shostak discloses or suggests this feature for the reasons discussed above for claim element 1[c]. (Section IX.F.1(d).)

e) 17[d]: wherein a number of windings of the second wireless communication coil is less than a number of windings of the first wireless communication coil,

196. Shostak discloses or suggests this feature for the reasons discussed above for claim element 1[e]. (Section IX.F.1(f).)

f) 17[e]: wherein a minimum distance between the second wireless communication coil and the wireless charging coil is greater than a minimum distance between the first wireless communication coil and the wireless charging coil, and

197. Shostak discloses or suggests this feature as I discussed above for claim element 17[e]. (Section IX.B.2(f).)

g) 17[f]: wherein a width of a winding of the second wireless communication coil is less than a width of a winding of the first communication coil.

198. Shostak in view of Kim discloses or suggests this feature for the reasons discussed above for claim element 1[f]. (Section IX.F.1(g).)

14. Claim 18

a) The wireless antenna according to claim 17, wherein the first wireless communication coil and the second wireless communication coil have different shapes.

199. Shostak discloses or suggests this feature for the reasons discussed above for claim 2. (Section IX.F.2(a).)

15. Claim 19

a) The wireless antenna according to claim 18, wherein a shape of the first wireless communication coil is a polygonal loop pattern, and wherein a shape of the second wireless communication coil is a circular loop pattern.

200. Shostak discloses or suggests these features for the reasons discussed above for claim 3. (Section IX.F.3(a).)

16. Claim 20

a) The wireless antenna according to claim 17, wherein the first wireless communication coil and the second wireless communication coil have different curvatures.

201. Shostak discloses or suggests these features for the reasons discussed above for claim 4. (Section IX.F.4(a).)

17. Claim 21

a) The wireless antenna according to claim 17, wherein the wireless charging coil and the second wireless communication coil have corresponding curvatures.

202. Shostak discloses or suggests these features for the reasons discussed above for claim 5. (Section IX.F.5(a).)

18. Claim 22

a) The wireless antenna according to claim 17, wherein the number of windings of the second wireless communication coil is one.

203. Shostak discloses or suggests these features for the reasons discussed above for claim 6. (Section IX.F.6(a).)

19. Claim 23

a) The wireless antenna according to claim 17, wherein a number of windings of the wireless charging coil is greater than the number of windings of the first wireless communication coil.

204. Shostak discloses or suggests this feature. For example, Shostak discloses in Figure 9 (annotated below) the wireless charging coil 502 has eleven windings and the first wireless communication coil 314 has three windings. Eleven windings is a greater number of windings than three windings.

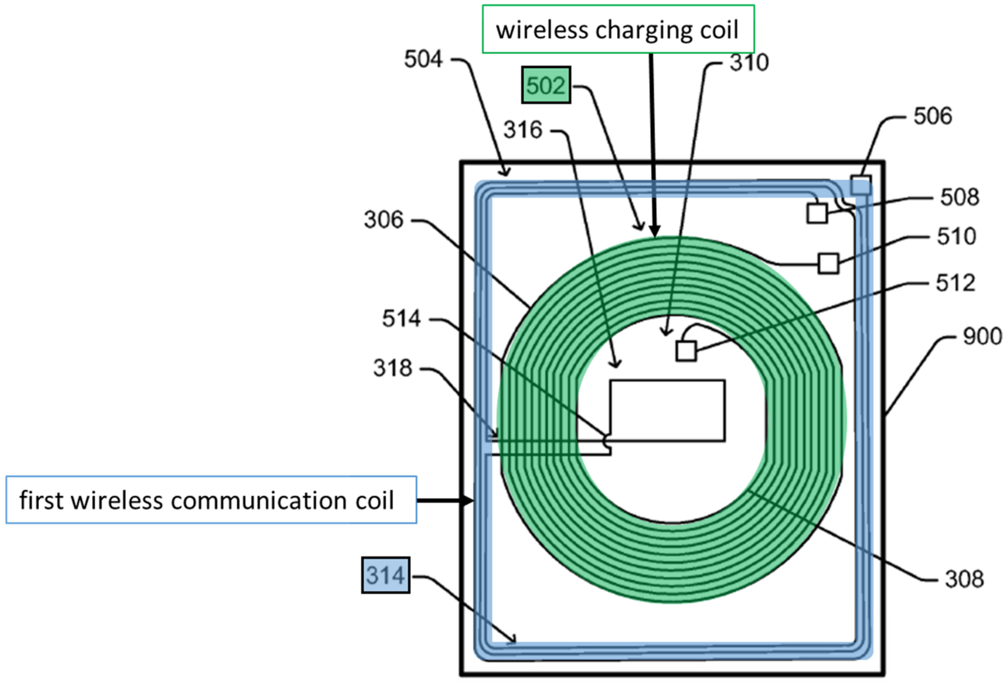


FIG. 9

(Ex-1006, FIG. 9 (annotated).)

20. Claim 24

a) The wireless antenna according to claim 23, wherein the number of windings of the wireless charging coil is greater than the number of windings of the second wireless communication coil.

205. Shostak discloses or suggests this feature for the reasons discussed for claim 8. (Section IX.F.8(a).)

21. Claim 25

a) The wireless antenna according to claim 17, wherein the wireless communication antenna further comprises a coil connection member traversing the wireless charging coil so as to interconnect the first wireless communication coil and the second wireless communication coil.

206. Shostak discloses or suggests this feature for the reasons discussed above for claim element 1[d]. (Section IX.F.1(e).)

22. Claim 26

a) The wireless antenna according to claim 25, wherein the coil connection member is insulated from the wireless charging coil.

207. Shostak discloses or suggests this feature for the reasons discussed for claim 9. (Section IX.F.9(a).)

23. Claim 27

a) 27[a]: The wireless antenna according to claim 17, wherein the first wireless communication coil and the second wireless communication coil are connected to each other in series, and

208. Shostak discloses or suggests this feature for the reasons discussed for claim element 10[a]. (Section IX.F.10(a).)

b) 27[b]: wherein the first wireless communication coil and the second wireless communication coil are wound in a same rotational direction of current.

209. Shostak discloses or suggests this feature for the reasons discussed for claim element 10[b]. (Section IX.F.10(b).)

24. Claim 28

a) The wireless antenna according to claim 17, wherein the wireless communication antenna and the wireless charging antenna are formed on a flexible printed circuit board.

210. Shostak, and Shostak in view of Kim, discloses or suggests this feature for the reasons discussed for claim 11. (Section IX.F.11(a).)

25. Claim 29

a) The wireless antenna according to claim 28, wherein the flexible printed circuit board further comprises a connector connected to both the wireless communication antenna and the wireless charging antenna.

211. Shostak discloses or suggests this feature for the reasons discussed for claim 12. (Section IX.F.12(a).)

26. Claim 34

a) 34[pre]: A wireless antenna comprising:

212. In my opinion, Shostak discloses or suggests this feature for the reasons discussed for claim element 1[pre]. (Section IX.F.1(a).)

b) 34[a]: a wireless communication antenna comprising a first wireless communication coil having a polygonal loop pattern and a second wireless communication coil having a circular loop pattern; and

213. Shostak discloses or suggests this feature for the reasons discussed for claim 3. (Section IX.F.3(a).)

c) 34[b]: a wireless charging antenna comprising a wireless charging coil having a circular loop pattern,

214. Shostak discloses this feature. For instance, Shostak discloses "a wireless charging antenna that is the wireless charging coil 502," disclosed as having a circular loop pattern. (Ex-1006, 9:58-60, FIGs, 9, 10.) Annotated figure 9 below shows wireless charging coil 502 and its circular loop pattern.

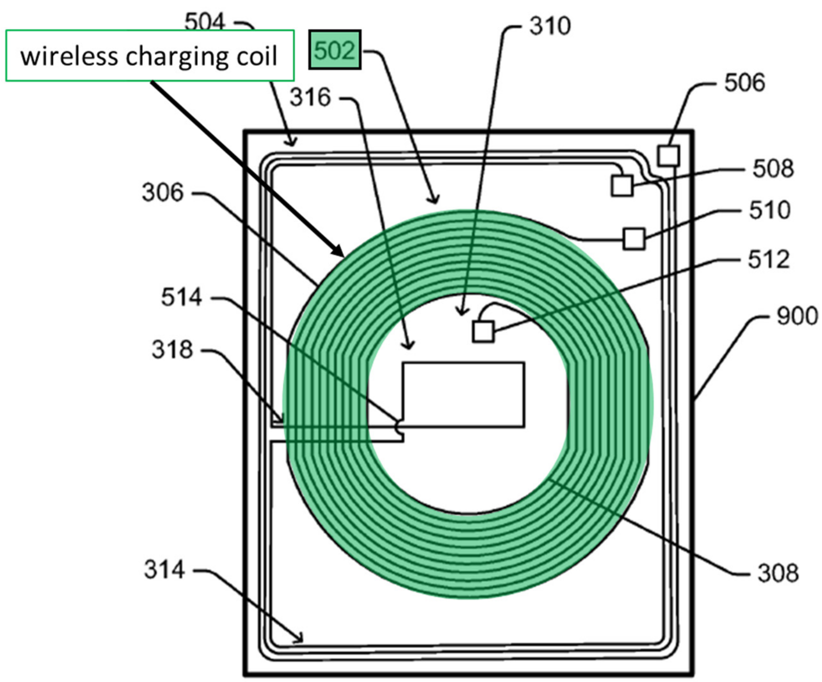


FIG. 9

(*Id.*, FIG. 9 (annotated).)

d) 34[c]: wherein the wireless charging coil is disposed inside the first wireless communication coil, and the second wireless communication coil is disposed inside the wireless charging coil,

215. Shostak discloses or suggests this feature for the reasons discussed for claim element 1[c]. (Section IX.F.1(d).)

e) 34[d]: wherein the wireless communication antenna further comprises a coil connection member traversing the wireless charging coil so as to interconnect the first wireless communication coil and the second wireless communication coil,

216. Shostak discloses or suggests this feature for the reasons discussed for claim element 1[d]. (Section IX.F.1(e).)

f) 34[e]: wherein a minimum distance between the second wireless communication coil and the wireless charging coil is greater than a minimum distance between the first wireless communication coil and the wireless charging coil, and

217. Shostak discloses or suggests this feature for the reasons discussed for claim element 17[e]. (Section IX.F.13(f).)

g) 34[f]: wherein a width of a winding of the second wireless communication coil is less than a width of a winding of the first communication coil.

218. Shostak discloses or suggests this feature for the reasons discussed for claim element 1[f]. (Section IX.F.1(g).)

27. Claim 35

a) The wireless antenna according to claim 34, wherein the first wireless communication coil and the second wireless communication coil have different curvatures.

219. Shostak discloses or suggests this feature for the reasons discussed for claim 4. (Section IX.F.4(a).)

28. Claim 36

a) The wireless antenna according to claim 34, wherein the wireless charging coil and the second wireless communication coil have corresponding curvatures.

220. Shostak discloses or suggests this feature for the reasons discussed for claim 5. (Section IX.F.5(a).)

29. Claim 37

a) The wireless antenna according to claim 34, wherein a number of windings of the wireless charging coil is different from a number of windings of the second wireless communication coil.

221. Shostak discloses or suggests this feature. For example, as I discussed above in Sections IX.B.1(a), IX.F.6(a)-8(a), Shostak discloses that the wireless charging coil has eleven windings and the second wireless communication coil has one winding. (Ex-1006, FIG. 9.) Eleven windings is a different number of windings than one winding.

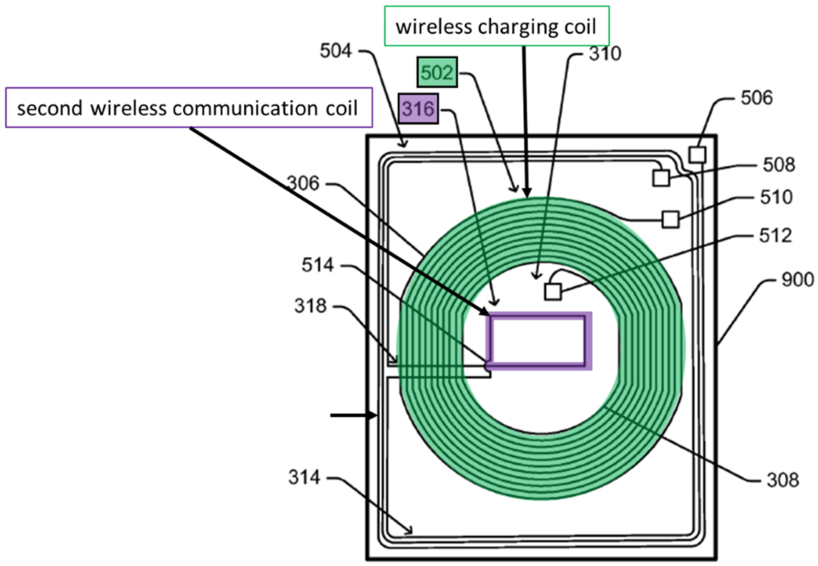


FIG. 9

(Ex-1006, FIG. 9.)

30. Claim 38

a) The wireless antenna according to claim 34, wherein a number of windings of the second wireless communication coil is one.

222. Shostak discloses or suggests this feature for the reasons discussed for claim 6. (Section IX.F.6(a).)

31. Claim 39

a) The wireless antenna according to claim 34, wherein a number of windings of the second wireless communication coil is less than a number of windings of the wireless charging coil.

223. Shostak discloses or suggests this feature for the reasons discussed for claim 37. (Section IX.F.29(a).) As I discussed, Shostak discloses that the second

wireless communication coil has one winding and the wireless charging coil has eleven windings. (Ex-1006, FIGs. 9, 10; Section IX.F.29(a).) One winding is less than eleven windings.

32. Claim 40

a) The wireless antenna according to claim 39, wherein the number of windings of the wireless charging coil is greater than a number of windings of the first wireless communication coil.

224. Shostak discloses or suggests this feature for the reasons discussed for claim 7. (Section IX.F.7(a).)

33. Claim 41

a) The wireless antenna according to claim 40, wherein the number of windings of the wireless charging coil is greater than the number of windings of the second wireless communication coil.

225. Shostak discloses or suggests this feature for the reasons discussed for claim 8. (Section IX.F.8(a).)

34. Claim 42

a) The wireless antenna according to claim 34, wherein the coil connection member is insulated from the wireless charging coil.

226. Shostak discloses or suggests this feature for the reasons discussed for claim 9. (Section IX.F.9(a).)

35. Claim 43

a) 43[a]: The wireless antenna according to claim 34, wherein the first wireless communication coil and the second wireless communication coil are connected to each other in series, and

227. Shostak discloses or suggests this feature for the reasons discussed for claim element 10[a]. (Section IX.F.10(a).)

b) 43[b]: wherein the first wireless communication coil and the second wireless communication coil are wound so as to have a same rotational direction of current.

228. Shostak discloses or suggests this feature for the reasons discussed for claim element 10[b]. (Section IX.F.10(b).)

36. Claim 44

a) The wireless antenna according to claim 34, wherein the wireless communication antenna and the wireless charging antenna are formed on a flexible printed circuit board.

229. Shostak discloses or suggests this feature for the reasons discussed for claim 11. (Section IX.F.11(a).)

37. Claim 45

a) The wireless antenna according to claim 44, wherein the flexible printed circuit board further comprises a connector connected to both the wireless communication antenna and the wireless charging antenna.

230. Shostak discloses or suggests this feature for the reasons discussed for claim 12. (Section IX.F.12(a).)

38. Claim 50

a) The wireless antenna according to claim 1, wherein each of the windings of the first communication coil has a width that is greater than the width of the winding of the second wireless communication coil.

231. Shostak in view of Kim discloses or suggests this feature for the reasons discussed for claim element 1[f]. (Section IX.F.1(g).) A person of ordinary skill in the art would have had good reasons to make each of the windings of the first communication coil with a width that is greater than the width of the winding of the second wireless communication coil for the same reasons.

39. Claim 51

a) The wireless antenna according to claim 17, wherein each of the windings of the first communication coil has a width that is greater than the width of the winding of the second wireless communication coil.

232. Shostak discloses or suggests this feature for the reasons discussed for claim 50. (Section IX.F.38(a).)

40. Claim 52

a) The wireless antenna according to claim 34, wherein each of the windings of the first communication coil has a width that is greater than the width of the winding of the second wireless communication coil.

233. Shostak discloses or suggests this feature for the reasons discussed for claim 50. (Section IX.F.38(a).)

G. Shostak in Combination with Kim and An Discloses or Suggests the Features of Claims 12, 29, and 45

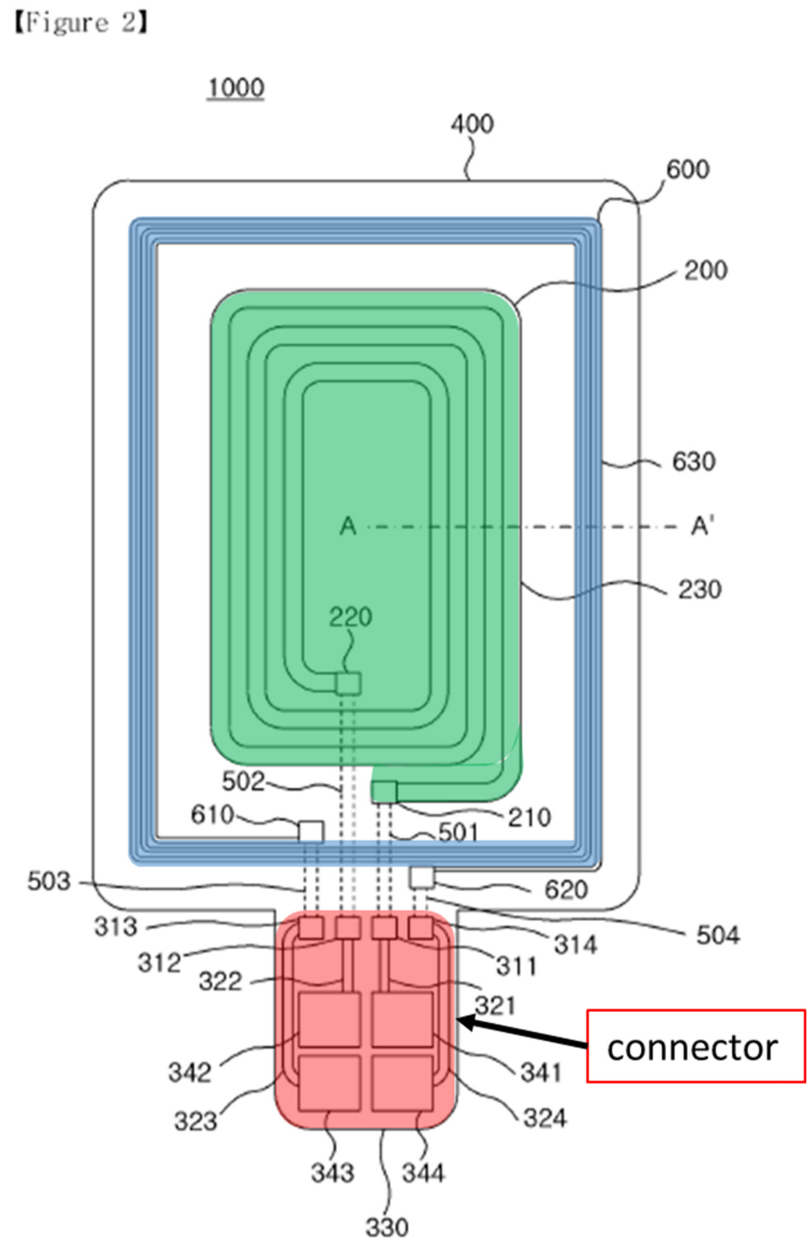
1. Claim 12

a) The wireless antenna according to claim 11, wherein the flexible printed circuit board further comprises a connector connected to the wireless communication antenna and to the wireless charging antenna.

234. As I discussed above in Section IX.F.12(a), Shostak (in combination with Kim) discloses or suggests this feature. I have been asked to alternatively assume, however, that Shostak (in combination with Kim) does not disclose or suggest this feature. Under that assumption, it is my opinion that Shostak in combination with Kim and An discloses or suggests this feature. Similar to Shostak and Kim, An discloses an antenna having a connector disposed on a flexible printed circuit board that is connected to a wireless communication antenna and a wireless charging antenna, and, in view of An, a person of ordinary skill in the art would have had good reason to implement a similar connector in Shostak's antenna (as modified by Kim for claim 1).

235. Similar to Shostak, An discloses an antenna assembly 1000 ("wireless antenna") including an inner antenna 200 which may be a wireless charging antenna pattern and an outer antenna 600 which may be a near field communication antenna. (Ex-1008, ¶¶[6]-[7], [66], [71]-[72].) I discussed the details of An's antenna assembly and connector in Section IX.D.1(a), along with the reasons a person of ordinary skill in the art would have included a connector on the flexible printed

circuit board that is connected to the wireless communication antenna and wireless charging antenna.



(*Id.*, FIG. 2 (annotated).)

236. An explains that "the antenna assembly 1000 may be buried in a back cover of the terminal device," and "[w]hen the back cover of the terminal device is

coupled to the terminal device, the antenna assembly 1000 may be electrically connected to the terminal device through the contact part 300 of the antenna assembly 1000." (*Id.*, ¶[68].) As shown in annotated figure 2 above, "[t]he outer terminal 210 of the inner antenna 200 may be connected with the first connector 311 of the contact part 300," "the internal terminal 220 of the inner antenna 200 may be connected to the second connector 312 of the contact part 300," "[t]he inner terminal 610 of the outer antenna 600 may be connected to the third connector 313 of the contact part 300," and "the outer terminal 620 of the outer antenna 600 may be connected to the fourth connector 313 of the contact part 300." (*Id.*, ¶[338].)

237. Similar to An, Shostak's antennas may be positioned at the housing surface of a computing device. (Ex-1006, 2:28-30 ("[T]he two antennas are located in approximately a central area of the housing of a computing device").) Shostak explains that "with many portable devices, the front side of the device is dominated by a touch screen, and thus the multiple antennas are co-located at or near the back housing of the computing device." (*Id.*, 2:35-38; *see also id.* 3:51-54 ("The antenna apparatus 204 is situated within the housing of the computing device 102, and is situated **at** or near **surface** of the opposite side of the computing device 102 (the back or rear of the computing device 102.") (emphasis added), 12:31-35 ("The wireless communication coil and the wireless charging coil may be positioned **at** or

near any **housing surface of the device** 1200, but the wireless communication coil and the wireless charging coil are co-located with each other.") (emphasis added).)

238. Similar to An, as shown in annotated figure 9 below, Shostak's antenna apparatus "also includes communication connector contacts 506 and 508 for coupling to a wireless communication circuit and wireless charging connector contacts 510 and 512 for coupling to a wireless charging circuit." (*Id*., 8:34-38.) The wireless communication circuit "perform[s] or otherwise facilitate[s] wireless communication (e.g., near field communication) with other devices." (*Id*. 3:24-27.) The wireless charging circuit manages recharging the battery of the computing device. (*Id*. 3:34-38 ("The receiving of energy using the wireless charging antenna 118 is managed by the wireless charging circuit 116, which stores the received energy in the power storage component 108 (e.g., recharging the battery of the computing device 102).").)

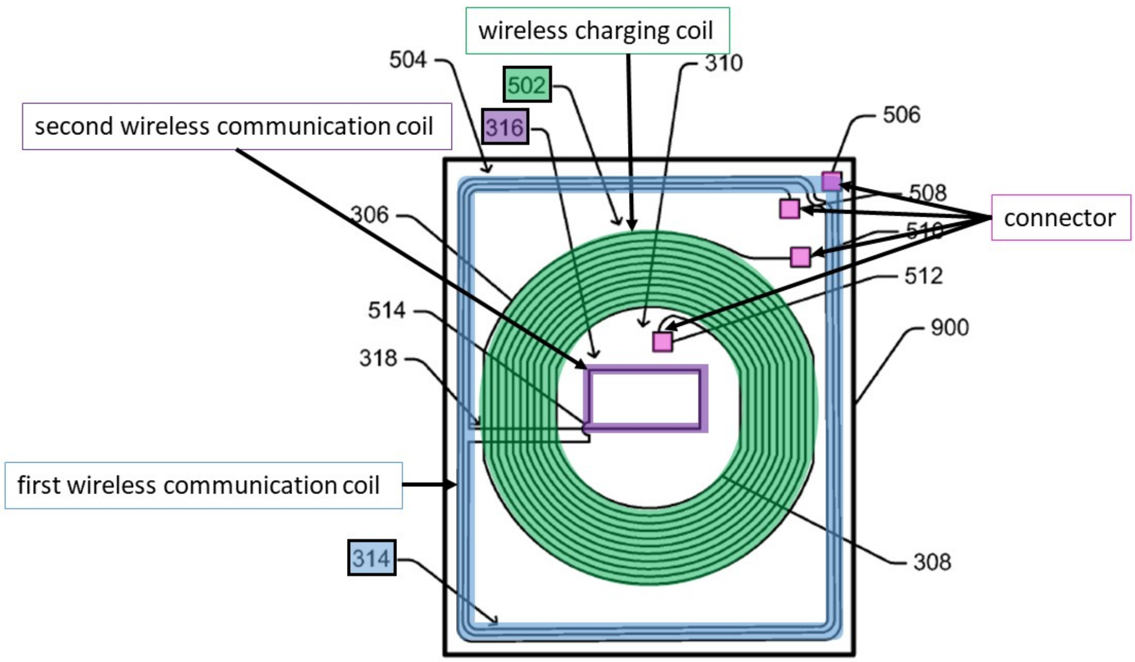


FIG. 9

(*Id.*, FIG. 9 (annotated).)

239. A person of ordinary skill in the art would have had good reason to modify Shostak's antenna with An's connector for the same reasons such a person would have implemented An's connector in Kim's antenna. Such a person would have had a reasonable expectation of success, as there is nothing particularly difficult or challenging about adding additional connection lines and terminals to Shostak's antenna, making it predictable and well within such a person's skill. In fact, Shostak's terminals 506, 508, 510, and 512 are similar to An's terminals 620, 610, 210, and 220, respectively. Thus, to the extent the Shostak-Kim antenna does not already disclose the claimed connector, such a skilled person would have only

needed to add An's sub-connection parts 501 to 504, conductive lines 321 to 324, and contact terminals 341 to 344, or a similar structure, to the Shostak-Kim antenna's flexible printed circuit board to form a "connector" as disclosed by An.

240. A person of ordinary skill in the art would have had good reason to make such a modification. For instance, An discloses that the antenna assembly may be buried in the back cover of a device, and when coupled to the device, the contact terminals (i.e., the connector) make an electric connection to the device. (Ex-1008, ¶[68].) Thus, a skilled person would have appreciated the benefits of using An's connector, and had good reason to form a single connector on the Shostak-Kim antenna's flexible printed circuit board for easier electrical connection between the antenna and a device.

2. Claim 29

a) The wireless antenna according to claim 28, wherein the flexible printed circuit board further comprises a connector connected to both the wireless communication antenna and the wireless charging antenna.

241. Shostak in combination with Kim and An discloses or suggests this feature for the reasons discussed for claim 12. (Section IX.G.1(a).)

3. Claim 45

a) The wireless antenna according to claim 44, wherein the flexible printed circuit board further comprises a connector connected to both the wireless communication antenna and the wireless charging antenna.

242. Shostak in combination with Kim and An discloses or suggests this feature for the reasons discussed for claim 12. (Section IX.G.1(a).)

X. CONCLUSION

243. In summary, it is my opinion that all of the features recited in claims 1-12, 17-29, 34-45, 50-52 of the '426 patent are disclosed or suggested by the prior art.

244. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: May 23, 2022 By: R. J. Baker
R. Jacob Baker, Ph.D., P.E.