IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re *Inter Partes* Review of:	)
U.S. Patent No. 9,767,955	)
Issued: Sept. 19, 2017	)
Application No.: 14/120,197	)
Filing Date: May 5, 2014	)

For: Multi Power Sourced Electric Vehicle

DECLARATION OF MARK ALLEN

CONTENTS

I. Introduction

1. I have been retained as an expert witness on behalf of Momentum Dynamics Corporation. ("Momentum" or "Petitioner") in the above-captioned *inter partes* review ("IPR") relating to U.S. Patent No. 9,767,955 ("the '955 patent") (Ex. 1001). The '955 patent relates to an inductive power transfer pad for receiving wireless power through inductive coupling.

2. I understand that Momentum is petitioning for IPR of claims 1-13 of the '955 patent and requests that the United States Patent and Trademark Office ("PTO") cancel those claims.

3. In preparing this Declaration, I have reviewed the '955 patent and considered the documents identified in Section III in light of the general knowledge in the relevant art. In forming my opinions, I relied upon my education, knowledge, and experience (including my extensive research and development experience with wireless power transfer) and considered the level of ordinary skill in the art as discussed below.

4. I am being compensated for my time in connection with this IPR at my standard consulting rate, which is $625.00 per hour, plus actual expenses. My compensation is not dependent in any way upon the outcome of this matter.

II. Background and Qualifications

5. I received a B.A. degree in Chemistry, a B.S.E. degree in Chemical

Engineering, and a B.S.E. degree in Electrical Engineering from the University of Pennsylvania, and a S.M. and Ph.D. (1989) from the Massachusetts Institute of Technology. From 1989 to 2013, I was a member of the faculty of the School of Electrical and Computer Engineering of the Georgia Institute of Technology, ultimately holding the rank of Regents' Professor and the J.M. Pettit Professorship in Microelectronics. In 2013, I joined the University of Pennsylvania faculty as the Alfred Fitler Moore Professor of Electrical and Systems Engineering, as well as was named the founding director of the Singh Center for Nanotechnology at Penn.

6. As discussed below, my technical expertise is in microelectromechanical systems (MEMS), microfabrication technologies for MEMS, and the application of MEMS in multiple fields. A particular research interest area of mine is the application of microfabrication technologies to magnetics, including magnetoquasistatic problems such as those inherent in near-field wireless power transfer based on magnetic field coupling.

7. At the beginning of my academic career in 1989, I founded my research group, the Microsensors and Microactuators Group. This group, consisting of graduate students and postdoctoral associates of both the Georgia Institute of Technology and the University of Pennsylvania, has been in continuous existence since that time. Although the composition as well as the specific research topics of the group have changed over time, the group has maintained a focus since its

founding on the development of new microfabrication technologies and their application to MEMS.

8. In 1990 I began a project on integrated magnetics with my first Ph.D. student. Our group has continuously worked on magnetics projects since then, with applications including magnetic energy storage and conversion, inductors and transformers, magnetically-driven relays, magnetic generators, permanent magnets, magnetic sensors, and wireless power transfer based on magnetic coupling.

9. In 1994 my student and I gave a plenary address to the IEEE Applied Power Electronics Conference and Exposition on the topic of micromachined inductors.

10. Over the past three decades, our group has published its work on magnetics in multiple IEEE journals, including the IEEE Journal of Microelectromechanical Systems, IEEE Transactions on Magnetics, IEEE Magnetics Letters, and IEEE Transactions on Power Electronics.

11. I am co-founder of multiple MEMS-related companies, including CardioMEMS, Axion Biosystems, and EnaChip.

12. CardioMEMS was founded in 2001 has commercialized wireless implantable microsensors for treatment of aneurysms and congestive heart failure – ultimately becoming the first MEMS-based medical device transducer FDA-approved for permanent human implantation. CardioMEMS received the 2006

Company of the Year award from Small Times magazine and the 2006 Frost and Sullivan Patient Monitoring Product Innovation of the Year Award, and its wireless aneurysm pressure monitor was highlighted by the FDA in its 2005 ODE annual report as a cleared medical device likely to have a significant impact on patient care. CardioMEMS completed a 550-patient clinical trial for its second product, a MEMS-based wireless implantable hemodynamic monitor for patients with congestive heart failure. After receiving FDA approval for its hemodynamic monitor, CardioMEMS was acquired by St. Jude Medical (now Abbott) in 2014.

13. The CardioMEMS wireless pressure sensor relies on near-field magnetic coupling between a source coil and a sensor coil, as detailed in U.S. Patents 6,111,520 and 7,245,117, among others, of which I am a co-author.

14. EnaChip was launched in 2017 and is focused on exploiting electroplatable, nanoengineered materials for the realization of ultracompact power supplies. In particular, Enachip is using these nanoengineered materials as the magnetic core of integrated inductors to produce multiwatt power supplies on a chip.

15. I have graduated approximately 50 PhD students and approximately 24 postdoctoral associates from the MSMA Group in the field of MEMS. Together with this group, I have published approximately 400 technical articles in the field of MEMS. I hold approximately sixty U.S. patents in the MEMS area.

16. The work of my research group has been cited approximately 28,000 times as estimated by Google Scholar.

17. In addition to the above, I have maintained my leadership position within the MEMS community. I was co-chair of the 2012 Power MEMS Conference, and chair of the 2016 Solid State Sensors, Actuators, and Microsystems Conference ('Hilton Head'). In 2021 I will chair the IEEE PwrSoC ('Power Supply on a Chip') conference, sponsored in part by the IEEE Power Electronics Society.

18. I am a Fellow of the IEEE, with the citation "for contributions to micro and nanofabrication technologies for microelectromechanical systems."

19. I received the 2016 IEEE Daniel P. Noble award in emerging technologies, with the citation "For contributions to research and development, clinical translation, and commercialization of biomedical microsystems."

20. I was elected to the U.S. National Academy of Inventors in 2017.

21. Additional details are provided in my CV, attached as Ex. 1004.

III. Documents Considered in Forming My Opinions

22. In addition to the information identified above (*e.g.*, ¶ 3) and elsewhere in this Declaration, in forming my opinions, I have considered the following documents:

Ex. No.	Description
1001	U.S. Patent No. 9,767,955 ("'955 patent")

Ex. No.	Description
1002	File History for ’955 patent (“’955 FH”)
1005	U.S. Patent Application Publication No. 2005/0189910 (“Hui-910”)
1006	International Publication No. WO 2005/024865 (“Beart”)
1007	U.S. Patent Application Publication No. 2004/0119576 (“Nakao”)
1008	U.S. Patent No. 8,749,334 (“’334 patent”)
1009	File History for ’334 patent (“’334 FH”)
1010	Frederick Emmons Terman, *Electronic and Radio Engineering* (4th ed. 1947) (“Terman”) (excerpts)
1011	New Zealand Patent No. 274,939
1012	U.S. Patent No. 6,501,364 (“Hui-364”)
1013	U.S. Patent No. 6,350,951
1014	U.S. Patent No. 8,639,191
1015	U.S. Patent No. 6,459,218
1016	Klaus Finkenzeller, *RFID Handbook* (Rachel Waddington trans., 2d ed. 2003) (“RFID Handbook”) (excerpts)
1017	Kathleen O’Brien, *Inductively Coupled Radio Frequency Power Transmission System for Wireless Systems and Devices* (2007) (Ph.D. dissertation, Technical University of Dresden) (“O’Brien”)
1018	Ned Mohan, et al., *Power Electronics* (2d ed. 1995) (“Mohan”) (excerpts)
1019	UK Patent Application Publication No. GB 2389720 A (“Hui-720”)
1020	Xun Liu & S.Y. Ron Hui, *Equivalent Circuit Modeling of a Multilayer Planar Winding Array Structure for Use in a Universal Contactless Battery Charging Platform,* 22 IEEE Transactions on Power Electronics 21 (Jan. 1, 2007) (“Liu”)

Ex. No.	Description
1021	*IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields 2 kHz to 300 GHz*, IEEE Standard C95.1-2005 (Apr. 19, 2006) (“IEEE C95.1-2005”)
1022	International Commission on Non-Ionizing Radiation Protection, *Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields*, 74 Health Physics 494 (1998) (“ICNIRP Guidelines”)
1023	H. Sakamoto et al., *Large Air-Gap Coupler for Inductive Charger,* 35 IEEE Transactions on Magnetics 3526 (Sept. 1999) (“Sakamoto”)
1024	U.S. Patent No. No. 7,804,272 (“Morita”)
1025	Chwei-Sen Wang, *Design Considerations for Inductively Coupled Power Transfer Systems* (Oct. 21, 2004) (Ph.D. thesis, University of Auckland) (“Wang”)
1026	U.S. Patent Application Publication No. 2007/0188284 (“Dobbs”)
1027	Mahendra Pratap Singh & Manoj Kumar Jain, *Evolution of Processor Architecture in Mobile Phones* 90 International Journal of Computer Applications 34 (Mar. 2014) (“Singh”)
1028	Sascha Segan, *The Evolution of the Blackberry*, PC Mag (Jan 28, 2013), https://www.pcmag.com/news/the-evolution-of-the-blackberry-from-957-to-z10 (“The Evolution of the Blackberry”)
1029	Tom Hormby, *A History of Palm, Part 1: Before the PalmPilot*, Low End Mac (July 19, 2016), https://lowendmac.com/2016/a-history-of-palm-part-1-before-the-palmpilot/ (“History of Palm”)

IV. Understanding of Legal Principles

A. Understanding of Legal Principles Relevant to Anticipation and Obviousness

23. I understand that a prior art reference can anticipate a patent claim when the prior art's disclosure renders the recited claim elements not novel. I understand that in order to anticipate a patent claim, a prior art reference must teach each and every element of the claim, expressly or inherently, with the same arrangement as in the claims. I understand that the words of a claim are generally given the ordinary and customary meaning that the term would have to a person of ordinary skill in the art at the time of invention. Because a claim is interpreted according to its meaning to a person of skill in the art, the knowledge, education, and experience of that person are also relevant to determining the scope and meaning of a patent claim. I understand that, in construing terms, one must look first to the intrinsic evidence of record, which includes the patent itself (including the claims and specification) and the prosecution history. I also understand that one may consider extrinsic evidence,

such as expert and inventor testimony, dictionaries, and learned treatises, though the intrinsic record is the most important.

24. In analyzing anticipation, I understand that it is important to consider the scope of the claims, the level of skill in the relevant art, and the scope and content of the prior art.

25. I understand that a prior art reference can render a patent claim obvious to one of ordinary skill in the art if the differences between the subject matter set forth in the patent claim and the prior art are such that the subject matter of the claim would have been obvious at the time the claimed invention was made.

26. In analyzing obviousness, I understand that it is important to consider the scope of the claims, the level of skill in the relevant art, the scope and content of the prior art, the differences between the prior art and the claims, and any secondary considerations.

27. I understand that when the claimed subject matter involves combining pre-existing elements to yield no more than one would expect from such an arrangement, the combination is obvious. I also understand that in assessing whether a claim is obvious one must consider whether the claimed improvement is more than the predictable use of prior art elements according to their established functions. I understand that there need not be a precise teaching in the prior art directed to the specific subject matter of a claim because one can take account of the inferences and

creative steps that a person of skill in the art would employ. I further understand that a person of ordinary skill is a person of ordinary creativity, not an automaton.

28. I understand that obviousness cannot be based on the hindsight combination of components selectively culled from the prior art. I understand that in an obviousness analysis, neither the motivation nor the avowed purpose of the inventors controls the inquiry. Any need or problem known in the field at the time of the invention and addressed by the patent can provide a reason for combining elements, even if that reason is different from the reason(s) that subjectively led the inventor to make its claimed combination. For example, I understand that it is important to consider whether there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims. I understand that known techniques can have obvious uses beyond their primary purposes, and that in many cases a person of ordinary skill can fit the teachings of multiple pieces of prior art together like pieces of a puzzle.

29. I understand that, when there is a reason to solve a problem and there is a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. I further understand that, if this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense, which bears on whether the claim would have been obvious.

30. I understand that secondary considerations can include, for example, evidence of commercial success of the invention, evidence of a long-felt need that was solved by an invention, evidence that others copied an invention, or evidence that an invention achieved a surprising or unexpected result. I further understand that such evidence must have a nexus, or causal relationship to the elements of a claim, in order to be relevant. I am unaware of any such secondary considerations for the ’955 patent. To the extent that Patent Owner puts forth any secondary considerations in these IPRs, I reserve the right to rebut those considerations with rebuttal evidence.

B. Person of Ordinary Skill in the Art

31. I understand that a person of ordinary skill in the art (“POSA”) is a hypothetical person who is presumed to be aware of all pertinent art, possesses conventional wisdom in the art, is a person of ordinary creativity, and has common sense. I understand that this hypothetical person is considered to have the normal skills and knowledge of a person in a certain technical field (including knowledge of known problems and desired features in the field).

32. I have been asked to focus my analysis on claims 1-13 of the ’955 patent, and prior art relating thereto, from the perspective of such a person at the time of the alleged inventions. I understand that the ’955 patent is a division of application no.

12/451,436, which was filed on May 9, 2008, and I understand that the ’955 patent was filed on May 5, 2014.

33. It is my opinion that a person of ordinary skill in the art in the 2008 to 2014 time frame would have had at least a bachelor’s degree in electrical engineering (or equivalent) and at least two years’ industry experience or equivalent research. Alternatively, a POSA could substitute directly relevant additional education for experience, e.g., an advanced degree in electrical engineering (or equivalent) with at least one year of industry experience.

34. As of May 9, 2008, I would have qualified as at least a POSA, and my opinions herein are informed by my own knowledge based on my personal experiences and observing others of various skill levels (including those above and below the level of a POSA).

35. My opinions below are not restricted to the precise definition of a POSA above. The claims of the ’955 patent are directed to common inductive power transfer and shielding techniques that were well-known in the art and taught by numerous prior art references, including the references discussed below. Thus my opinions below would apply under any reasonable definition of a POSA.

V. Overview of the ’955 Patent

A. The ’955 Patent

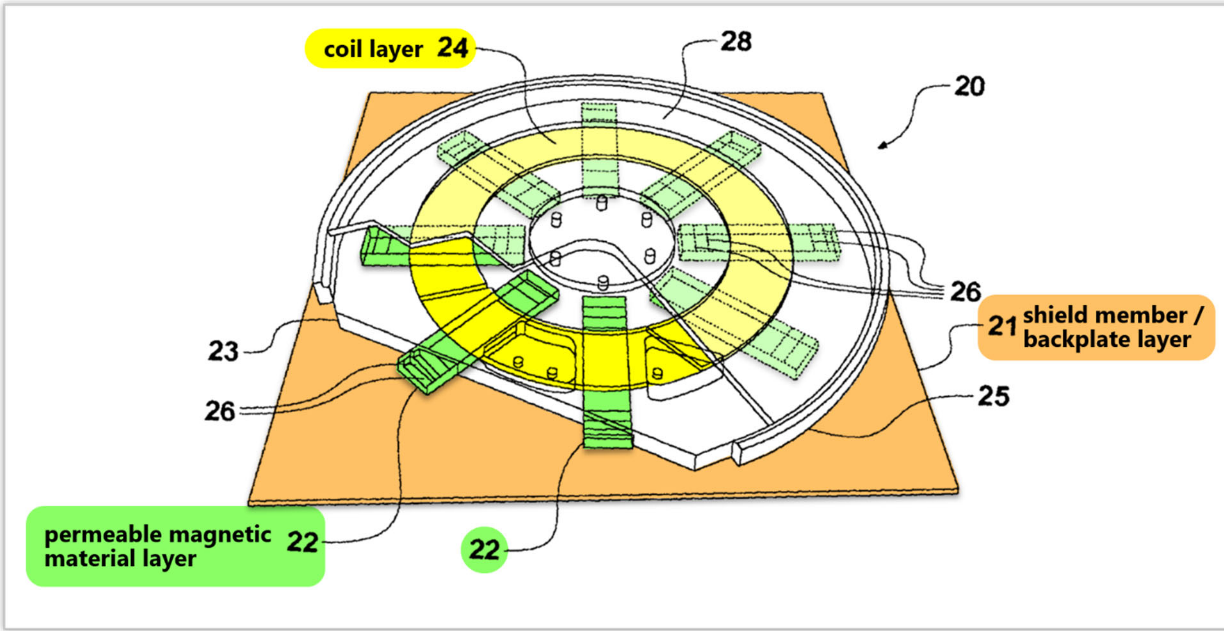
36. The ’955 patent is entitled “Multi Power Sourced Electric Vehicle” and names John Talbot Boys and Grant Anthony Covic as inventors. The ’955 patent was filed in the United States on May 5, 2014, and issued on September 19, 2017. The ’955 patent is a division of application no. 12/451,436, later issued as U.S. Patent No. 8,749,334 (“’334 patent,” Ex. 1008), which was filed on May 9, 2008. The ’955 patent generally relates to “[a]n inductive power transfer pad for transmitting power to a wireless power receiver separable from the inductive power transfer pad.” ’955 patent Abstract. More particularly, the ’955 patent is directed to an inductive power transfer pad for charging the battery of an electric vehicle, where the pad comprises three layers: a coil layer, a layer of ferromagnetic slabs, and a layer of conductive material for “channeling the flow of flux from the charging pad.” *Id.* at Abstract, 3:51-52; *see also id.* at 1:18-25, 2:39-44.

37. As the ’955 patent states, wireless “Inductive Power Transfer” (IPT) was already known as a “useful alternative to conventional charging” that incorporated well-known principles of energy transfer through inductive coupling. ’955 patent 2:12-24, 8:28-36, 9:62-10:4. Inductive coupling, also referred to as magnetic coupling, relates to the concept that a changing current through wire in one conductor creates a changing magnetic field that, in turn, induces a voltage

and/or current in other nearby conductors. Terman (Ex. 1010) 57. In this way, power can be transferred wirelessly between the two conductors. Electromagnetic induction was not a new concept as of the time of the '955 patent's earliest effective filing date—it was first discovered by Michael Faraday in 1831. The '955 patent operates on similar principles, with its two pads operating essentially as a transformer without a common core when transferring power.

38. The '955 patent is directed to improving the performance of inductive power transfer systems using its three layer pad structure, which it states will "channel[] the flow of flux from the charging pad" and "improves the inductive coupling but also reduces the chance that any undesired objects will be subjected to the induced fields during use." '955 patent 3:51-62. The patent also states that its three layer design is "beneficial in that it is relatively slimline compared to more conventional IPT pickups." *Id.* at 3:63-65.

39. An embodiment of the '955 patent's three layer charging pad structure is shown in annotated Figure 4 below.



’955 patent Fig. 4 (annotated), 8:62-9:5; *see also id.* at Abstract, 2:49-50, 3:5-17.

40. As annotated above, the pad includes a “metallic backplate 21” in one layer forming a shield member/backplate, “ferrite bars 22” in a separate permeable magnetic material layer, and a “coil of litz wire 27” in another coil layer, wherein the litz wire “is located on ferrite bars 22 in region 24” near the center of each bar. ’955 patent 8:62-9:5; *see also id.* at Abstract (“The inductive power transfer pad includes a coil having at least one turn of a conductor in a first layer and a plurality of ferromagnetic slabs arranged in a second layer substantially parallel to that of the coil.”).

41. I have referred to the “ferrite bars” as part of the “permeable magnetic material layer” because that is how those members are referred to in the claims, despite the word “permeable” not appearing in the specification. ’955 patent, cls. 1,

13 ("one or more permeable magnetic material members in a first layer"); *see also id.* at cl. 8 ("The inductive power transfer pad as claimed in claim 1, wherein the one or each permeable magnetic material member comprises ferrite."). While not explained in the '955 patent, a POSA would have understood that permeability refers to the relationship between the magnetic flux density and magnetic field intensity in a material, and is generally denoted using the Greek letter μ. The permeability μ of a material is the product of the relative permeability μ_r and the permeability of free space, μ_0. Some authors use μ as the symbol for μ_r, with the understanding that relative permeability is being referred to clear from the context. For example, in such cases, a typical soft magnetic material might be referred to as having a 'permeability or μ much greater than 1'. Using this notation, the permeability of ferrite would have been known to be much greater than 1, and thus it would have been (and still is) referred to as a permeable magnetic material. *See, e.g.*, O'Brien (Ex. 1017) 82 (referring to a "1mm thick sheet of ferrite" with permeability "μ=1000"); *see also* discussion and citations in Element/Step 1/15[a] of Ground 1 below.

42. The '955 patent states that the backplate 21 in Figure 4 above is "formed from a material which substantially inhibits the passage of magnetic flux," which is "aluminum in a preferred embodiment." '955 patent 8:62-65, 3:28-31. The inhibited magnetic flux is the flux that is generated by current flowing through the litz coil, which the '955 patent states is "channeled" by the metallic backplate so that

flux is directed "upwards from the plane of the backplate with less splay of flux in and parallel to the plane of the backplate." '955 patent 3:51-56. In other words, flux that would otherwise go "down" from the litz coil (as the pad is shown in Figure 4 above) would be inhibited by the metallic backplate 21, such that the flux is primarily directed "upwards" from the plane of the backplate. *Id.* The '955 patent states that the backplate thus provides "improved coupling between a charging pad and a pickup pad." *Id.* at 9:15-21. The '955 patent also states that the backplate can be coupled to (or formed integrally with) an "aluminum strip 25" that can "assist in controlling the pattern of the flux generated." '955 patent 9:5-7, 3:32-33. A POSA would have understood that using conductive shielding materials, like copper or aluminum, to control and prevent leakage flux was not new. For example, Dr. Frederick Terman's seminal textbook *Electronic and Radio Engineering*, Fourth Edition (published in 1947), was directed to describing the "basic tools of the electronic and radio engineer" (Ex. 1010, "Terman" at Preface) and taught:

> **The most practical shield for magnetic flux at radio frequencies is made of material having low electrical resistivity, such as copper or aluminum**. Magnetic flux in attempting to pass through such a shield induces voltages in the shield which give rise to eddy currents. These eddy currents oppose the action of the flux, and in large measure prevent its penetration through the shield.

Terman 35, Fig. 2-19; *see also id.* at 3 (classifying frequencies down to 10 kHz as radio frequencies).

43. I also note that the embodiments of the specification and the control of flux by the backplate is entirely with reference to the IPT pad that ***transmits*** power, whereas the independent claims of the '955 patent both recite the structure of an IPT pad that ***receives*** power. *Compare* '955 patent Abstract ("An inductive power transfer pad for ***transmitting*** wireless power . . ."),[1] 2:17-18 ("This ***charger*** provides many advantages . . . ."), 8:37-61 (describing a "charging pad"), *with id.* at cls. 1, 13. In the specification, the receiving (or "pickup") IPT pad is only discussed as being "preferably of the same shape and configuration of charging pad 20." '955 patent 8:37-42, 8:56-61 ("Note that the pickup pad is of the same configuration as charging pad 20 and description of charging pad 20 also applies to the pickup pad, except that charging pad 20 is coupled to an electrical supply (e.g., the mains electricity supply) and the pickup pad is attached to a load (i.e., the vehicle battery to be charged."); *see also* '955 FH 581-88 (Ex. 1002) (Applicant amending claims from a charging pad

[1] All emphasis has been added throughout unless otherwise noted.

to a pickup pad and arguing that Examiner-asserted prior art taught only an inductive power transfer pad to transmit power, not receive power).

B. The Challenged Claims

44. The ’955 patent recites two independent claims—claims 1 and 13. Claim 1 recites an “inductive power transfer pad to receive power” that comprises three elements formed in “layers”:

1. one or more permeable magnetic material members in a first layer;
2. a coil having at least one turn of a conductor, the coil being arranged in a second layer substantially parallel to that of said permeable magnetic material members; and
3. a shield member comprising a backplate defining a third layer, said backplate arranged to control electromagnetic flux generated by said transmitting pad.

45. Claim 13 has the same structure as claim 1, but where claim 1 is directed to the structure of the pad receiving power, claim 13 requires both a “wireless power receiver pad” and the “wireless power transmitter pad” to have the three-layer structure.

C. Prosecution History

46. I have reviewed the prosecution history of the ’955 patent and the prosecution history of its parent application, the ’334 patent. During prosecution of

the ’334 patent, the Examiner rejected the independent claims as anticipated by W.O. Publication No. 2005/024865 to Beart, et al. (Ex. 1006). ’334 FH 259 (Ex. 1009). Exemplary independent claim 72 is reproduced below and required, e.g., “one or more ferromagnetic slabs,” “a coil,” and “a shield member comprising a backplate”

72. (currently amended) An inductive power transfer pad comprising:

one or more ferromagnetic slabs;

a coil having at least one turn of a conductor, the coil being arranged in a plane substantially parallel to that of said ferromagnetic slabs; and

a shield member comprising a backplate defining a second plane substantially parallel to that of said ferromagnetic slabs, said backplate arranged to control said magnetic field generated by said coil ~~arranged around both said coil and said ferromagnetic slab(s) for channeling electromagnetic flux when in use.~~

’334 FH at 245-53 (Ex. 1009).

47. Specifically, the Examiner found that Beart taught a support backplate, a flux generating unit provided on the backplate, and a flux shield made of conductive material.

> Claims 72, 97 are rejected under 35 U.S.C. 102(b) as being anticipated by Beart et al [WO 2005/024865 A2.]
>
> Beart et al. discloses an inductive device comprising:
>
> - a support backplate [200];
>
> - a flux generating unit [coils 50] provided on the support backplate; and
>
> - a flux shield [70] made of electrically conductive material.

Id. at 259.

48. The Examiner also found that the remaining claims were obvious over Beart in view of U.S. Patent No. 5,528,113 to Boys, et al.

> Claims 73-83, 92-96 and 98-115 are rejected under 35 U.S.C. 103(a) as being unpatentable over Beart et al. in view of Boys et al. [US 5,528,113.]
>
> Regarding claims 72-83, Beart et al. discloses the instant claimed invention except for the specific arrangement of the coil/winding relative to the ferromagnetic slabs.

> The specific arrangement of the coil/winding relative to the ferromagnetic slabs would have been an obvious design consideration for the purpose of facilitating magnetic flux/field characteristics.
>
> Regarding claims 92-96, Beart e t al. discloses the instant claimed invention except for the specific material use for the backplate.
>
> The specific metal use for the backplate would have been an obvious design consideration based on the intended application and/or environments uses.
>
> Regarding claims 98-115, Beart et al. discloses the instant claimed invention except for the specific use of the inductive device.
>
> Boys et al. discloses the use of inductive device in charging system.
>
> It would have been obvious to one having ordinary skilled in the art at the time the invention was made to use the inductive of Beart et al. in a charging system, as suggested by Boys et al., for the purpose of providing induction for the charging system.

Id. at 259-60. The Examiner stated that Beart discloses the claimed invention except for the specific arrangement of the coil/winding relative to the ferromagnetic slabs, but the ’955 patent’s arrangement would have been an obvious design consideration for the purpose of facilitating magnetic flux/field characteristics. *Id.* The Examiner also found that the material used for the backplate and the specific use of the device would have been obvious. *Id.*

49. In response, the Applicant amended the claims to specify the ferromagnetic slabs, the coil, and the shield member are three layers of the inductive power transfer pad.

> 72. (currently amended) An inductive power transfer pad comprising:
>
> one or more ferromagnetic slabs in a first layer;
>
> a coil having at least one turn of a conductor, the coil being arranged in a second layer ~~plane~~ substantially parallel to that of said ferromagnetic slabs; and
>
> a shield member comprising a backplate defining a third layer ~~second plane substantially parallel to that of said ferromagnetic slabs~~, said backplate arranged to control said magnetic field generated by said coil.

Id. at 293-303. Applicant's argued that there was "no teaching or suggestion in Beart et al. of such a multi-layer structure." *Id.* at 302. The Examiner allowed the claims without remarks, and the '334 patent issued on June 10, 2014. *Id.* at 311-12.

50. On May 5, 2014, Applicant filed the divisional application that resulted in the '955 patent, and in the process, the Applicant amended the Abstract to specifically reference a coil layer and a second layer comprising a plurality of ferromagnetic slabs. '955 FH 21 (Ex. 1002). The '955 patent was filed with one independent claim reciting a "transmitting pad" having a "coil" and "ferromagnetic slabs" (but no shielding member) as reproduced below:

> 72. (New) An inductive power transfer pad for transmitting wireless power to a wireless power receiver separable from the inductive power transfer pad, the inductive power transfer pad comprising:
>
> a coil having at least one turn of a conductor in a first layer; and
>
> a plurality of ferromagnetic slabs arranged in a second layer substantially parallel to that of the coil, the ferromagnetic slabs being arranged so as to be spaced apart from one another about the coil with their lengths extending across a longitudinal length of the coil.

Ex. 1002 at 19.

51. That claim was found anticipated by U.S. Patent No. 5,469,036 to Eto, and the remaining dependent claims were obvious in light of Eto. *Id.* at 559-60. Regarding the independent claim, the Examiner found that Eto discloses an inductive power transfer pad comprising a coil of a conductor in a first layer and a plurality of magnetic material members in a second layer substantially parallel to the coil.

> Claim(s) 72 is/are rejected under pre-AIA 35 U.S.C. 102(b) as being anticipated by Eto [US 5,469,036.]
>
> Eto discloses an inductive power transfer device/pad comprising:
>
> - a coil [33] having at least one turn of conductor in a first layer; and
>
> - a plurality of magnetic material [35] arranged in a second layer substantially parallel to that of the coil wherein the magnetic material arranged so as to be spaced apart from one another about the coil with their lengths extending across a longitudinal length of the coil.

Id. at 559.

52. The Examiner found the remaining dependent claims were obvious because ferrite is a known magnetic material, the specific arrangement of the magnetic materials and shape of the coil would have been an obvious design consideration for the intended application, and the specific additional magnetic materials and/or the positioning of the magnetic materials would have been obvious for the purpose of providing the intended magnetic flux/field desired.

> Regarding claims 73-74, the specific arrangement of the magnetic materials and shape of the coil would have been an obvious design consideration based on the intended applications and/or environments uses.
>
> Regarding claim 78, ferrite material is a known magnetic material use in magnetic device.
>
> Regarding claim 75-77 and 79, the specific additional magnetic materials and/or positioning of the magnetic materials would have been obvious for the purpose providing intended magnetic flux/field desired.

Id. at 559-60.

53. In response, the Applicant canceled the pending claims and drafted a new set of claims directed to a pad to receive power rather than to transmit power as in the canceled claims. *Id.* at 582-84. The Applicant argued, among other things, that Eto disclosed only the transmitting side pad structure, rather than the newly claimed receiving pad, and that Eto did not suggest or teach a shield for controlling the magnetic flux.

> Independent claim 80 relates to an inductive power transfer pad to *receive* power from a

> transmitting pad. In contrast the coils of Eto (33, 35) referenced in the Office Action are arranged on the transmitting side. Eto shows a transmitting coil for providing power to a toy horse. The coils of Eto (33, 35) are formed by a plurality of panels connected in a track shape (col. 4, lines 31-32) and placed beneath the toy horse. This structure is designed to stay in a fixed position and transmit power to a different receiver. There is no suggestion in Eto that such an arrangement provides a useful receiver. The person skilled in the art would not be led to modify the structure into a receiver because it relies on a plurality of connected panels which would be unwieldy in a receiver.
>
> Eto is not understood to teach or suggest a shield for controlling the magnetic field as recited in independent claim 80. The arrangement in Eto is intended to promote a wide uncontrolled magnetic field in order to provide a wide and sufficiently continuous magnetic flux around the track to enable operation of the horse. Eto is not concerned with controlling the splaying of the magnetic flux, but instead the opposite to allow for movement of the horse. Eto's primary concern is to avoid the use of contact brushes for transferring electrical power (Col. 1, lines 49-63). Accordingly, a person of ordinary skill in the art would have no motivation to consider restriction or controlling of the magnetic flux since this would limit the effectiveness of horse's movements.

Id. at 585-87. The Examiner allowed the amended claims without any remarks. *Id.* at 723.

VI. Claim Construction

A. The three layers may be in any order

54. Independent claims 1 and 13 recite a similar three-layer structure for both the transmitting pad and the receiving pad. For example, claim 1 recites:

1. "one or more permeable magnetic materials in a **first layer**";

2. "a coil having at least one turn of a conductor, the coil being arranged in a **second layer** . . ."; and,

3. "a shield member comprising a backplate defining a **third layer** . . ."

55. It is my opinion that a POSA would have understood the terms "first layer," "second layer," and "third layer" to require separate layers but in no specific order.

56. First, if the independent claims required a particular order where the "coil" (second layer) is between the permeable magnetic material (first layer) and the backplate (third layer), dependent claim 4 would not make sense. Claim 4 depends from claim 1 and recites that the "permeable magnetic material" is between the backplate and the coil, i.e., the "first layer" is between the third and second layers:

> The inductive power transfer pad as claimed in claim 1 wherein a plane of the backplate is substantially parallel to planes of each of the permeable magnetic material members and the coil, **the plane of the or each permeable magnetic material is located between the plane of the backplate and the plane of the coil**.

'955 patent claim 4.

57. A POSA reading claim 4 and claim 1 together would therefore have understood that claim 1 simply recites that there are three layers without imparting any particular order.

58. The specification is consistent with this as well, as it also discloses embodiments where the ferrite is between the coil and backplate (like claim 4), rather than where the coil is between the ferrite and backplate as would be required if claim 1 required a particular order. For example, the specification recites:

> Preferably, the plane of the backplate is substantially parallel to the planes of the ferromagnetic slabs and the coil, with **the plane of the slabs located between the planes of the backplate and the coil**.

’955 patent 3:14-17.

59. In view of the above, it is my opinion that the independent claims do not require the three layers to be in any particular order.

B. “a shield member comprising a backplate”

60. Independent claims 1 and 13 also recite “a shield member comprising a backplate defining a third layer, said backplate arranged to control electromagnetic flux [generated by said transmitting pad].” As explained below, a POSA would have understood the claimed “shield member” only requires a backplate defining a third layer, although other components of the shield member could be included (like an aluminum strip or sidewalls).

61. First, I understand from counsel that the term "comprising" is a term of art in patent claims that means that a particular construct "comprising" other elements means that the named elements are essential, but other elements may be added and still form a construct within the scope of the claim. Here, the claim language only names the backplate defining a third layer as an element of the "shield member," and thus a POSA would understand that the only essential element is the backplate.

62. Second, I understand that the '955 patent is a continuation of the parent '334 patent, which shares the same specification as the '955 patent. The '334 patent also includes similar independent claims, including in particular, claim 1 of both the '334 patent and the '955 patent recite a "shield member comprising a backplate defining a third layer":

'955 patent, claim 1	'334 patent, claim 1
1. An inductive power transfer pad to receive power from a transmitting pad, the inductive power transfer pad comprising: one or more permeable magnetic material members in a first layer; a coil having at least one turn of a conductor, the coil being arranged in a second layer substantially parallel to that of said permeable magnetic material members; and **a shield member comprising a backplate defining a third layer, said backplate arranged to control**	1. An inductive power transfer pad for transmitting wireless power to a wireless power receiver separable form the inductive power transfer pad, the inductive power transfer pad comprising: one or more ferromagnetic slabs in a first layer; a coil having at least one turn of a conductor, the coil being arranged in a second layer substantially parallel to that of said ferromagnetic slabs; and

electromagnetic flux generated by said transmitting pad.	**a shield member comprising a backplate defining a third layer, said backplate arranged to control said magnetic field generated by said coil.**

63. The '334 patent also includes several dependent claims specifying additional elements for "the/said" shield member of claim 1, such as a "side wall" or "a metal strip forming a barrier" as reproduced below:

> 9. The inductive power transfer pad as claimed in claim 1, wherein the **shield member forms a side wall around the pad**.
>
> 10. The inductive power transfer pad as claimed in claim 9, wherein **the side wall extends from the backplate** and is integrally formed therewith.
>
> 16. The inductive power transfer pad of claim 1, wherein **said shield member further comprises a metal strip defining a barrier**, wherein said backplate and said metal strip are arranged to control said magnetic field generated by said coil.

'334 patent, cls. 9, 10, 16.

64. These claims of the '334 patent demonstrate that the claimed "shield member comprising a backplate defining a third layer" requires the backplate, but other unnamed elements that could be included, like side walls or a metal strip, could form part of a shield member but are not required.

65. The specification of the '955 patent does not require a different interpretation. The Summary of the Invention recites a "shield member" that may

be "formed from a strip of material" that is "coupled to the backpla[t]e." '955 patent 3:31-35; *see also id.* at 3:45-50 (similarly discussing a shield member as "extend[ing] from the backplate"). That statement could potentially be interpreted as indicating the shield member and backplate are separate elements. However, there are no definitional words in the specification that would indicate that the inventor redefined the word "shield member" to require a strip, or otherwise disavow shield members that do not have sidewalls, which would be inconsistent with the claims of the '334 patent discussed above.

66. Indeed, looking at the claim language and specification together, a POSA would have understood that nothing more than the backplate is required for the claimed "shield member." The '955 patent explains that the backplate is "formed from a material which substantially limits the passage of magnetic flux" such as "aluminium in a preferred embodiment." '955 patent 8:62-65, 3:28-31. A POSA would have therefore understood the "aluminium" [aluminum] backplate alone would act as a "shield member" because it would "shield" components on the opposite side of the backplate from magnetic flux. Indeed, aluminum plates were commonly referred to in the art as "shields" or "flux-shields" in systems that generate magnetic flux. For example, Dr. Frederick Terman explained in the 1947 edition of his book on Electronic and Radio Engineering that the "most practical shield for magnetic flux at radio frequencies is made of material having low

electrical resistivity, such as copper or aluminum." Terman (Ex. 1010) 35, Fig. 2-19; *see also id.* at Table 1-1 (listing radio frequency ranges). Terman explains that magnetic flux induces voltages in the aluminum, which give rise to eddy currents that "oppose the action of the flux, and in large measure prevent its penetration through the shield." *Id; see also* Beart 2:29-3:4 ("[C]onductive materials can be seen as 'flux-**shields'** – the lines of flux in any magnetic system are excluded from them.").

67. The '955 patent is consistent that the backplate, with or without an aluminum strip, is a shield member for magnetic flux. The '955 patent states that the "[a]luminium strip" may "**assist** in controlling the pattern of the flux generated," but as discussed above it is not required for controlling the pattern of the flux. '955 patent 9:5-7; *see also id.* at 3:28-31 (similar)

68. As a result, it is my opinion that a POSA would understand the claimed "shield member" as requiring a backplate defining a third layer, and could include, but does not require, other elements. However, even if the claim were interpreted to require that the "shield member" must include a strip of material or side wall, it is my opinion that the claims would be invalid for the reasons discussed with respect to Grounds 2 and 3 below.

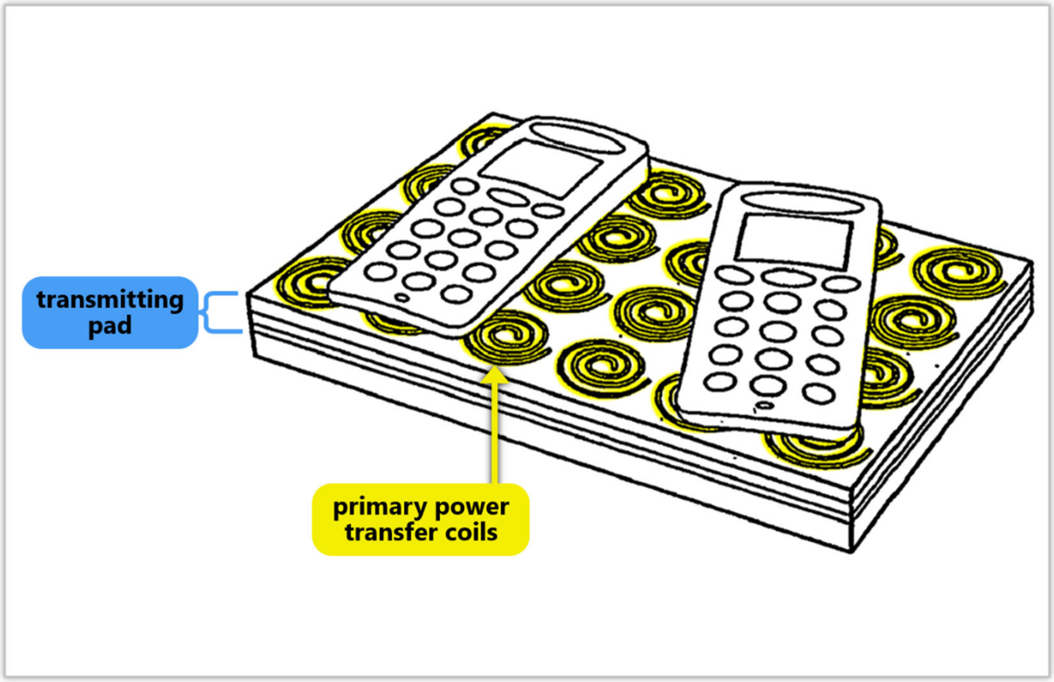
VII. Overview of the Prior Art

A. Overview—Hui-910 (Ex. 1005)

69. U.S. Patent Publication No. 2005/0189910 to Hui ("Hui-910," Ex. 1005) was published on September 1, 2005. I have been informed by counsel that Hui-910 is therefore prior art under 35 U.S.C. § 102(a), (b), and (e).

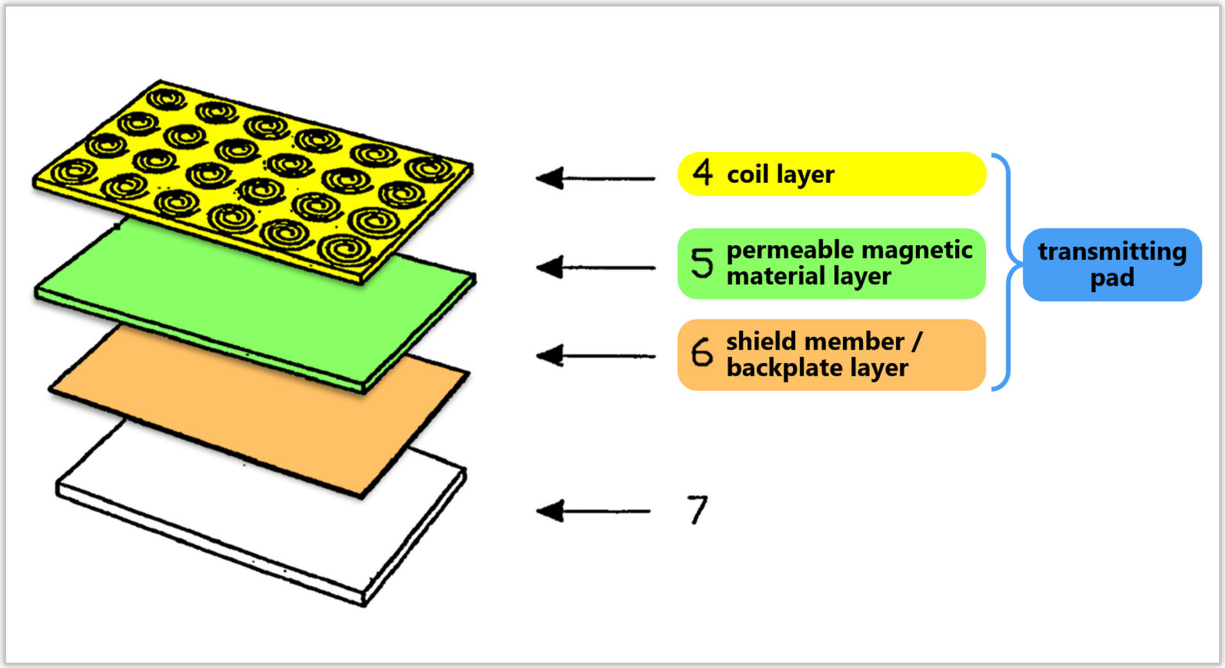
70. Hui-910 teaches an inductive power system for wirelessly charging the batteries of portable electronic devices, where the system consists of a "power delivering charger circuit" and a "separate secondary transformer circuit" in the portable electronic device being charged. Hui-910 ¶ 81. As I discuss below, both the power delivering charger circuit and the secondary transformer circuit have similar structures with multiple planar layers, including a planar spiral inductor coil layer, a permeable magnetic material layer comprising ferrite, and a backplate layer that comprises a conductive material such as copper to shield other electronics from the electromagnetic flux. *Id.* at Abstract, ¶¶ 1, 5, 11. 70-72, 80, 83.

71. Annotated Figure 4(c) below shows an example of two mobile phone embodiments placed on the power delivering charger circuit, or transmitting pad, for wireless charging.



Hui-910 Fig. 4(c) (annotated); *see also id.* at Abstract, Figs. 4(a), 4(b), 5(a), 5(b), 10(a), 10(b) (other figures showing power delivering charger circuit), Fig. 10(c) (depicting a representative circuit diagram showing energy coupled zones between primary and secondary windings), Fig. 11 (depicting "integrated secondary charger system" in a mobile phone battery pack), Figs. 12-13 (exemplary layer-by-layer diagrams of secondary transformer circuits in a mobile phone and watch), ¶¶ 72-73.

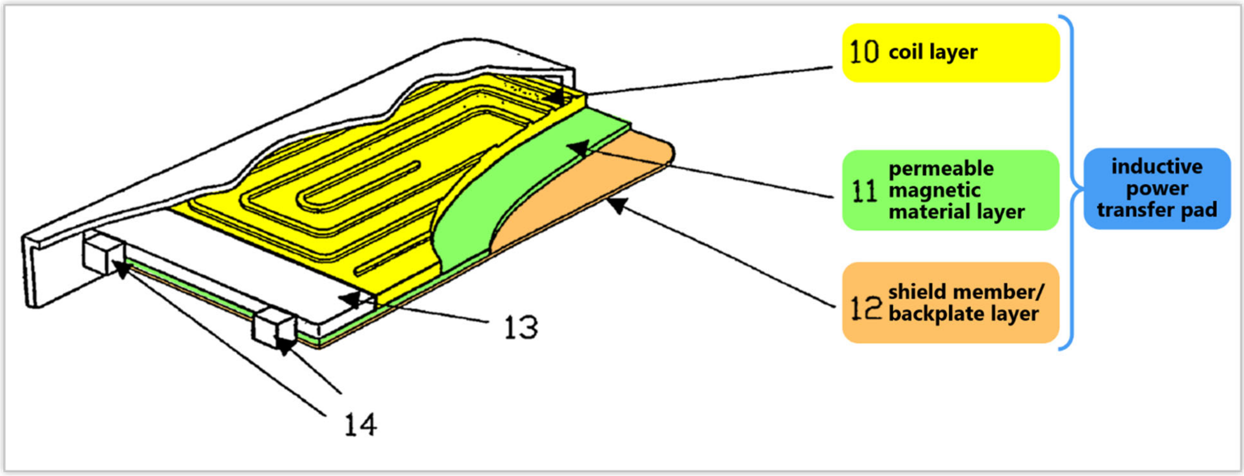
72. One view of a power delivering charger circuit, or transmitting pad, in Hui-910 is shown in Figure 5(a) below. The transmitting pad includes a primary winding(s) layer (element 4, forming a coil layer), a "ferrite" sheet (element 5, forming a permeable magnetic material layer), and a "sheet of conductive material" such as copper (element 6, forming an EMI shield/backplate layer). *Id.* ¶ 71. Beneath the copper sheet is an optional substrate material, such as a plastic case. *Id.*



Hui-910 Fig. 5(a) (annotated), ¶¶ 72-73; *see also id.* at Figs. 4(a), 4(b), 4(c), 5(b), 10(a), 10(b) (other figures showing power delivering charger circuit).

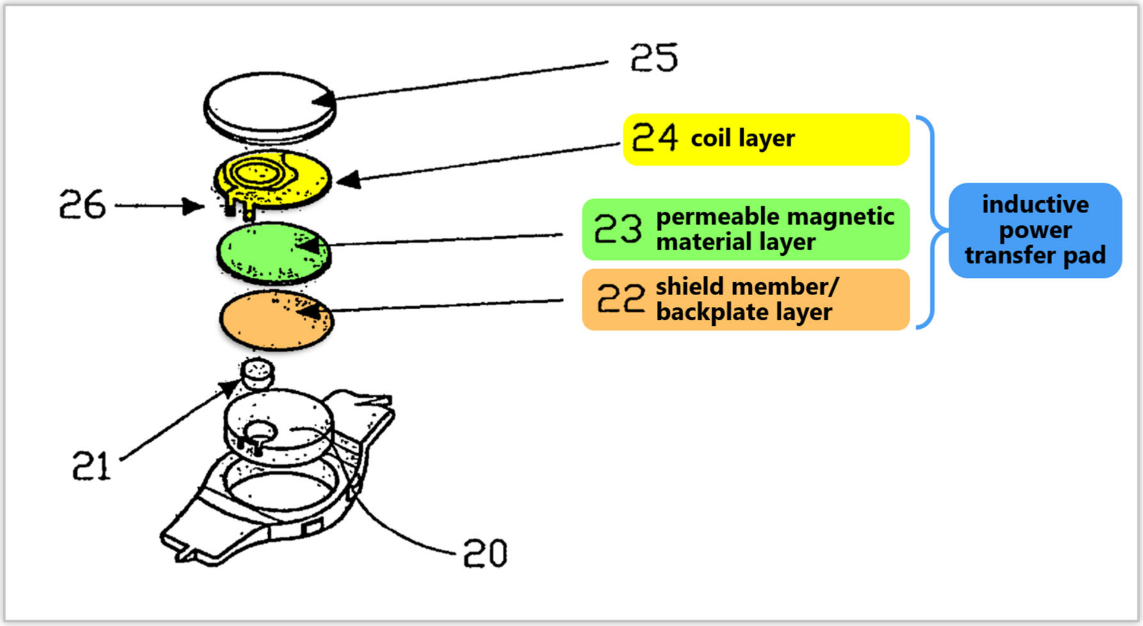
73. Hui-910 teaches two exemplary portable electronic devices that can be charged using the above transmitting pad, a mobile phone or a watch. The mobile phone embodiment is depicted with reference to Figure 12, and the watch embodiment with reference to Figure 13.

74. In the mobile phone embodiment, depicted below in annotated Figure 12(d), the receiving pad includes the claimed three layer structure: (1) a planar coil layer, (2) a ferrite magnetic material layer, and (3) a copper shield layer forming a backplate.



Hui-910 Fig. 12(d) (annotated), ¶ 80 ("[T]his back cover has a built-in secondary planar transformer winding 10, a diode rectifier circuit 13 and preferably a thin EMI shield 11, 12 . . . . This EMI shield can be . . . preferably a combination of a ferrite sheet 11 and then a thin sheet 12 of copper o[r] another conductive material such as aluminum."); *see also id.* at Figs. 11, 12(a), 12 (b), 12(c) (other figures showing mobile phone embodiment), ¶¶ 12, 28-29, 80, 81.

75. The watch embodiment has the same three-layer structure and is shown in annotated Figure 13(b) below.



Hui-910 Fig. 13(b) (annotated), ¶ 83 ("an EMI shield consisting of, for example, a copper sheet 22 and a ferrite sheet 23 (with the copper sheet closer to the watch mechanism than the ferrite sheet). The other side of the EMI shield is provided a planar coreless transformer secondary winding 24 formed with electrical contacts 26 for connection to the battery 21."); *see also id.* at Fig. 13(a) (other view).

76. Hui-910 taught the purpose of each of the three layers (coil, ferrite, and conductive backplate) in the power delivering charger circuit, and mobile phone and watch embodiments.

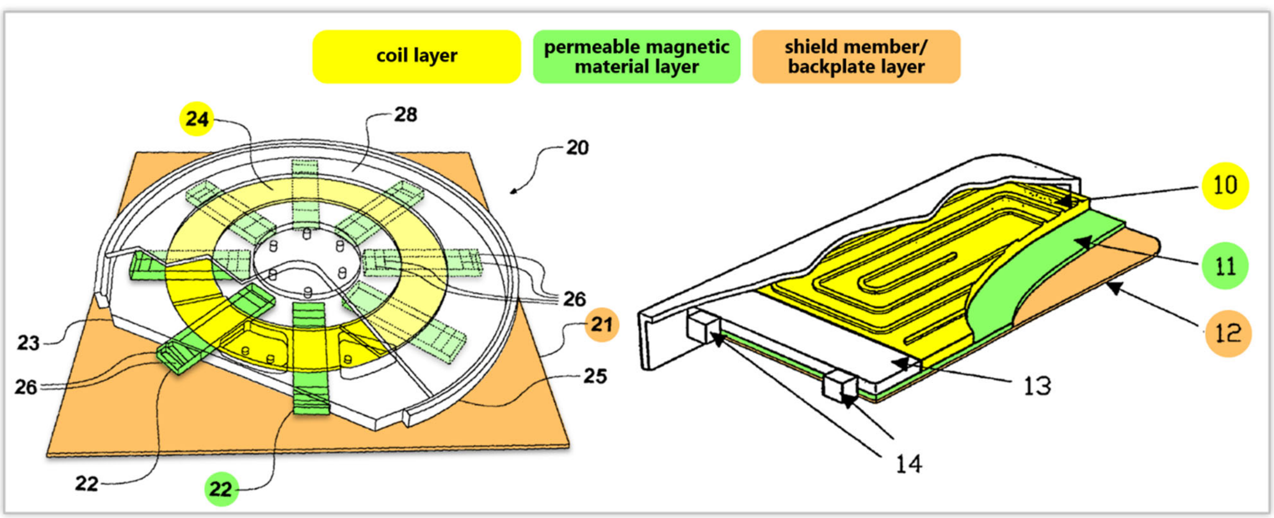
77. First, the coil layers transfer power wirelessly through inductive coupling. The primary coils or windings in the power delivering charger circuit are connected to a power supply, such as another battery plus AC generation circuitry or AC mains, and the resulting alternating current flowing through the primary coils

generates a magnetic field. *Id.* ¶¶ 74, 79 (explaining that the "parallel primary transformer winding . . . will generate magnetic flux"). In accordance with Faraday's Law, this time-varying magnetic field, in turn, induces a voltage, and a corresponding current, in appropriately-configured secondary coils nearby, such as the secondary coils in the mobile phone or watch embodiments. *Id.* ¶ 107 ("According to Faraday's Law, an AC voltage will be induced across the secondary winding if the secondary winding senses a changing magnetic flux . . . generated by the primary winding in the primary inductive charging system."); *see also* Terman (Ex. 1010) 11-21 (describing basic principles of inductive coupling). As a result, the secondary windings wirelessly "couple[] the energy from the nearby primary transformer winding." *Id.* ¶¶ 80, 95, 106. A rectifier circuit then converts the coupled AC voltage into a DC voltage to charge the battery in the mobile phone or watch. *Id.* at Fig. 10(c), ¶¶ 72, 80, 83.

78. Second, the ferrite and copper layers direct and control the electromagnetic flux generated by the primary coils in the charger circuit. As discussed above, magnetic flux is used to transfer power wirelessly through inductive coupling. However, the same magnetic flux that induces current in the secondary coils can also induce currents in other metallic objects in the portable electronic equipment, potentially causing damage. *Id.* ¶ 4 ("without proper EMI shielding, undesirable induced currents may flow in other metallic parts of the

portable electronic equipment"). In Hui-910's embodiments, the ferrite and copper layers serve as an "EMI shield" that redirects the magnetic flux away from other components besides the secondary coils in order to "avoid induced [current] from circulating in other metal parts inside portable electronic circuit." *Id.* ¶¶ 4, 80, 103 ("appropriate [EMI] shielding such as the combined use of ferrite and copper sheets . . . can be placed under the PCB winding in order to ensure that the magnetic flux generated in the PCB winding will not penetrate through the base of the primary inductive charging extension system."); *see also id.* ¶¶ 71, 80, 83-84.

79. The claims of the '955 patent are directed to the inductive power transfer pad that receives power from the transmitting pad, and requires the pad to have the three layers described above. Hui-910's receiving pads are very similar to those of the '955 patent as shown in the annotated comparison between Figure 4 of the '955 patent and Figure 12(d) of Hui-910 below:



'955 patent Fig. 4 (annotated); Hui-955 Fig. 12(d) (annotated). Claim 13 also requires the three layer structure for the transmitting pad, which Hui-910 discloses in a similar manner to the ’955 patent.

80. As described in detail below, it is my opinion that Hui-910 anticipates challenged claims 1, 4-6, and 8-13 of the ’955 patent.

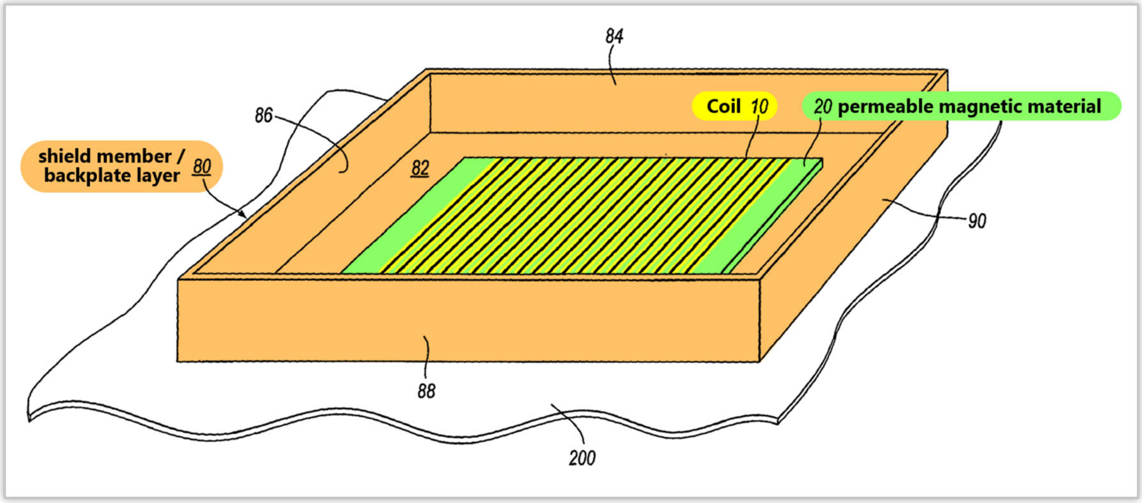
B. Overview—Beart (Ex. 1006)

81. W.O. Patent Publication No. 2005/024865 to Beart (“Beart,” Ex. 1006) was published on March 17, 2005. I have been informed by counsel that Beart is therefore prior art under 35 U.S.C. § 102(a), (b), and (e).

82. Like Hui-910 and the ’955 patent, Beart is directed to “inductive power transfer units having flux shields.” Beart Abstract, 1:3, 6:31-7:20. Beart explained that “[i]t is known that when conductive materials, for example copper or aluminum, are placed into an alternating magnetic field, the field induces eddy-currents . . . [that] generate a second field which – in the limit of a perfect conductor – is equal and opposite to the imposed field, and cancels it out at the surface of the conductor.” *Id.* at 2:29-3:1. Beart explains that “these conductive materials can be seen as ‘flux shields’ . . . used to shield one part of a system from a magnetic field and consequently concentrate the field in another part.” Beart 3:1-4.

83. One example of Beart’s improved flux shield is shown in annotated Figure 7 below, where the conductive flux shield has a backplate (referred to as “base

82") that extends beyond the coil and ferrite core, and also includes "side walls 84, 86, 88, and 90."



Beart Fig. 7 (annotated), 8:24-25, 10:6-16 (noting the height of the sidewalls in Figure 7 is "exaggerated" for "clarity"), 10:31-11:11 ("the flux shield shields objects outside the unit, adjacent to the external surfaces of the unit, from flux generated by the flux generating unit 50"); *see also id.* at 5:9-6:29.

84. Beart taught that extending the backplate and adding side walls can be beneficial compared to a flat copper shield (such as in Hui-910 and Hui-720 (Ex. 1019)). Beart explains, for example, that side walls "increases still further, compared to a flat sheet, the path that flux would have to travel in order to travel through a metal object underneath the flux generating unit." *Id.* at 5:16-18. As another example, the side walls further directs and controls the flux, "allow[ing] the flux to be concentrated in directions in which it is useful, improving the flux-efficiency of the unit," and it allows the flux to be "shielded from directions where it can cause side-

effects." *Id.* at 3:3-4, 4:11-14, 13:26-31. Beart also explains that its flux shield with side walls "increases the coupling between the flux generating unit and the secondary device(s) by forcing most of the flux to go over the power transfer surface." *Id.* at 4:16-20.

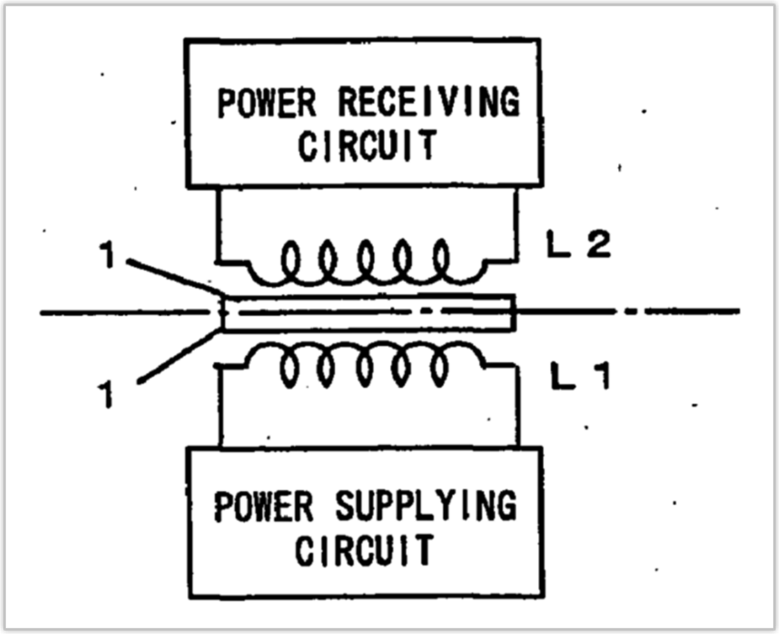
85. Beart also demonstrates the effect of its flux shield on directing and controlling flux using "finite element analysis views." *Id.* at 2:6-7, 2:15-17, 9:26, 10:21. For example, Beart illustrates the improved control of "flux lines" using its five-walled flux shield (Figure 8) as compared to a flux shield in the form of a flat sheet (Figure 6) and as compared to where no conductive shield is provided (Figure 3). *Id.* at Figs. 3, 6, 8, 8:12-13, 8:21-22, 8:27-28, 9:26-31, 10:21. Similarly, Beart provides a set of test results for a flux generating unit with no shield, a flat shield, and a flat shield with side walls, concluding that the "test results clearly demonstrate the two key advantages of a flux shield in reducing the side effects of metal objects: less power delivered into the steel by the generator, and less variation in power seen by the secondary device." *Id.* at 12:1-13:31.

86. As discussed in detail below in Ground 2, it is my opinion that a POSA would have been motivated to combine Hui-910 and Beart, and that claims 1 and 4-13 would have been obvious over Hui-910 in view of Beart.

C. Overview—Nakao (Ex. 1007)

87. U.S. Patent Publication No. 2004/0119576 to Nakao ("Nakao," Ex. 1007) was published on June 24, 2004. I have been informed by counsel that Nakao is therefore prior art under 35 U.S.C. § 102(a), (b), and (e).

88. Nakao taught wireless power transfer through a "noncontact coupler using magnetic coupling" that can be used "to supply power to or charge an electronic apparatus such as an electric car without contacting." Nakao ¶¶ 1, 2 ("a means of supplying power to or charging an electric car, electric bicycle or other electric apparatuses"). Nakao taught a coupler comprising transmitting and receiving pads, also referred to as the "primary" and "secondary" sides respectively, where the pads include "a pair of magnetic cores 1,1 around which the coils L1, L2 are wound." *Id.* ¶ 78. Nakao depicts this general configuration of a transmitting pad and receiving pad, each including a magnetic core 1 and a coil, in Figure 12D below.

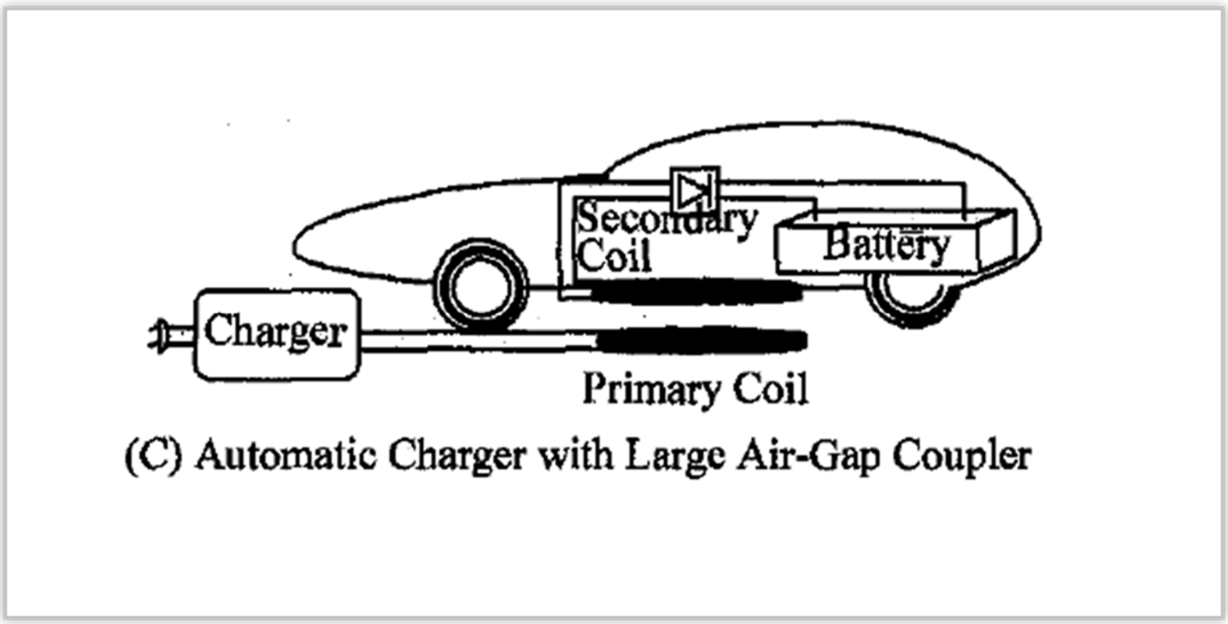


Nakao Fig. 12D, ¶ 42.

89. Nakao taught that the coupler "transmit[s] AC (high frequency) power from coil L1 of the core 1" in the transmitting pad connected to the "power supplying circuit," "to the other coil L2 of the other core 1" in the receiving pad. *Id.* ¶¶ 51, 78 ("these closed magnetic paths enable to transmit AC (high frequency) power from one coil L1 of the core 1 to the other coil L2 of the other core 1"), 95; *see also id.* ¶¶ 5, 7, 21, cl. 7.

90. As shown above in Figure 12D, Nakao's transmitting pad is located underneath the receiving pad, consistent with the understanding that, for an electric vehicle, the transmitting pad may be placed on or in the ground while the receiving pad is attached to the underside of the vehicle chassis. *See, e.g.*, Nakao ¶ 60, Figs. 1C, 1E, 3A-3B, 4A-4B, 10B, 11A, 12C-12D, 14, 15C, 16C-16D, 17A-B. This

configuration allows the receiving pad to be attached to the underside of the vehicle, enabling a vehicle to charge its battery by driving over and stopping the vehicle over the transmitting pad. Indeed, that configuration was well known in electric car charging applications using inductive power transfer pads like Nakao. For example, in another prior art article coauthored by Nakao, Nakao provided the following illustration of the primary pad in the ground and secondary pad under the car's vehicle chassis:



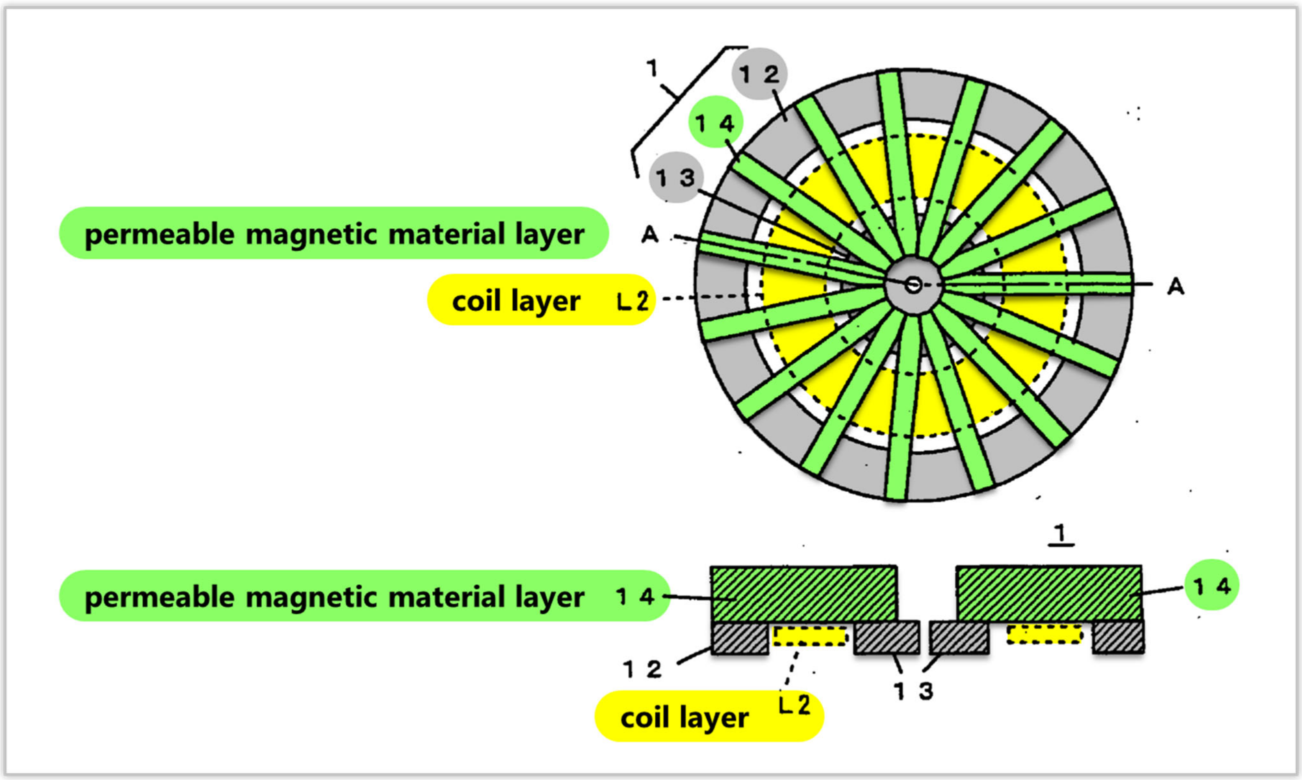
Sakamoto (Ex. 1023) Fig. 2(C). Likewise, other prior art references disclosing wireless car charging using inductive power transfer pads indicate that this configuration of the transmitting pad in the ground and the receiving pad under the vehicle were typical. *See, e.g.,* Morita (Ex. 1024) at 7:52-61 ("[t]he power receiving portion 2 is mounted in a mobile vehicle . . . [m]eanwhile, the power feeding portion

1 is embedded in, for example, a track way for the mobile object or a floor surface of a garage, a repair firm or the like.”), 5:56-67 (“[t]he power receiving portion 2 is attached in the lower part of the mobile object at a position where the power receiving portion 2 is opposed to the power feeding portion 1.”); Wang (Ex. 1025) 71 (“the secondary winding is attached to the underside of an electric vehicle, while the primary winding is buried in the ground. Once an electric vehicle has stopped over the charging station, electric power is transferred to the vehicle across an air gap via magnetic coupling between the primary coil in the ground and secondary coil on the vehicle.”).

91. According to Nakao, prior art systems used “magnetic cores . . . of solid integral structure” (i.e., solid layers of magnetic material) that resulted in at least three problems. Nakao Figs. 16A-D, ¶¶ 2-6. First, the prior art cores were heavy. *Id.* ¶ 10. Second, the prior art “large sized ferrite core[s]” were brittle and easily damaged during manufacturing, conveying, or assembling. *Id.* ¶ 55. Third, prior art core coupling was degraded unless the secondary coil was precisely aligned laterally relative to the primary coil. *Id.* ¶¶ 9, 13, 17, 27, 101, 104.

92. Nakao addressed those problems through different magnetic core arrangements that reduced weight, eased manufacturing, and improved coupling despite lateral displacement. *Id.* ¶¶ 11-13, 17, 27, 55, 101-02, 104. Regarding the claims of the ’955 patent, Nakao’s “second main technique of the invention” or third

embodiment is particularly relevant, which I refer to as the "Figure 7 embodiment." *Id.* ¶ 21. As shown below in Figures 7B and 7C, this embodiment includes a coil layer L2 (annotated in yellow) and a layer of magnetic ferrite bars (annotated in green, also referred to as "intermediate" or "middle core members 14"), where the ferrite bars are "arranged radially to form a circle" around a center point. Figure 7B shows a top-down perspective, while Figure 7C underneath it shows a profile view.



Nakao Figs. 7B, 7C (annotated); Nakao ¶¶ 19, 21, 30, 68-69, cl. 7.

93. Nakao's Figure 7 embodiment also includes "outer circumferential core members 12" and "disc-shaped inner circumferential core members 13." *Id.* ¶¶ 68-69. I've annotated those bars in gray in Figures 7B and 7C above for ease of

understanding of the figure. However, I do not refer to those additional core members 12 and 13 in my analysis below, as they are not pertinent to any specific limitation. I note that the preambles of claims 1 and 13 include the transitional term "comprising," which counsel informs me is a term of art in patent claims that is open-ended, meaning other elements may be added and still form a construct within the scope of the claim.

94. As discussed in detail in Ground 3 below, it is my opinion that claims 1-13 would have been obvious over Nakao in view of Beart.

VIII. Ground 1: Claims 1, 4-6, and 8-13 are anticipated by Hui-910

95. It is my opinion that Hui-910 discloses each and every claim element as arranged in claims 1, 4-6, and 8-13, and therefore anticipates those claims as discussed below.

A. Claims 1 and 13 are anticipated by Hui-910

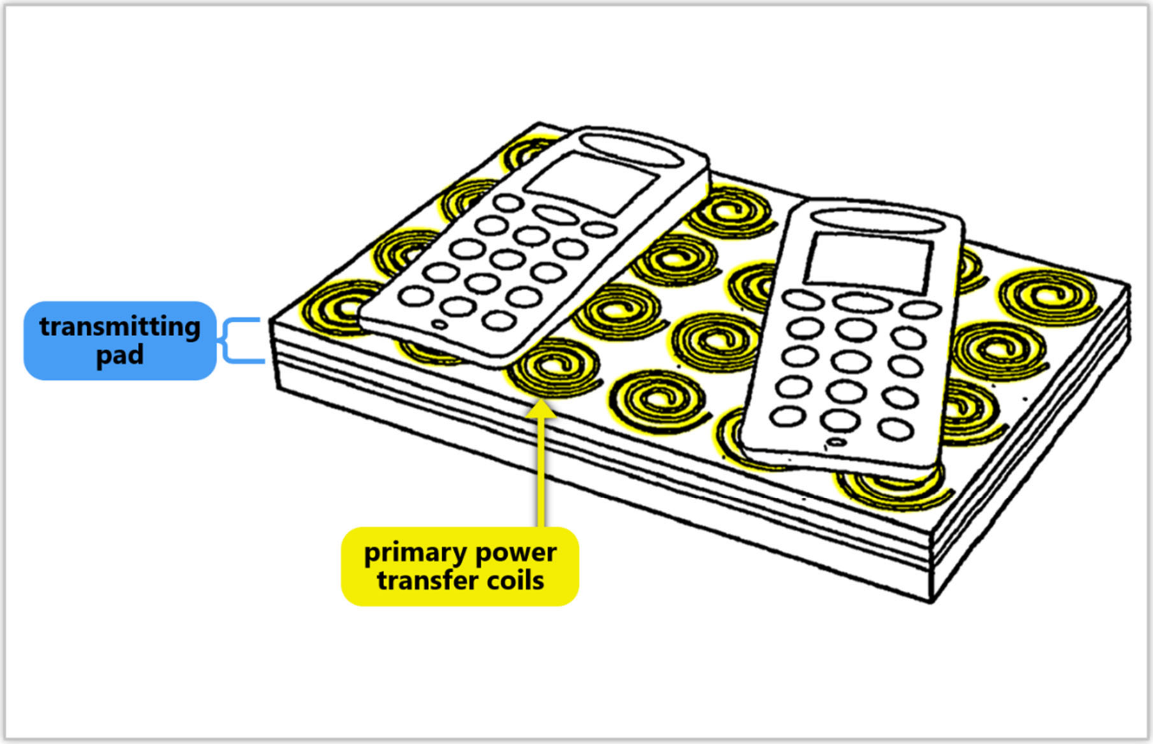
1. Preambles

96. The preamble to claim 1 recites "An inductive power transfer pad to receive power from a transmitting pad, the inductive power transfer pad comprising[.]" The preamble to claim 13 recites "An inductive power transfer system comprising a wireless power receiver pad separable from a wireless power transmitter pad, the two said pads each comprising[.]" Both claims are directed to inductive power transfer pads including what I refer to as the "transmitting pad" (the "transmitting pad" in claim 1 and the "transmitter pad" in claim 13) and a "receiving

pad" (the "inductive power transfer pad to receive power" in claim 1 and the "wireless power receiver pad" in claim 13). The primary difference between the preambles is that the remaining limitations of claim 1 are directed only to the receiving pad, whereas claim 13 is directed to both pads.

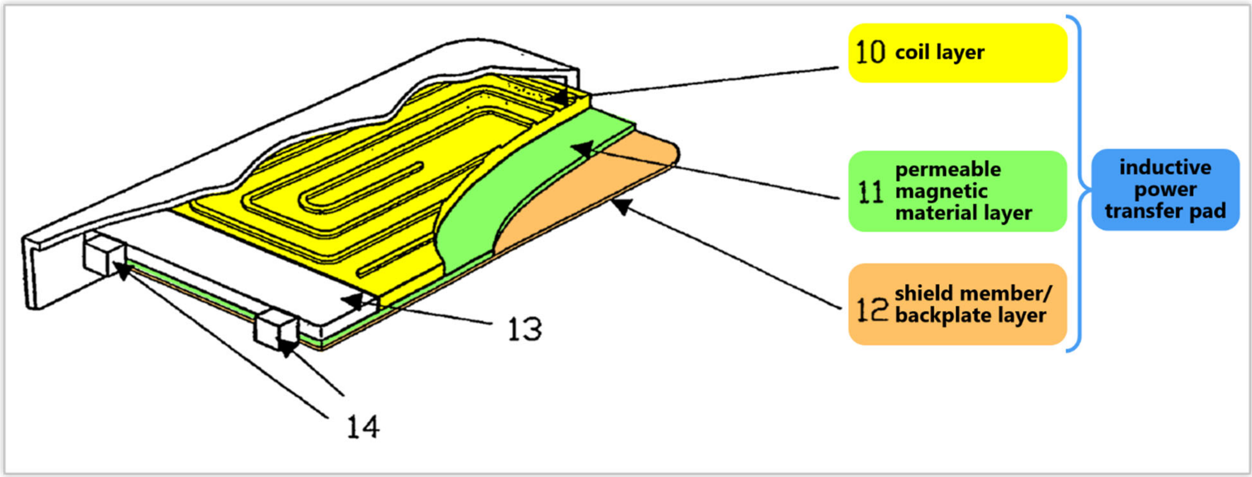
97. To the extent that these preambles are limiting, they are disclosed by Hui-910. Hui-910 teaches an "inductive charger system consist[ing] of two modules," where the first module is a "power delivering charger circuit" and the second module is a "secondary transformer circuit" for receiving power from the "power delivering charger circuit." Hui-910 ¶ 81; *see also id.* at Abstract, ¶¶ 1, 5, 11, 70, 72; Hui-910 Overview above. This inductive charger system is the same as the claimed "inductive power transfer system," with the "power delivering charger circuit" corresponding to the claimed transmitting pad, and the "secondary transformer circuit" corresponding to the claimed receiving pad.

98. Hui-910's "power delivering charger circuit," which corresponds to the claimed "transmitting/transmitter pad," is shown in annotated Figure 4(c) below. The power delivering charger circuit comprises one or more primary transformer windings, or inductor coils, that are substantially parallel to the flat charging surface in order to wirelessly transmit power, i.e., "no physical electrical connection" is needed, to inductor coils in the back cover of a secondary device, such as a mobile phone or watch.



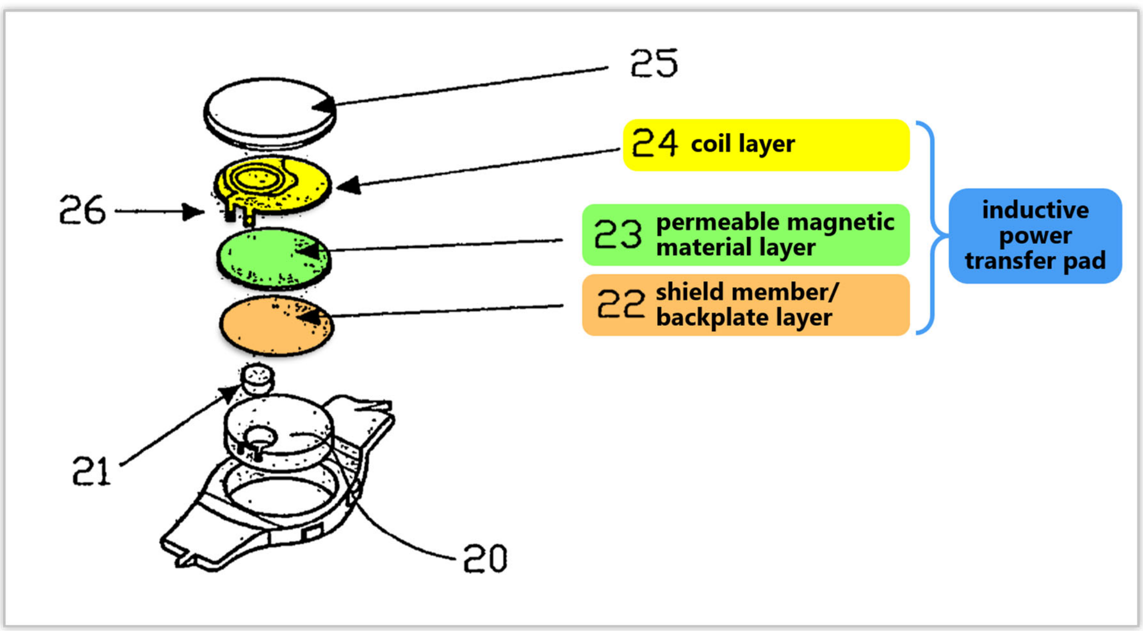
Hui-910 Fig. 4(c) (annotated) ¶¶ 21-22, 70-73, *see also id.* at Abstract, Figs. 4(a), 4(b), 5(a), 5(b), 10(a), 10(b) (showing other views of the transmitting pad).

99. As to the claimed receiving pad, Hui-910 taught mobile phone and watch embodiments that include an "integrated secondary charger system." *Id.* ¶¶ 28, 80. The mobile phone embodiment is depicted, for example, in Figure 12(b) below, which I have annotated to show its three-layer structure. In the figure below, the "back cover" is partially removed to show the winding "formed integrally with a back cover of [the] device," which receives power from the power delivering charger circuit.



Hui-910 Fig. 12(d) (annotated), ¶¶ 13 ("[p]referably the winding is formed integrally with a back cover of said device"), 80, 81, 28-29; *see also id.* at Figs. 11, 12(a), 12(b), 12(c) (other views).

100. Annotated Figure 13(b) below shows the watch embodiment, which similarly includes a planar secondary winding to receive power from the power delivering charger circuit. *Id.* ¶¶ 81, 83.

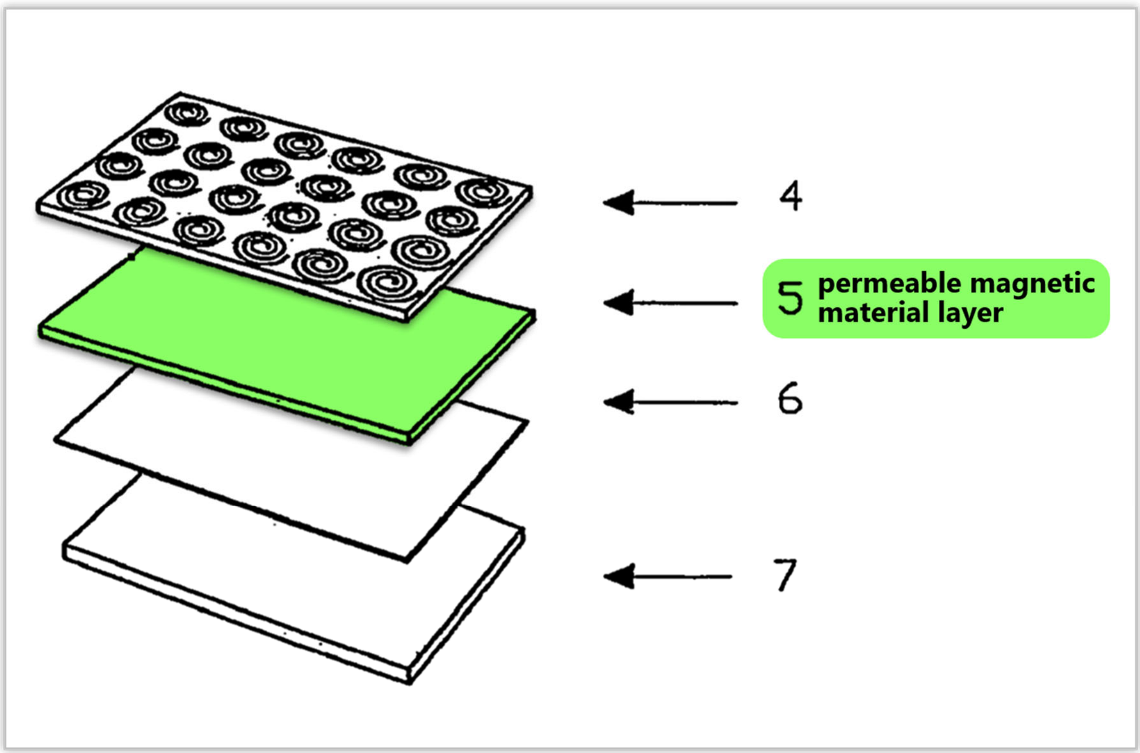


Hui-910 Fig. 13(b) (annotated), ¶¶ 30, 83; *see also id.* at Fig. 13(a).

2. Element 1/13[a]: permeable magnetic material layer

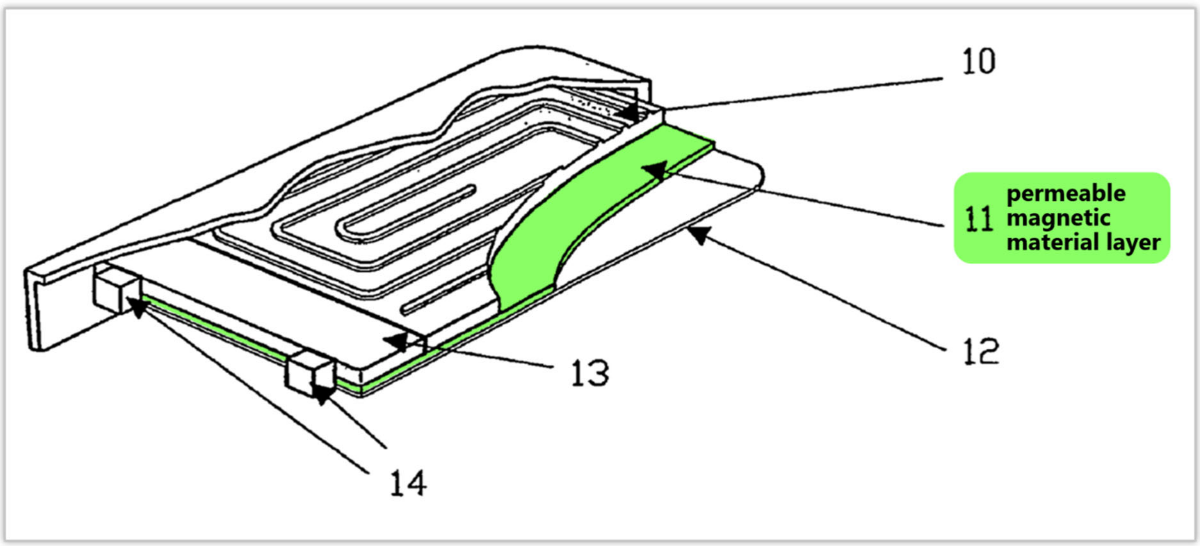
101. This claim element recites "one or more permeable magnetic material members in a first layer" in the receiving pad (claim 1) or in both the transmitting and receiving pads (claim 13). Hui-910 discloses this element for both claims.

102. As discussed in the Preambles, Hui-910's power delivering charger circuit corresponds to the claimed transmitting pad. That transmitting pad includes a "ferrite sheet 5," as shown in annotated Figure 5(a) below, which corresponds to the claimed layer of permeable magnetic material.



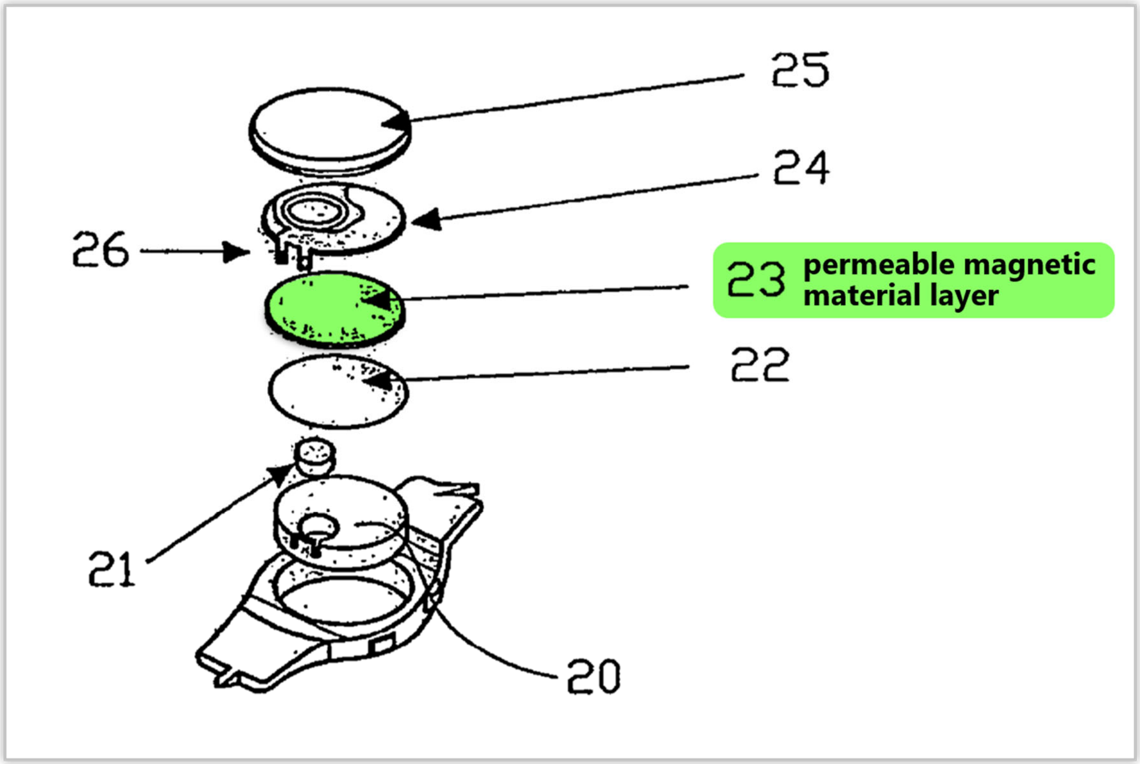
Hui-910 Fig. 5(a) (annotated); *see also id.* at Figs. 4(a), 4(b), 4(c), 5(b), ¶¶ 5, 8 ("[t]he primary winding is provided with electromagnetic shielding . . . [that] may include a **sheet of ferrite material** . . ."), 71 ("Beneath the PCB [printed circuit board] 4 (i.e., the side of the PCB away from the charging surface) is provided EMI shielding comprising firstly a **ferrite sheet 5** adjacent to the PCB 4 and then a conductive sheet 6."), 72-73; *see also* Hui-910 Overview above.

103. As to the receiving pad, Hui-910 discloses "one or more permeable magnetic material members in a first layer" in the secondary transformer circuit in both the mobile phone and watch embodiments. The mobile phone embodiment is shown below in annotated Figure 12(d), which includes "ferrite sheet 11" that corresponds to the claimed "one or more permeable magnetic material members in a first layer."



Hui-910 Fig. 12(d) (annotated); *see also id.* at Figs. 11, 12(a), 12(b), 12(c), ¶¶ 29, 80 ("This EMI shield can be a thin piece of **ferrite material** (such as a flexible ferrite sheet developed by Siemens) **or ferrite sheets**, or more preferably a combination of a **ferrite sheet 11** and then a thin sheet of copper or another conductive material such as aluminum"); *see also id.* ¶ 12 ("Preferably, the shielding comprises a sheet of ferrite material . . . .").

104. Similarly, as shown in annotated Figure 13(b) below, Hui-910's watch embodiment teaches a "a ferrite sheet 23" that corresponds to the claimed "permeable magnetic material member[] in a first layer."



Hui-910 Fig. 13(b) (annotated); *see also id.* at Fig. 13(a), ¶¶ 30, 83; *see also id.* ¶ 12 ("Preferably, the shielding comprises a sheet of ferrite material . . . .").

105. A POSA would have understood that Hui-910's ferrite sheets are "permeable magnetic materials" in the context of the '955 patent. First, claim 8 depends from claim 1 and defines exemplary permeable magnetic materials as

including "ferrite." '955 patent 15:6-8 ("wherein the or each permeable magnetic material member comprises **ferrite**"). Second, the specification of the '955 patent never uses the term "permeable magnetic material member," but does disclose the use of "ferrite" bars arranged in a layer consistent with the claim language. *Id.* at 2:48 ("[p]referably, the ferromagnetic slabs are **ferrite** slabs"), 8:62-9:5 (teaching "**ferrite** bars"), 10:67-11:1 (teaching "**ferrite** or ferromagnetic bars"); *see also id.* at claim 2 ("permeable magnetic material members in a form of bars").

106. Third, a POSA would have understood ferrite to have a high magnetic permeability, and thus would generally be considered a "permeable magnetic material." Indeed, that is reflected in other prior art from the named inventors of the '955 patent. For example, New Zealand Patent No. 274,939, also to Boys, teaches inductive power pick-up coils with a ferrite core and explains that "high magnetic permeability" materials are preferred to "concentrate the available flux into a smaller space." NZ Pat. No. 274,939 (Ex. 1011) at 13:33-36. The patent further explains that "[w]e prefer to use **ferrites**, some preferred types of which have a permeability (μ) of 2000 to 3000." *Id.* at 14:1-2. Other patents by Boys similarly refer to ferrite as permeable magnetic material. *See, e.g.*, U.S. Patent No. 8,539,191 (Ex. 1014) at 7:53-54 ("power transfer units which try to attract flux using **ferrite or similar high permeability materials**"); U.S. Patent No. 6,459,218 (Ex. 1015) at 12:12-13 ("magnetically permeable coupler such as a **ferrite**"). Similarly, Hui

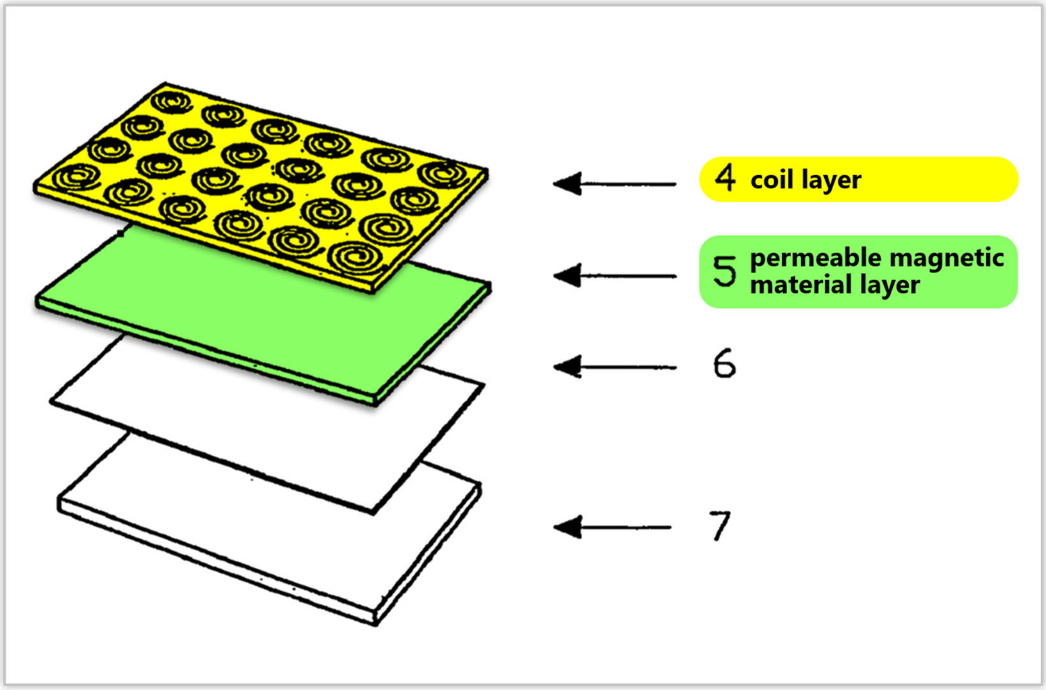
expressly referred to ferrite as a high permeability material in other patents where he is named as an inventor. For example, in U.S. Patent No. 6,501,364, Hui teaches electromagnetic shielding of printed-circuit-board transformers and explains that "[t]he high relative permeability, μ_r, of the **ferrite** material guides the magnetic field along the inside of the ferrite plates." U.S. Patent No. 6,501,364 ("Hui-364," Ex. 1012) at 3:29-31. Other authors recite the same. *See, e.g.*, U.S. Patent No. 6,350,951 (Ex. 1013) at 4:40-41 ("[e]xamples of high permeability material include ferrous materials, such as **ferrite**."); O'Brien 82 (referring to a "1mm thick sheet of ferrite" with permeability "μ=1000").

107. In sum, a POSA would have understood that Hui-910's "ferrite sheet" in its transmitting and receiving pads disclose "one or more permeable magnetic material members in a first layer" as claimed.

3. Element 1/13[b]: coil layer

108. This claim element recites "a coil having at least one turn of a conductor, the coil being arranged in a second layer substantially parallel to that of said permeable magnetic material members." Claim 1 applies to the coil in the receiving pad, while claim 13 applies to both the receiving pad and the transmitter pad. Hui-910 teaches these elements.

109. Annotated Figure 5(a) below shows Hui-910's transmitting pad, which includes a plurality of planar "primary windings" that corresponds to the claimed "coil having at least one turn of a conductor."

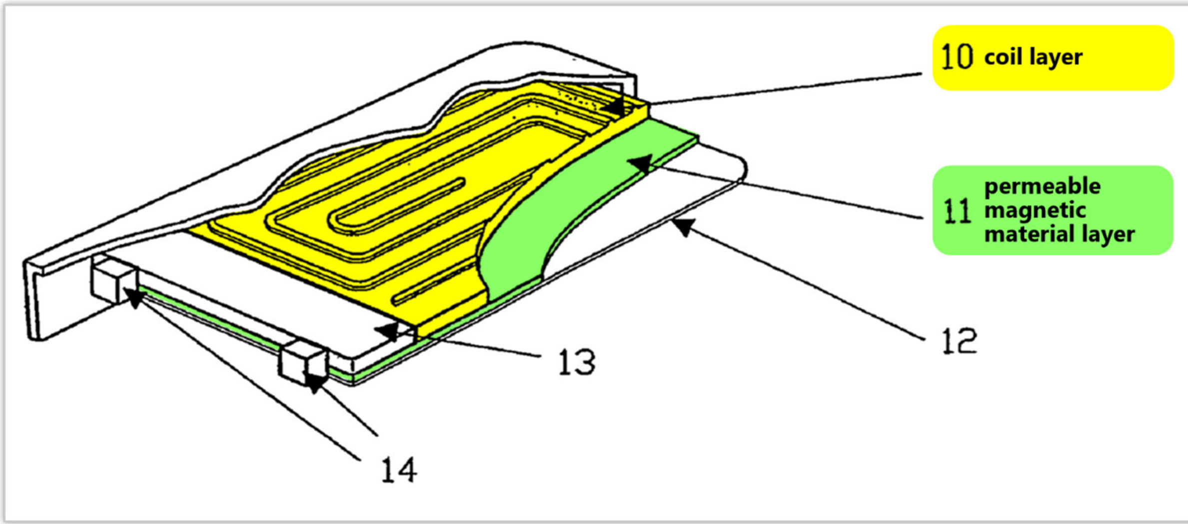


Hui-910 Fig. 5(a) (annotated); *see also id.* at Figs. 4(a), 4(b), 4(c), 5(b), 10(a), 10(b), 10(c).

110. As annotated above and shown in the figures, the coil layer "is arranged in a second layer substantially parallel to that of said permeable magnetic material members," where the permeable magnetic material layer is ferrite as discussed with respect to Element 1/13[a] above. Consistent with the fact that the coil layer and ferrite are substantially parallel, Hui-910 repeatedly refers to the coil layer as "flat," "planar," and "parallel to the charging surface" as it is depicted above. *See, e.g., id.*

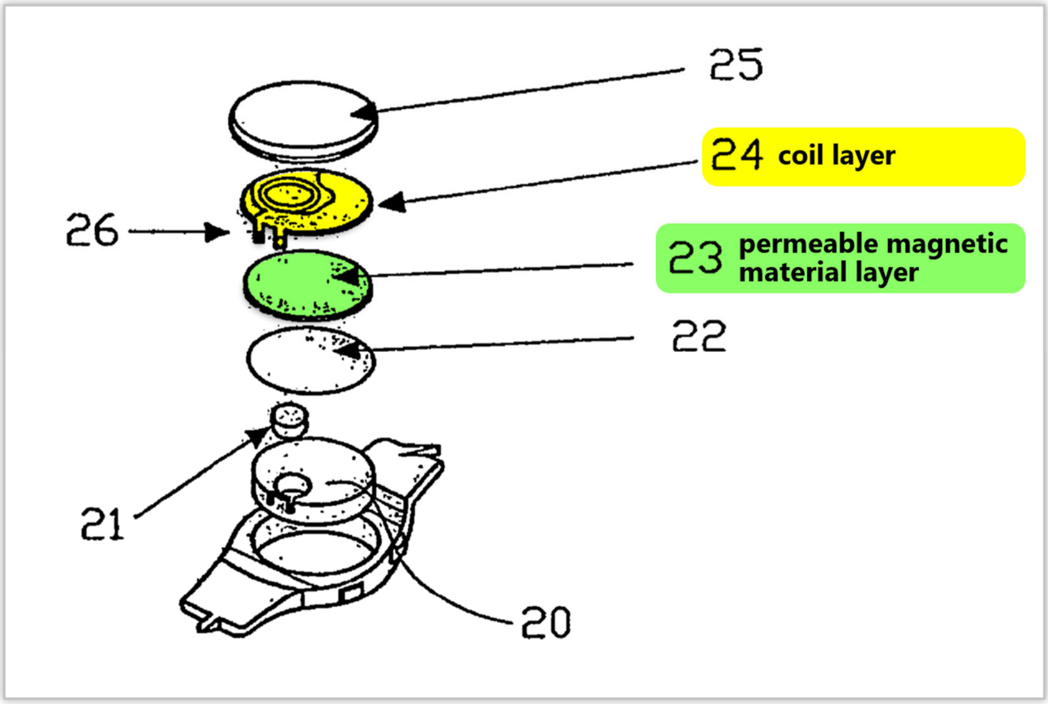
at Abstract ("There is provided a **planar** inductive battery charging system . . . [that] includes a **planar** charging module . . . ."), ¶¶ 1 ("battery charger having a **planar** surface"), 70 ("**flat** charging surface"), 5 (primary winding being **substantially parallel** to said **planar** charging surface"), 6 ("In a preferred embodiment the primary winding formed on a **planar** printed circuit board."), 7-9, 14, 70, 72 ("**flat** charging surface that contains the primary transformer windings"), 73 ("**planar** transformer that consists of a group of primary windings"), 74 ("primary **planar** windings"), 77, 81 ("**planar** inductive battery charger"), 82-83, 91, 92; *see also id.* at cls. 1, 3, 13, 14, 17, 21 ("primary transformer windings are **planar and substantially parallel** to a planar charging surface"), 27 ("**planar** charging surface").

111. Regarding the claimed receiving pad, annotated Figure 12(d) below shows the integrated back cover of Hui-910's mobile phone embodiment, where the "back cover has a built-in secondary planar transformer winding 10."



Hui-910 Fig. 12(d) (annotated), ¶¶ 72, 80; *see also id.* at Figs. 11, 12(a), 12(b), 12(c), ¶ 14 ("secondary **coil** located in the device being charged . . . able to couple to the secondary **coil**"). Because the receiving pad is intended to receive power from the flat charging surface of the transmitting pad, "[t]he secondary winding is also planar" and parallel to the ferrite layer 11 (the permeable magnetic material layer). *Id.* ¶¶ 72, 11 ("wherein the device includes a **planar** secondary winding"), 70 ("the equipment is charged simply by placing the equipment on the surface so that the planar surface on the equipment is brought into contact with the planar surface on the equipment"), 80 ("this back cover has a built-in secondary planar transformer winding").

112. Hui-910's watch embodiment likewise has a "planar coreless transformer secondary winding 24," which corresponds to the claimed "coil having at least one turn of a conductor" that is parallel to the ferrite layer 23.



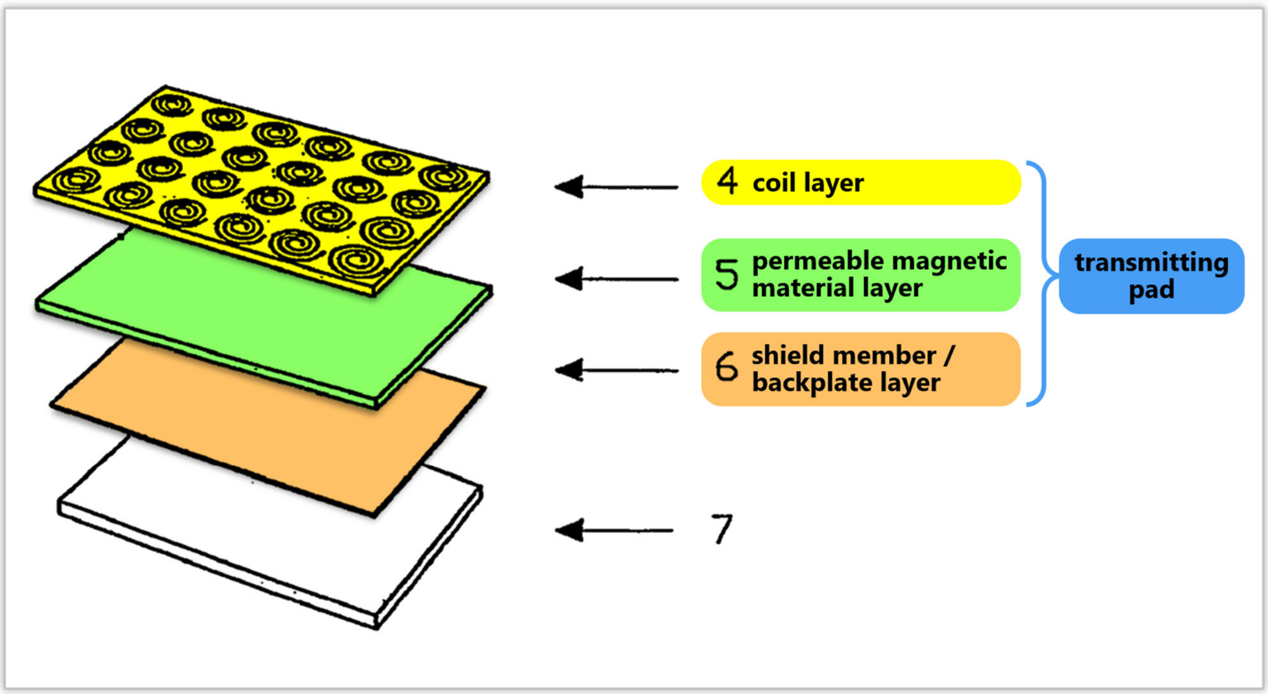
Hui-910 Fig. 13(b) (annotated), ¶¶ 12, 30 83 ("planar coreless transformer secondary winding"), Fig. 13(a); *see also id.* ¶ 11 ("wherein the device includes a **planar** secondary winding").

4. Element 1/13[c]: shield member comprising a backplate for controlling flux

113. In claim 1, this element recites "a shield member comprising a backplate defining a third layer, said backplate arranged to control electromagnetic flux generated by said transmitting pad." Claim 13 is substantively similar as it recites "a shield member comprising a backplate defining a third layer, said backplate arranged to control electromagnetic flux." As I discuss with respect to claim construction, a POSA would have understood the claimed shield member to

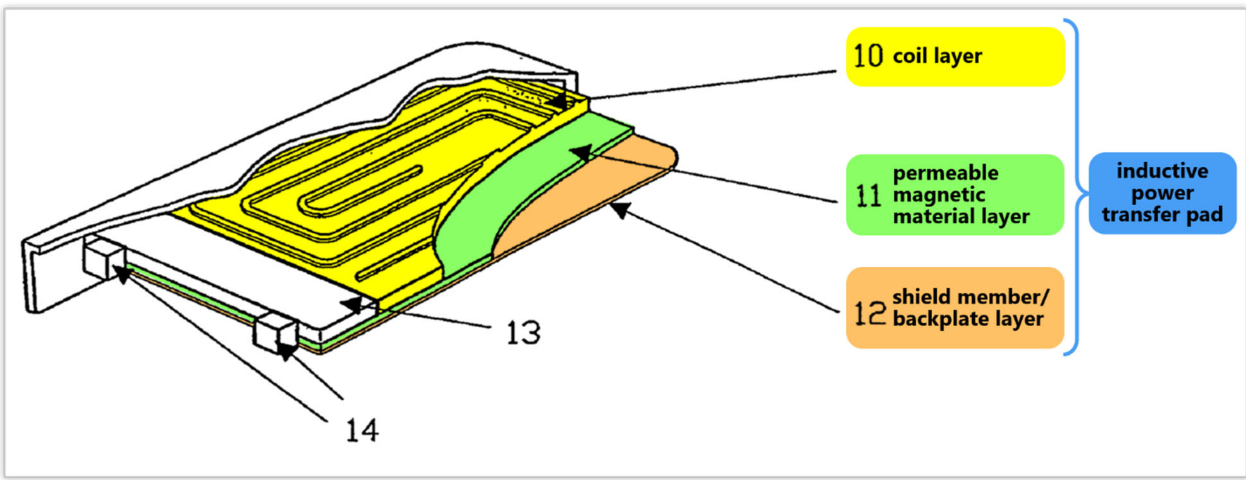
require the recited backplate, while permitting but not requiring other elements. *See* Claim Construction Section above. Hui-910 discloses this element for both claims.

114. Starting with the transmitting pad, Figure 5(a) below shows Hui-910's power delivery charging module, which includes a "conductive sheet 6 which . . . may be a copper sheet" that corresponds to the claimed "shield member comprising a backplate defining a third layer." Hui-910 ¶ 71. Taken together and as annotated below Hui-910 teaches that its transmitting pad includes all three claimed layers: coil layer 4 ("second layer," *see* Element 1/13[b] above), ferrite layer 5 ("first layer," *see* Element 1/13[a] above), and this backplate 6 (the "third layer").



Hui-910 Fig. 5(a) (annotated), ¶¶ 71, 73; *see also id.* at Figs. 4(a), 4(b), 4(c), 5(b), ¶¶ 5, 8.

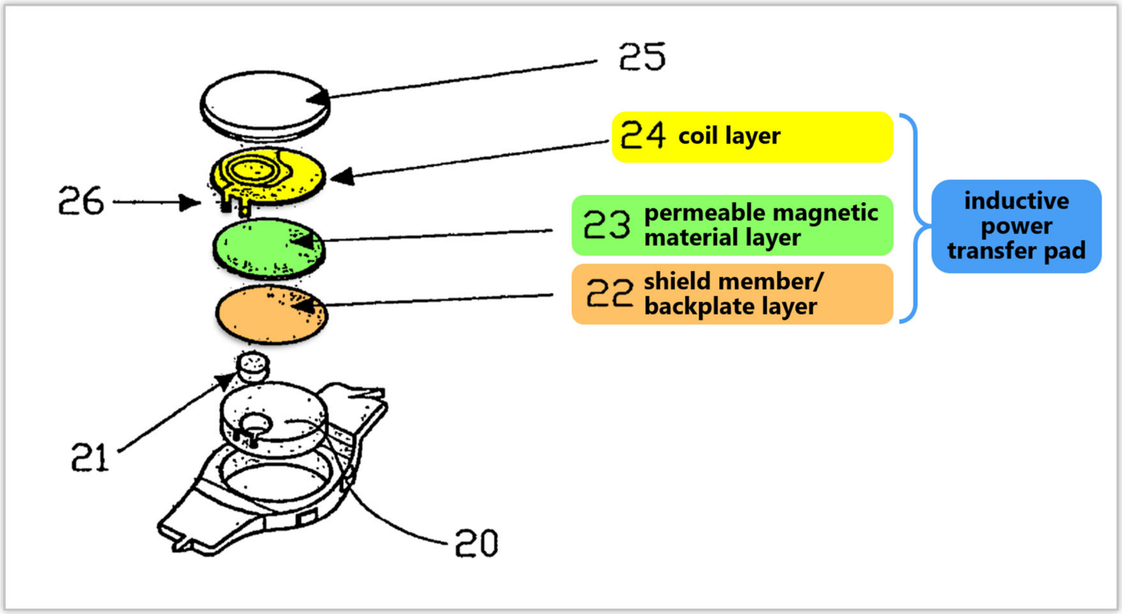
115. Regarding the receiving pad, Figure 12(d) below shows Hui-910's mobile phone embodiment, which includes a "thin sheet 12 of copper or another conductive material such as aluminum" that corresponds the claimed "shield member comprising a backplate defining a third layer." *Id.* ¶ 80. Like Hui-910's transmitting pad, the receiving pad in the mobile phone embodiment discloses the backplate as a third layer: coil layer 10 ("second layer," *see* Element 1/13[b] above), ferrite layer 11 ("first layer," *see* Element 1/13[a] above), and this backplate 12 (the "third layer").



Hui-910 Fig. 12(d) (annotated), ¶ 80; *see also id.* at Figs. 11, 12(a), 12(b), 12(c), ¶¶ 11, 28-29, 80-81.

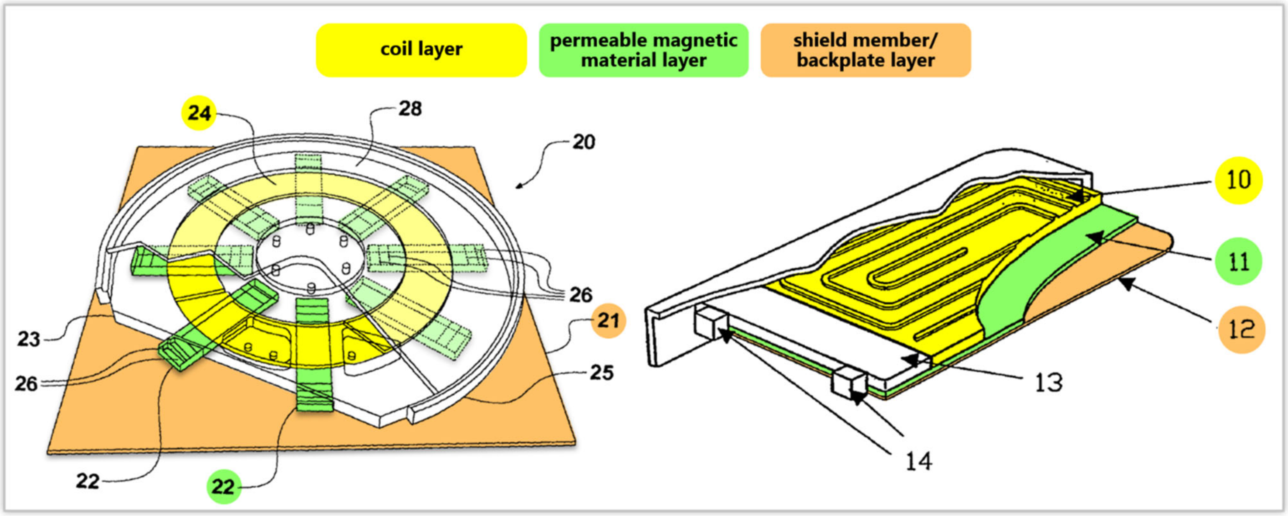
116. Hui-910's watch embodiment is similar, including a "copper sheet 22" which forms the "shield member comprising a backplate defining a third layer." *Id.* ¶ 83. Like the power delivering charger circuit and the mobile phone embodiment, the watch embodiment includes the backplate as a third layer: coil 24 ("second

layer," *see* Element 1/13[b] above), ferrite sheet 23 ("first layer," *see* Element 1/13[a] above), and this backplate (the "third layer").



Hui-910 Fig. 13(b) (annotated), ¶ 83; *see also id.* at Fig. 13(a), ¶¶ 12, 30, 83.

117. Pursuant to the above, Hui-910 teaches a backplate made of conductive material that is substantially planar and arranged beneath the coil and permeable magnetic material layers in the same manner as disclosed in the '955 patent. Notably, Hui-910's backplates are formed from copper or aluminum, which is an expressly listed material in dependent claim 6 for a backplate that "substantially inhibits the passage of magnetic flux." '955 patent claims 5-6. Below is an annotated comparison showing the claimed layers in the '955 patent IPT pad compared to the receiving pad in Hui-910's mobile phone embodiment.



'955 patent Fig. 4 (annotated), 8:62-9:5; Hui-910 Fig. 12(d) (annotated), ¶ 80. Likewise, the layered structure is the same in the transmitting pad of the '955 patent and in Hui-910. Hui-910 Fig. 5(a), ¶¶ 71, 73.

118. As explained below, a POSA would have understood the conductive layers in Hui-910's power delivering charger circuit and mobile phone and watch embodiments are "arranged to control electromagnetic flux" (claim 13) or are "arranged to control electromagnetic flux generated by said transmitting pad" (claim 1).

119. To explain, and as discussed in the Hui-910 Overview, the primary coils or windings in the power delivering charger circuit generate a time-varying magnetic flux that induces a current in nearby secondary windings according to Faraday's Law, thereby charging the secondary device's battery. Hui-910 ¶¶ 72, 74, 79, 80, 83, 95, 106-107; *see also* Terman (Ex. 1010) 11-21. However, the same time-varying magnetic flux can also induce currents in other metallic objects in the portable

electronic equipment, potentially causing damage. Hui-910 ¶¶ 4 ("[W]ithout proper EMI shielding, undesirable induced currents may flow in other metallic parts of the portable electronic equipment."), 8 (using "shielding" comprising "a sheet of conductive material such as copper or aluminum" help "avoid induced [current] from circulating in other metal parts inside portable electronic circuit"). Hui-910 teaches that these components can be protected through use of an "EMI shield" comprising ferrite and copper layers that redirect the magnetic flux away from other components besides the secondary coils. *Id.* ¶¶ 4, 80, 103; *see also id.* ¶¶ 71, 80, 83-84.

120. Hui-910 refers to its ferrite sheets as part of the "EMI shield" because the ferrite works in conjunction with the conductive backplate shield member (the copper layers 6, 12 and 22) to shield components from flux in a substantially similar way as the '955 patent. Specifically, the ferrite material in each of the transmitting and receiving pad guides or channels the magnetic flux parallel to the coil(s) in each respective pad, reducing the normal component of the transmitting pad's magnetic field so that less flux attempts to penetrate the copper backplate. '955 patent 2:40-44 ("ferromagnetic slabs for channeling electromagnetic flux when in use"), 8:67-9:2 ("the magnetic flux passing through ferrite bars 22"); Hui-910 ¶ 103 ("appropriate electromagnetic (EM) shielding such as the combined use of ferrite and copper sheets described in [Hui-364, Ex. 1012]"); Hui-364 3:26-31 ("the ferrite

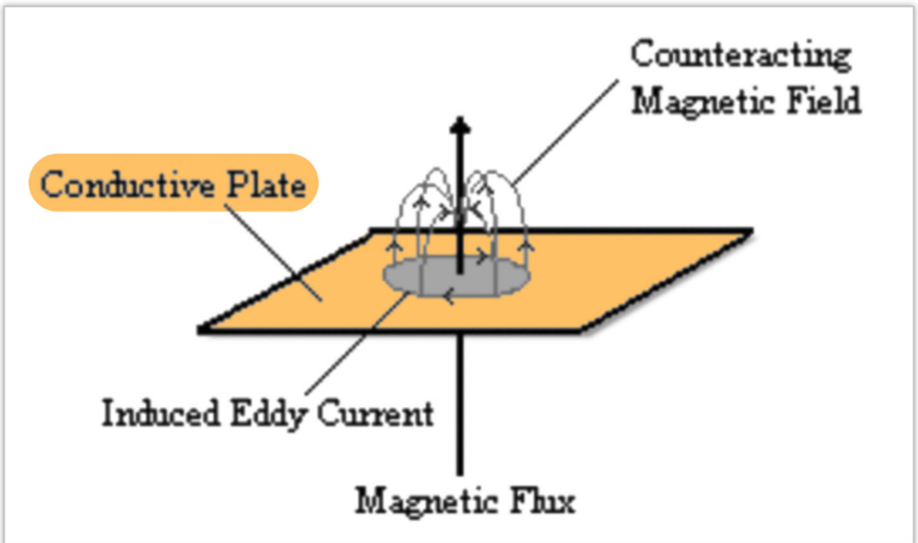
material guides the magnetic field"), 5:12-47 ("[A]t the ferrite-copper boundary, the H-field is nearly tangential and confined inside the ferrite plate."), 7:16-67 (ferrite layer increases energy efficiency); Terman 35-40, Fig. 2-19; RFID Handbook (Ex. 1016) 109-10 ("By inserting highly permeable ferrite between the coil and metal surface it is possible to largely prevent the occurrence of eddy currents.").

121. The backplate of Hui-910, which is made of a conductive material such as copper or aluminum (like in the '955 patent), in turn acts as a shield that prevents flux that is not channeled through the ferrite layer from entering into other objects. The manner of operation by which a conductive backplate controls electromagnetic flux was well known, and relates to basic principles of magnetics that would have been known to a POSA. More particularly, when conductive materials like copper or aluminum are placed into an alternating magnetic field, the field induces eddy currents that cancel out the incoming magnetic field. Terman explained this concept, for example, as a basic tool of the electronic and radio engineer in 1947:

> The most practical shield for magnetic flux at radio frequencies is made of material having low electrical resistivity, such as copper or aluminum. **Magnetic flux in attempting to pass through such a shield induces voltages in the shield which give rise to eddy currents. These eddy currents oppose the action of the flux, and in large measure prevent its penetration through the shield**.

Terman 35, Fig. 2-19(c); *see also id.* at 3 (classifying frequencies down to 10 kHz as radio frequencies), Preface.

122. This concept is an extension of Faraday's law and is shown conceptually in the figure below, where the eddy currents induced by the incoming magnetic flux generate a second magnetic field opposing the transmitting pad's field.

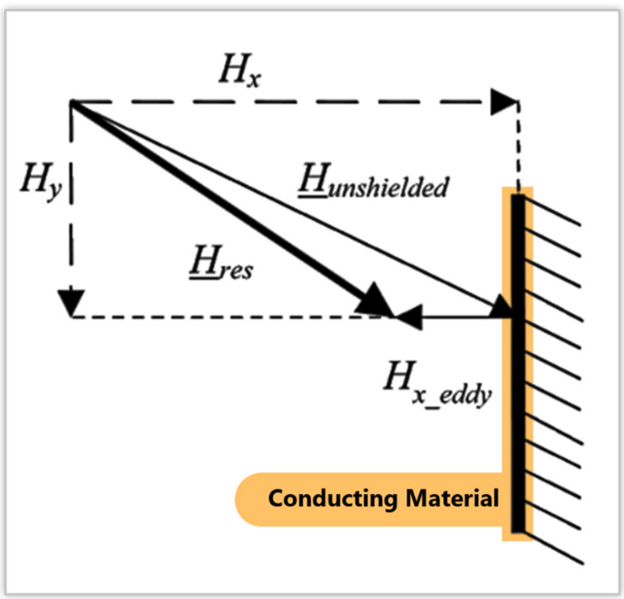


O'Brien (Ex. 1017) Fig. 4-4 (annotated), 65-68; *see also* RFID Handbook (Ex. 1016) 71-73 (disclosing a similar Figure 4.11 showing "induced electric field strength E in different materials" including a "metal surface"), 109-110; Mohan (Ex. 1018) 50-51.

123. Importantly, eddy currents "create magnetic fields with vector components **only in the direction normal to the surface** in which the eddy currents are flowing." O'Brien 65-68; *see also* RFID Handbook 71-73; Mohan (Ex. 1018) 50-51; Beart 2:29-3:1 ("[W]hen conductive materials, for example copper or

aluminum, are placed into an alternating magnetic field, the field induces eddy-currents . . . [that] generate a second field which – in the limit of a perfect conductor – is equal and opposite to the imposed field, and cancels it out at the surface of the conductor.”). In other words, regardless of the angle that the flux approaches the backplate, the resulting flux from the eddy currents will be generated in a direction substantially perpendicular to the plane of the backplate.

124. An example of how flux is generated by eddy currents in a conductive shield in a direction perpendicular to the conductive layer, even when the incoming magnetic flux approaches the shield at an angle, is shown in the figure below:



O’Brien Fig. 4-5 (annotated) (“Figure 4-5 Unshielded vector $H_{unshielded}$ and its components. Field vector H_{x_eddy} created by eddy currents in the shielding material, and resulting field vector H_{res}.”).

125. The ’955 patent includes a similar statement to these concepts in describing its backplate, in that the backplate “direct[s] flux upwards from the plane of the backplate” (with optional side walls that can also help reduce the splay of flux). ’955 patent 3:53-56, 9:15-21. In addition, Hui-910 refers to another reference by Hui, Hui-364, which taught “[t]he use of thin copper sheets is to direct the magnetic field in parallel to the ferrite plates so that the normal component of the magnetic field emitting into the copper can be suppressed significantly.” Hui-364 7:16-60; Hui-910 ¶¶ 80-81, 103.

126. In sum, Hui-910 discloses that its transmitting and receiving pads each include a shield member comprising a backplate defining a third layer, where the backplate is arranged to control electromagnetic flux as claimed.

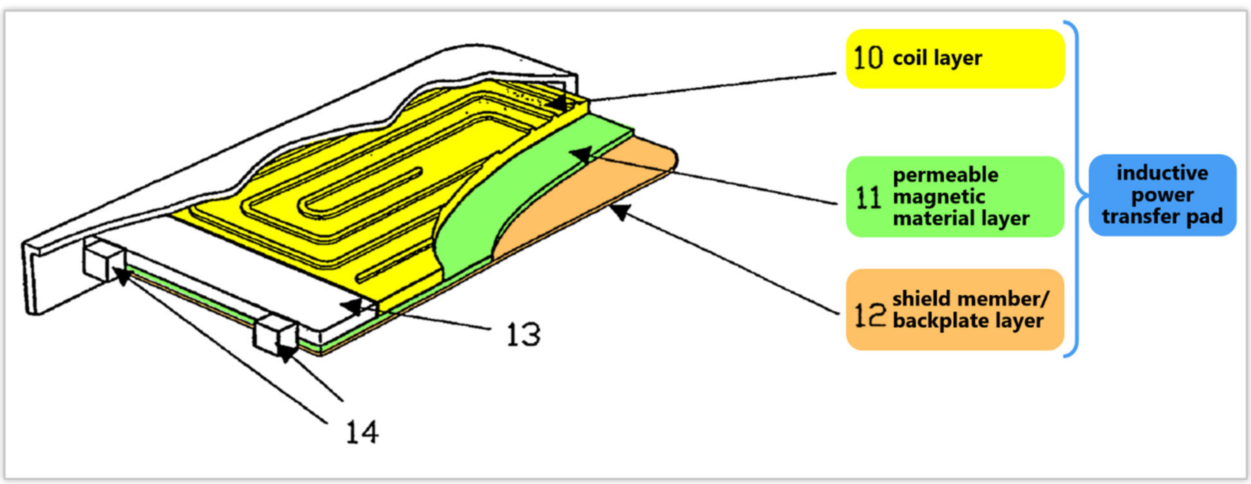
B. Dependent claims 4-6, 8-12 are anticipated by Hui-910

127. It is my opinion that the following dependent claims, which depend from claim 1 of the ’955 patent, are anticipated by Hui-910. My analysis and opinions regarding the dependent claims below should be read in light of, and including, the same reasons I have identified for claim 1 above. Conversely, it is my opinion that claim 1 is anticipated for the same reasons as their dependent claims below. I note that the following dependent claims, because they depend from claim 1, are directed only to the arrangement of the receiving pad.

1. Claim 4 – ordered, parallel layers

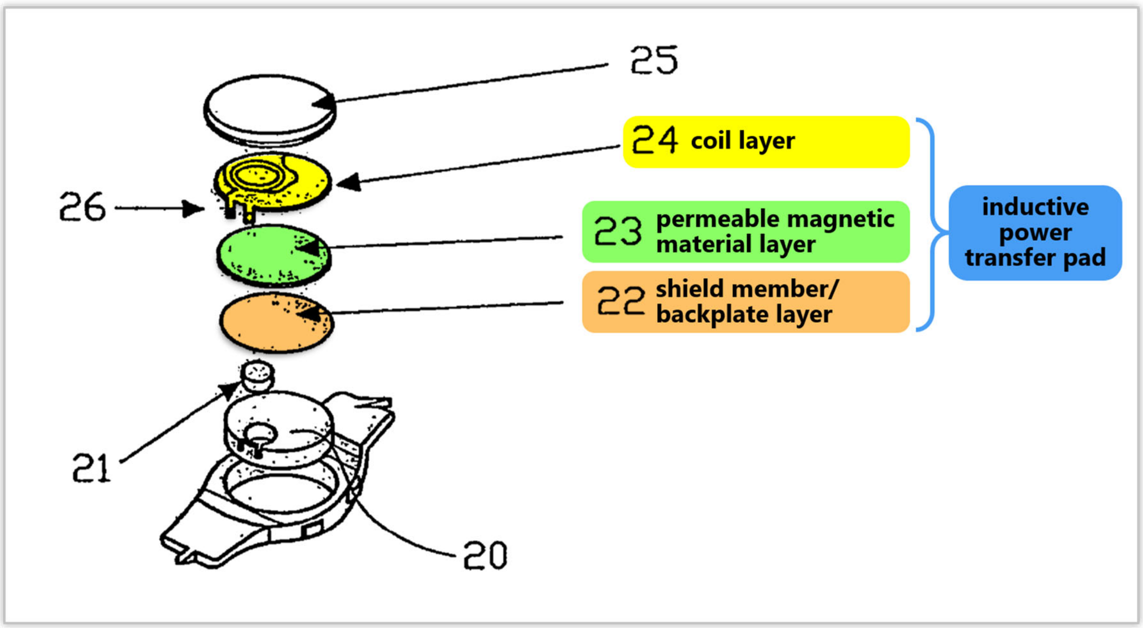
128. Claim 4 depends from claim 1 and further recites: "wherein a plane of the backplate is substantially parallel to planes of each of the permeable magnetic material members and the coil, the plane of the or each permeable magnetic material member is located between the plane of the backplate and the plane of the coil." Hui-910 discloses claim 4 for the same reasons as claim 1 and as further explained in the following paragraphs.

129. First, the layered structure in claimed 4 is disclosed by Hui-910's mobile phone embodiment. For example, Figure 12(d) below shows an integrated back cover structure comprising a ferrite sheet 11 (i.e., the permeable magnetic material layer, Element 1/13[a]) between the planar coil 10 (i.e., the coil layer, Element 1/13[b]) and the copper sheet 12 (i.e., the shield member layer, Element 1/13[1c]). *See* Elements 1/13[a]. 1/13[b], 1/13[c] above.



Hui-910 Fig. 12(d) (annotated), ¶ 80; *see also id.* at Figs. 11, 12(a), 12(b), 12(c), ¶¶ 12, 28-29, 81.

130. Figure 13(b) below shows a similar arrangement in Hui-910's watch embodiment, which teaches a ferrite sheet 23 (i.e., the permeable magnetic material layer, Element 1/13[a]) between the planar secondary winding 24 (i.e., the coil layer, Element 1/13[b]) and the copper sheet 22 (i.e., the shield member layer, Element 1/13[c]). *See* Elements 1/13[a]. 1/13[b], 1/13[c] above.



Hui-910 Fig. 13(b) (annotated), ¶ 83; *see also id.* at Fig. 13(a), ¶¶ 12, 30, 81.

131. As depicted in each figure showing Hui-910's receiving pad, whether in the mobile phone or watch, the three layers (coil, ferrite and copper) are planar and the planes of each layer are substantially parallel to each other as claimed. This makes sense, as Hui-910 taught a "**flat** charging surface that contains the primary

transformer windings" on which portable electronics are placed, where "[t]he secondary winding is also **planar**." *Id.* ¶¶ 70 ("planar surface on the equipment"), 72, 82 ("secondary **planar** transformer winding"), 83 ("a **planar** coreless transformer secondary winding"). Indeed, Hui-910 is ubiquitous in referring to the pads as having a planar surface. *See, e.g.*, *id.* ¶¶ 1, 5, 7-9, 14, 70, 73, 80-81, 84, 92, cls. 1, 3, 13, 14, 17, 21, 27 ("planar charging surface"); Element 1/13[b] above.

2. Claims 5 and 6 – backplate made of copper or aluminum

132. Claim 5 depends from claim 1 and further recites "wherein the backplate is formed from a material which substantially inhibits the passage of magnetic flux therethrough." Claim 6 depends from claim 5 and further recites: "wherein the backplate is formed from one at least one of copper and aluminum." These claims are anticipated by Hui-910 for the same reasons as claim 1 and as further explained below.

133. As discussed with respect to Element 1/13[c], Hui-910's mobile phone and watch embodiments disclose a "backplate" formed from copper or aluminum as required by claim 6. Hui-910 ¶¶ 12 ("Preferably, the shielding comprises . . . a sheet of conductive material such as copper."), 80 (in the context of the mobile phone embodiment, "[t]his EMI shield can be . . . a thin sheet 12 of **copper** o[r] another conductive material such as **aluminum**."), 83 (in the watch embodiment, "a **copper** sheet 22"), 103 (explaining that copper sheets will "ensure" that magnetic flux "will

not penetrate through the base of the primary inductive charging extension system”); *see also* Element 1/13[c] above.

134. As discussed with respect to Element 1/13[c], copper and aluminum are materials that substantially inhibit the passage of magnetic flux therethrough, as claimed. Specifically, magnetic flux induces eddy currents in conductive materials like copper or aluminum, and those eddy currents “oppose the action of the flux, and in large measure prevent its penetration through the shield.” *See, e.g.*, Terman 35; Beart 3:1-3 (“these conductive materials can be seen as ‘flux-shields’ – the lines of flux in any magnetic system are excluded from them”).

3. Claim 8 – permeable magnetic material comprises ferrite

135. Claim 8 depends from claim 1 and further recites “wherein the or each permeable magnetic material member comprises ferrite.” This claim is anticipated by Hui-910 for the same reasons as claim 1 and as further explained in the following paragraphs.

136. As explained with respect to Element 1/13[a], Hui-910 teaches that both the mobile phone embodiment and the watch embodiment include “a thin piece of **ferrite material**” or a “**ferrite** sheet” that is the permeable magnetic material member. Hui-910 ¶¶ 12 (“Preferably, the shielding comprises a sheet of **ferrite material** . . . .”), 80 (disclosing “**ferrite** sheet” in the mobile phone embodiment),

83 (disclosing "**ferrite** sheet" in watch embodiment); *see also* Element 1/13[a] above.

4. Claims 9-12 – backplate directs/controls flux

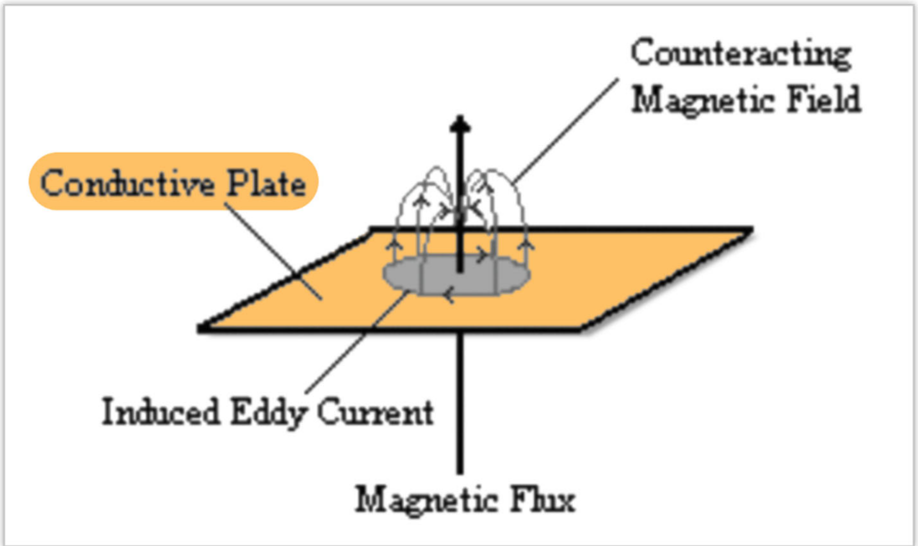
137. Claim 9 depends from claim 1 and further recites "wherein the backplate is arranged to control the electromagnetic flux substantially perpendicular to the third layer."

138. Claim 10 depends from claim 1 and further recites "wherein the shield member is arranged to control the electromagnetic flux between the inductive power transfer pad and the transmitting pad."

139. Claim 11 depends from claim 1 and further recites "wherein the backplate is arranged to direct electromagnetic flux generated by the transmitting pad."

140. Claim 12 depends from claim 11 and further recites "wherein the electromagnetic flux is directed substantially perpendicular to the third layer."

141. Hui-910 anticipates these claims for the same reasons as discussed in Element 1/13[c] and as further explained here. *See* Element 1/13[c] above. As explained with respect to Element 1/13[c], when magnetic flux interacts with a conductive material like copper or aluminum, it generates eddy currents in the copper or aluminum that "oppose the action of the flux, and in large measure prevent its penetration through the shield," as shown in O'Brien Figure 4-4 below.



O'Brien (Ex. 1017) Fig. 4-4 (annotated); O'Brien 65-68 (explaining that eddy currents will flow in the backplate and "create magnetic fields with vector components **only in the direction normal to the surface** in which the eddy currents are flowing"); *see also* Element 1/13[c] above. As a result, a layer of conductive material controls flux by generating flux perpendicular to the surface of the conductive material.

142. A POSA would have understood that, pursuant to these well-known principles, Hui-910's conductive copper sheet in its mobile phone and watch embodiments would "control" electromagnetic flux generated by the transmitting pad by suppressing flux that approaches the backplate, and directs flux by creating a counteracting magnetic field that is substantially perpendicular to the backplate. *See* discussion regarding conducting materials controlling flux in Element 1/13[c] above. Hui-910 also teaches that its transmitting pad may be sized to charge only

one portable electronic device at a time, indicating that the transmitting pad and the receiving pad are the same size. Hui-910 ¶¶ 71 ("the charging surface being large enough to **accommodate at least one,** and more preferably two or more, devices to be charged"), 75 ("Preferably, the **charger should be able to charge one** or more than one items of portable electronic equipment at the same time."), 82. Accordingly, the copper or aluminum backplate in the receiving pad would be arranged to control and direct flux "between" the two pads. *Id.* ¶¶ 71, 80, 83, Figs. 5(a)-5(b), 12(a)-12(d), 13(a)-13(b).

143. Hui-910's backplate in the receiving pad would also control and direct flux between the pads based on Hui-910's "localized charging zone principle." Hui-910 ¶ 79. In that configuration, even when the transmitting pad is larger than a receiving pad, the transmitting pad can be configured so that "power transfer between the primary charger circuit and the secondary windings inside the portable electronic equipment" takes place in the areas of the charging surface "covered by the portable electronics equipment" and its corresponding backplate. Hui-910 ¶¶ 79, 80, 83, Figs. 10(a)-10(c) (depicting modular transmitting pad). In other words, "when a device is placed on the planar charging surface that is greater in size than the device, energy is only transferred from that part of the planar charging surface that is directly beneath the device." *Id.* ¶¶ 14, 9.

144. In sum, Hui-910's backplate in its receiving pads "controls" and "directs" the flux from the transmitting pad in the direction substantially perpendicular (i.e., normal) to the backplate defining a third layer. It does so, for example, by suppressing the flux in that direction. Further, the backplate also "directs" flux substantially perpendicular to the third layer by creating an opposing magnetic field in that direction, disclosing claims 9-12.

IX. Ground 2: Claims 1 and 4-13 would have been obvious over Hui-910 in view of Beart

145. As discussed above, Hui-910 anticipates claims 1, 4-6, and 8-13 of the '955 patent with the understanding that the shield member requires only the backplate. Alternatively and in addition, if the "shield member" was narrowly construed to require sidewalls that are on or attached to the backplate, claims 1 and 4-13 would have been obvious over Hui-910 in light of Beart.

A. Motivations to combine Hui-910 and Beart

146. As discussed in the Beart Overview, Beart taught an improved flux shield with a backplate and walls that further controls and directs flux, as compared to a flat shield, improving flux-efficiency and preventing damage to surrounding objects. *See* Beart Overview above. As discussed below, a POSA would have been motivated to combine Hui-910's teachings with Beart's improved flux shield.

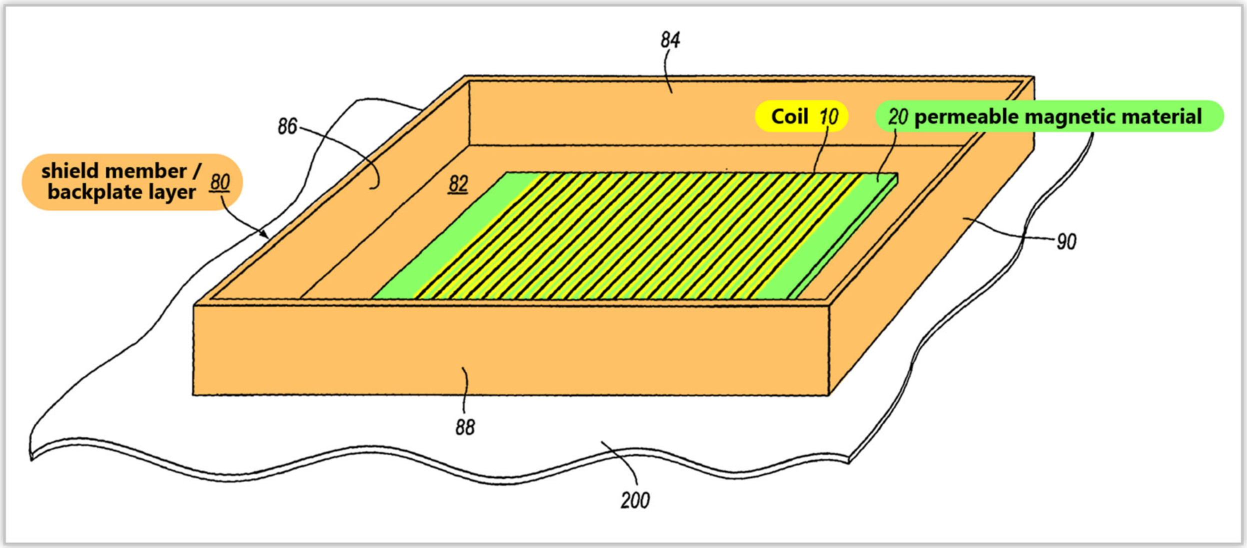
147. Initially, I understand from Counsel that a reference qualifies as prior art for an obviousness determination when it is "analogous" to the claimed invention,

which are references that are either in the field of the applicant's endeavor or, if not, then a reference that is reasonably pertinent to the particular problem with which the inventor was concerned. Here, Hui-910 and Beart are analogous art. Both references taught inductive power transfer with flux shields to better control and direct the electromagnetic flux and improve coupling between the primary and secondary windings. Hui-910 ¶¶ 4, 80; Beart 3:1-4, 4:11-14.

148. A POSA would have been motivated to combine Beart and Hui-910 for several reasons. First and foremost, a POSA would have been motivated to improve the shielding taught in Hui-910 because Beart expressly recognized that the shielding in Hui-910 could be improved. Specifically, Beart begins by introducing that it was well known that "conductive materials can be seen as 'flux shields'" that can be "used to shield one part of system from a magnetic field and consequently concentrate the field in another part" with reference to GB-2389720 to Hui ("Hui-720," Ex. 1019). Beart 2:29-3:10. Beart explained that in Hui-720, a flux generating unit includes a "ferrite sheet and conductive sheet" that "are of the same dimensions, parallel to the sheets" such that the flat "conductive sheet" provides the flux shield. *Id.* at 3:4-10. Beart then sets out to improve these flat conductive sheets that have the same dimensions as the ferrite sheet.

149. For example, Beart taught Hui-720's flat sheet could be made more effective by extending the flux shield beyond the edges of the flux-generating unit

and including four side walls made from the same conductive materials, as shown in annotated Figure 7 below.



Beart Fig. 7 (annotated), 3:12-22 (describing embodiment with flux shield "extending outwardly beyond at least one edge of the flux generating means"), 5:9-6:29, 10:6-16 (embodiment with flux shield having five sides)..

150. Accordingly, a POSA reading Beart would have understood and been motivated to modify Hui's flat copper flux shield in view of Beart because Beart taught that it's five-walled flux shield was an improvement. And while Beart references Hui-720, a POSA would have understood that the same improvement would have been equally applicable to Hui-910. Indeed, Hui-720 is the foreign priority document listed on the face of Hui-910 (*see* Hui-910 at Cover), and Hui-720 discloses nearly identical power delivering charger circuit and mobile phone and watch embodiments as discussed in the Hui-910 Overview above. *Compare, e.g.*,

Hui-910 Figs. 4(a)-4(c), 5(a)-5(b), 12(a)-12(d), 13(a)-13(b), *with* Hui-720 Figs. 4(a)-4(c), 5(a)-5(b), 12(a)-12(d), 13(a)-13(b).

151. Beart also taught why its flux shield improves performance compared to a flat backplate, such as used in Hui-910's transmitting and receiving pads. For example, Beart explained that when a "flux-generating unit" (e.g., a transmitting pad) is placed on a mild steel desk or part of vehicle chassis will result in flux being "sucked" down into the steel desk because the permeability of mild steel provides a lower reluctance path for the magnetic flux as compared to the surrounding air. Beart 2:11-19. Beart explains that this is undesirable for two reasons: (1) the system becomes less efficient because a "significant proportion of the flux generated by the inductive power transfer unit (primary unit) is flowing into the metal desk instead of flowing into any secondary devices on the upper surface of the unit," and (2) the "flux flowing through the metal desk causes core losses, for example via hysteresis and / or eddy current loss, which cause [the desk] to heat up." Beart 2:20-27.

152. Beart then taught that, while a flat flux shield can mitigate these effects, a flux shield with side walls better mitigates those effects. Beart taught that the embodiment with side walls "increases still further, compared to a flat sheet, the path that flux would have to travel in order to travel through a metal object underneath the flux generating unit." *Id.* at 5:16-18. Put another way, extending the shield and/or providing sidewalls allows for more control and direction of flux by further

increasing the distance the flux must travel to pass through a surrounding permeable object or low conductivity metallic components. Beart 5:9-18, Figs. 5-8, 9:26-10:4, 10:21. Beart then explains that his improved shielding arrangement "increases the coupling between the flux generating unit and the secondary device(s) by forcing most of the flux to go over the power transfer surface," and therefore "less drive current is needed in the flux generating unit to create a given flux density in the secondary device(s)." Beart 4:16-19. Beart explains that use of such conductive shields "allow[s] the flux to be concentrated in directions in which it is useful, improving the flux-efficiency of the unit, and to be shielded from directions where it can cause side-effects, for example by coupling into a metal desk under the unit." Beart 4:11-14. Like the embodiment disclosed in the '955 patent, Beart's backplate and sidewalls would reduce splay, further controlling and directing flux so that less flux would go out the back and the sides. *See* Beart 2:29-3:4, 4:25-30, 10:6-16, 10:31-11:11, 13:13-31, Figs. 3, 6, 8.

153. Beart also discloses finite element analysis and testing that demonstrates that extending the shield and/or providing sidewalls increases efficiency by increasing the distance the flux must travel to pass through a surrounding permeable object or low conductivity metallic components and by minimizing generation of eddy current that may damage or heat up surrounding components. Beart 5:9-18, Figs. 3, 5-8, 9:26-10:4, 10:21, 12:1-13:31 ("A shield

extending completely around the magnetic assembly, except over the desired power transfer surface, can reduce the effect of metal desks on the generator by more than an order of magnitude, and on the secondary device by more than half.”). Beart explains that the “test results clearly demonstrate the two key advantages of a flux shield in reducing the side effects of metal objects: less power delivered into the steel by the generator, and less variation in power seen by the secondary device.” *Id.* at 12:1-13:31. Beart’s improved flux shield is similar to the ’955 patent in this way—it reduces the amount of flux splaying out the sides and parallel to the flux-generating surface while also attenuating any flux that would travel out of the back of the unit. *See* Beart 2:29-3:4, 4:25-30, 10:6-16, 10:31-11:11, 13:13-31, Figs. 3, 6, 8.

154. A POSA would have understood these same principles would apply to the receiving pad as well. Hui-910, for example, taught the same shielding for both the transmitting and receiving sides of the inductive power system. This is because the equipment being charged needs to be shielded as well, as Hui-910 recognized. Hui-910 explains that shielding on the receiving pad prevents “undesirable induced currents [that] may flow in other metallic parts of the portable electronic equipment.” Hui-910 ¶¶ 4, 11 (“electromagnetic shielding between the winding and the major components of [the portable electronic] device”), 80 (“In order to prevent induced current from circulating in other metal parts inside portable electronic circuit, it is preferable to include a thin EMI shield . . . .”), 83 (“The watch mechanism is shielded

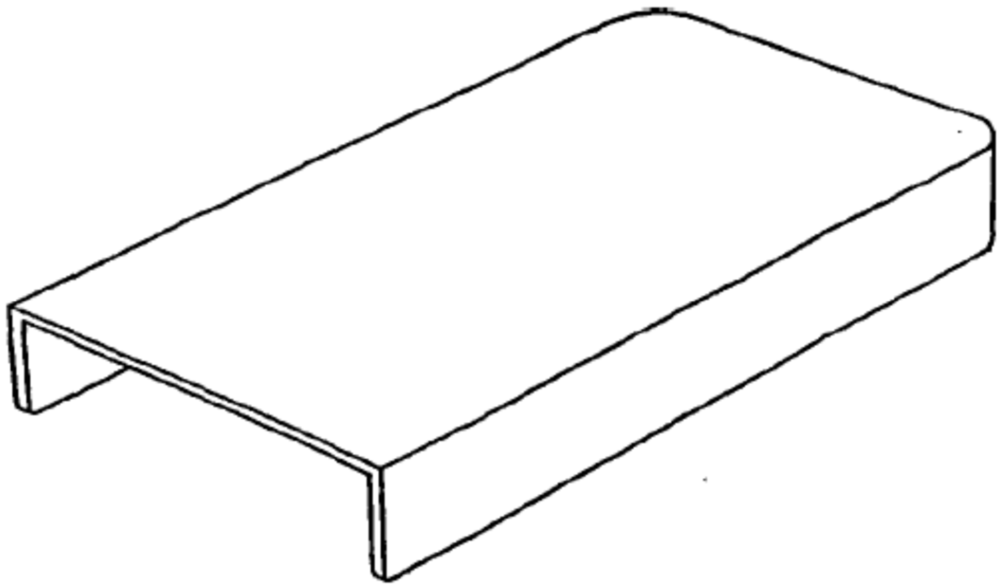
from electrical interference in the charging process by an EMI shield . . . ."). Indeed, a POSA would have understood that induced currents could interfere with a device's operation, or even damage its components by heating them up. *See* Hui-910 ¶¶ 4, 8.

155. A POSA would have recognized that Beart's improved flux shield could and should be used, for example, in Hui-910's system because mobile phones that Hui-910 intends to charge were becoming increasingly complex with more sensitive electronic circuitry. Personal Digital Assistants (PDAs), for example, were available as mobile phones since the 1990s. Those devices initially acted as little more than pagers, but by 2008 (six years after Hui-910 was filed and still prior to the '955 patent) those PDAs were being replaced with much more powerful devices. Blackberry, for example, had released a mobile phone capable of email with attachments, a web browser, and a high resolution color screen. Singh (Ex. 1027) 35; The Evolution of the BlackBerry (Ex. 1028); *see also* History of Palm (Ex. 1029) (describing increasing complexity of Palm devices). Similarly, the iPhone was introduced in 2007. Those developments in the complexity of devices introduced after Hui-910 was filed leading up to the filing of the '955 patent would have motivated a POSA to look for ways to further protect the sensitive electronics through improved shielding, as taught by Beart.

156. A POSA would have also been motivated to reduce the splay of magnetic flux in Hui-910's system by adding side walls to the flux shield in the

transmitting and receiving pad in order to reduce the splay of magnetic flux to protect surrounding people and objects from stray magnetic fields. Indeed, prior to the '955 patent there had been significant efforts domestically and internationally in developing safety standards limiting magnetic field strength from devices. *See, e.g.*, O'Brien 23-24, 27, 155-60 (describing international safety standards limiting magnetic field strength). A POSA would be familiar with standard setting organizations, like the Institute of Electrical and Electronics Engineers (IEEE) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines, that publish standards and guidelines on limiting exposure to electromagnetic flux. For example, in 2005, the IEEE published recommended exposure limits and mitigative measures to minimize public exposure, explaining that electromagnetic flux below 100 kHz may cause painful electrostimulation and electromagnetic flux above 100 kHz may cause heating of human tissue. *See* IEEE C95.1-2005 (Ex. 1021) 2-3, 14-29. Similarly, ICNIRP Guidelines from 1998 recommend exposure limits and use of "engineering controls wherever possible to reduce device emissions." ICNIRP Guidelines (Ex. 1022) 509-15. In view of these regulations, a POSA would have been motivated to implement Beart's sidewalls in Hui-910's system because it was a readily available "engineering control" that would "reduce device emissions" by preventing the splay of flux. *See* ICNIRP Guidelines at 509-13, 514-15 (describing a need to prevent "interference with medical electronic equipment and devices (including cardiac pacemakers); detonation of electro-explosive devices (detonators); and fires and explosions resulting from ignition of flammable materials by sparks caused by induced fields, contact currents, or spark discharges."); *see also* Dobbs (Ex. 1026) ¶¶ 10-11 (describing how conductive "half-shields" that cover the back and side walls of a transmitting and receiving pad are "capable of substantially canceling magnetic flux lines impinging thereon before effects of such impinging magnetic flux lines" before they extend beyond the surface of the shield.), Figs. 7, 9.

157. Beart also taught how a POSA could have implemented such a shield in portable electronic devices like Hui-910's mobile phones. Beart taught, for example, that its five-walled shield can be "contained in a casing" of the unit. Beart 10:23-29, Fig. 9, 8:30-31. That "casing" in Beart in substantially similar to the "back cover of the portable electronic device" that Hui-910 taught would include the flat copper sheet in its mobile phone embodiment. Hui-910 ¶ 82. While Hui-910's mobile phone only includes a flat copper backplate, the back cover that it is installed in also includes side walls as shown in Figure 12(a) below:



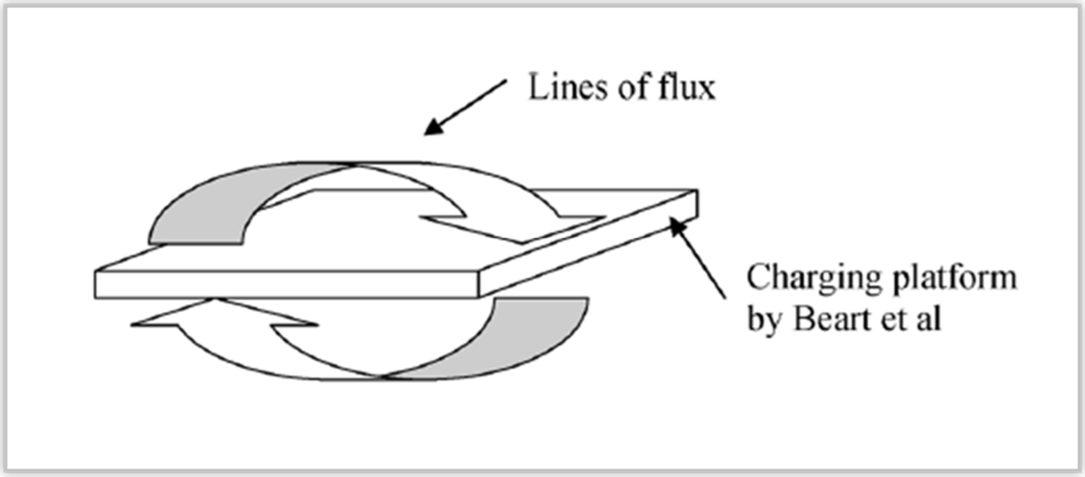
Hui-910 Fig. 12(a), ¶ 80 ("The back cover of the portable electronic equipment is a detachable back cover shown in FIG. 12(a) that covers the battery and which may be removed when the battery is replaced"); *see also id.* at Figs. 12(c)-12(d).

158. Those side walls could be modified to include conductive materials that are formed integrally with the backplate, as taught in Beart. Beart 5:13-16, 7:30-32; Hui-910 ¶ 80. Similarly, Beart taught a POSA a five-walled flux shield could be "cut and folded up at the edges to form a tray-form member," which could also be implemented in Hui-910's integrated back cover. Beart Fig. 9, 10:18-11:31.

159. For the reasons discussed above, a POSA would also have had a reasonable expectation of success implementing Beart's flux shield in Hui-910. Indeed, as discussed in Element 1/13[c] of Ground 1, the effects of conductive materials on a magnetic field were well known in the art, and the effects of adding

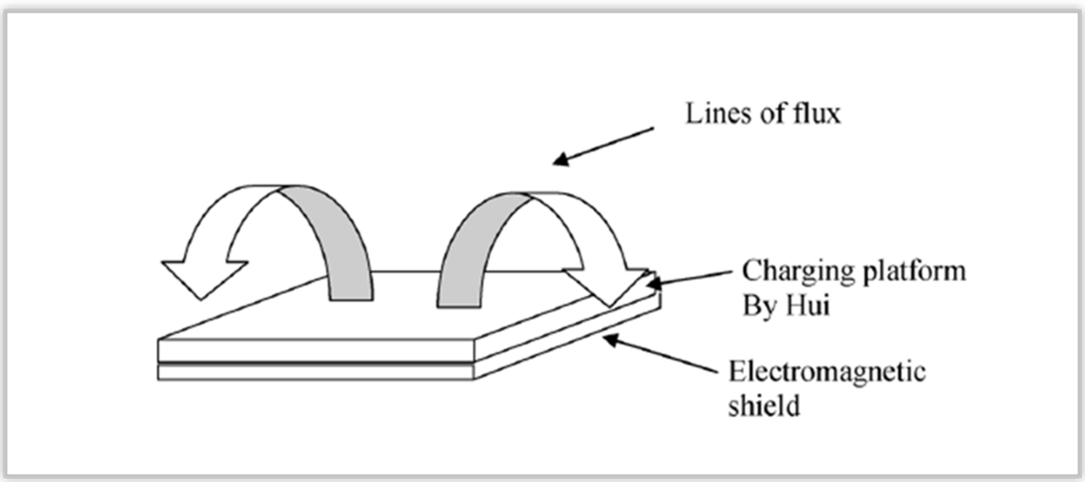
walls to a flat flux-shield would be predictable. *See* Ground 1, Element 1/13[c] above. This is particularly true given that the flux shields in both Hui-910 and Beart were made from the same material (copper or aluminum). *See, e.g.*, Hui-910 ¶¶ 8, 80; Beart 2:29-3:10.

160. I also note that the flux-generating units in Hui-910 and Beart are somewhat different in their arrangement of the coils. The coils are planar and arranged in a layer in Hui-910, whereas the coil is a solenoid wound around a former 20 in Beart. Beart 1:5-27, Figs 1, 7. Beart's "former 20" is a permeable magnetic material similar to Hui-910's ferrite sheet in that it provides a low-reluctance path for flux in a lateral direction. Beart 1:21-23, 9:9-10; *see* Ground 1, Element 1/13[a], Claim 8 above; *see also* Ground 1, Element 1/13[c] above. These different configurations of the coil and permeable material would generate differently shaped flux lines, but in both configurations a POSA would understand that both system would (1) require similar shielding and (2) that the conductive shielding would work in substantially the same way in both configurations. For example, another reference to Liu specifically analyzed the flux generation of Beart and Hui's coil configurations. Liu illustrated that Beart's coil produces a "horizontal flux" along the upper and lower surfaces of the magnetic former, as shown in Figure 1 below:



Liu (Ex. 1020) Fig. 1(a) ("Inductive battery charging platform (with magnetic flux lines flow "horizontally" along the charging surfaces proposed by Beart *et al*.").

161. In contrast, Hui-910's windings generate a "perpendicular flux" that flows perpendicularly into and out of the charging surface, as shown in Figure 2 below.



Liu Fig. 2 ("Inductive battery charging platform (with magnetic flux lines flowing in and out perpendicularly of the charging surface) proposed by Hui."); *see also* Liu (Ex. 1020) 21-22 (comparing Beart and Hui's proposed flux generation units).

162. Conductive shielding attenuates magnetic flux from both flux-generating units in the same way—i.e., by generating eddy currents that serve to cancel the incoming flux. And, as Liu explains, both flux-generating units require conductive shielding to prevent magnetic flux from coupling to surrounding components. Liu 22 ("For both planar charging platforms described above, it is necessary to use an electromagnetic shield on the bottom surface. In case the charging platform is placed on a metal desk, the ac flux generated in the charging platform may induce currents in the metallic desk, resulting in incorrect energy transfer and even heating effects in the metallic desk."); *see also* Beart 2:29-3:10 (recognizing Hui-910's shield works in Beart's system). Indeed, other systems for wireless power transfer using planar coils in the transmitting and receiving pads, which would generate flux much like Hui-910, utilized conductive shields including a backplate and sidewalls, indicating that such a combination would work. Dobbs ¶¶ 8 (describing that it "is often desired" to shield transmitting and receiving pads because there may be "undesirable RF emission, increased leakage inductance, and/or reduced power transfer efficiency"), 43-44 (describing inductor "windings 110, 116" in parallel planes), 82, 91, Figs. 7 (depicting conductive shields 120 and 170 with backplate and side walls around inductor windings), 11 (similar).

163. Accordingly, a POSA could have and would have modified Hui-910 by adding sidewalls to its backplate, as taught by Beart.

B. Independent claims 1 and 13

1. Preambles, Elements 1/13[a]-[b]

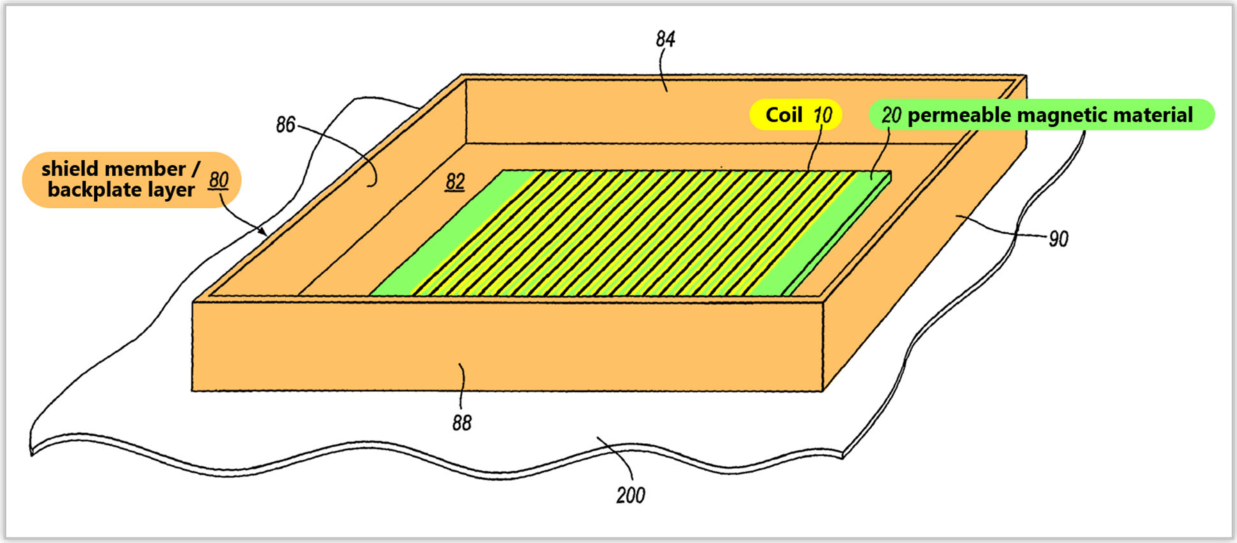
164. These elements are taught by Hui-910 for the same reasons as set forth in Ground 1. *See* Ground 1, 1/13[Preambles], 1/13[b], and 1/13[c] above.

2. Element 1/13[c]: shield member comprising backplate for controlling flux

165. In claim 1, this element recites "a shield member comprising a backplate defining a third layer, said backplate arranged to control electromagnetic flux generated by said transmitting pad." Claim 13 is substantively similar as it recites "a shield member comprising a backplate defining a third layer, said backplate arranged to control electromagnetic flux." As I discuss with respect to claim construction, a POSA would have understood the claimed shield member to require the recited backplate, while permitting but not requiring other elements. *See* Claim Construction Section above. But even if the "shield member" were construed more narrowly, these elements were taught by the combination of Hui-910 and Beart. *See* Claim Construction above.

166. As discussed in the Motivation to Combine section, Hui-910 taught a flat flux shield made from conductive material, and Beart taught that the flat shield could be improved by adding sidewalls made of the same conductive material. *See* Ground 1, Element 1/13[c] and Motivation to Combine above. In particular, Beart taught extending the shielding and providing sidewalls so that "the conductive shield

extends in a substantially continuous sheet substantially over all but one face" of the inductive power transfer pad as shown in Figure 7 below.



Beart Fig. 7 (annotated), 5:9-14, 8:24-25, 10:6-15 (forming a "five walled" flux shield that is a "shield member comprising a backplate defining a third layer" with four side walls).

167. Beart also explains that "[t]he advantage of such an arrangement is that it increases still further, **compared to a flat sheet**, the path that flux would have to travel in order to travel through a metal object underneath the flux generating unit." Beart 5:16-18; *see also* Beart 9:26-10:4 (explaining that the flat sheet "forces any flux lines flowing through the metal desk to travel around the shield, increasing the path length and thus the effective reluctance of the 'desk' path"). Beart explains, therefore, that a flat sheet controls and directs the flux, as discussed with respect to Element 1/13[c] of Ground 1, and that the side walls serve to further control and

direct that flux by increasing the path the magnetic flux has to travel to couple to metal under the flux shield.

168. A POSA would have reasonably expected such a modification to Hui-910 to further improve the directing and control of the flux as taught by Beart. For example, modifying Hui-910 to include Beart's five walled flux shield would "allow the flux to be concentrated in directions in which it is useful, improving the flux-efficiency of the unit," and providing shielding for "directions where [the flux] can cause side-effects" to increase efficiency and minimize damaging effects (including heating) of surrounding metal components and objects. Beart 3:3-4, 4:11-14, 13:26-31; *see also* Motivation to Combine section above.

C. Dependent claims 4-12

169. The following dependent claims would have been obvious over the combination of Hui-910 and Beart for the same reasons as claim 1, and for the additional reasons that follow. I note that the following dependent claims, because they depend from claim 1, are directed only to the arrangement of the receiving pad.

1. Claim 4 – ordered, parallel layers

170. Claim 4 depends from claim 1 and further recites: "wherein a plane of the backplate is substantially parallel to planes of each of the permeable magnetic material members and the coil, the plane of the or each permeable magnetic material member is located between the plane of the backplate and the plane of the coil."

171. These claims are taught by the combination of Hui-910 and Beart for the same reasons explained for Claim 4 in Ground 1 above, except that the conductive layer in Hui-910 now includes four walls in addition to the backplate, as taught by Beart. Those four walls would not affect the otherwise recited order of a permeable magnetic material layer (i.e., *see* Ground 1, Element 1/13[a] above), a coil layer (i.e., Ground 1, Element 1/13[b]), and a backplate comprising a copper or aluminum sheet (i.e., *see* Ground 1, Element 1/13[c]) taught in Hui-910.

2. Claims 5 and 6 – backplate made of copper or aluminum

172. Claim 5 depends from claim 1 and further recites "wherein the backplate is formed from a material which substantially inhibits the passage of magnetic flux therethrough." Claim 6 depends from claim 5 and further recites: "wherein the backplate is formed from one at least one of copper and aluminum."

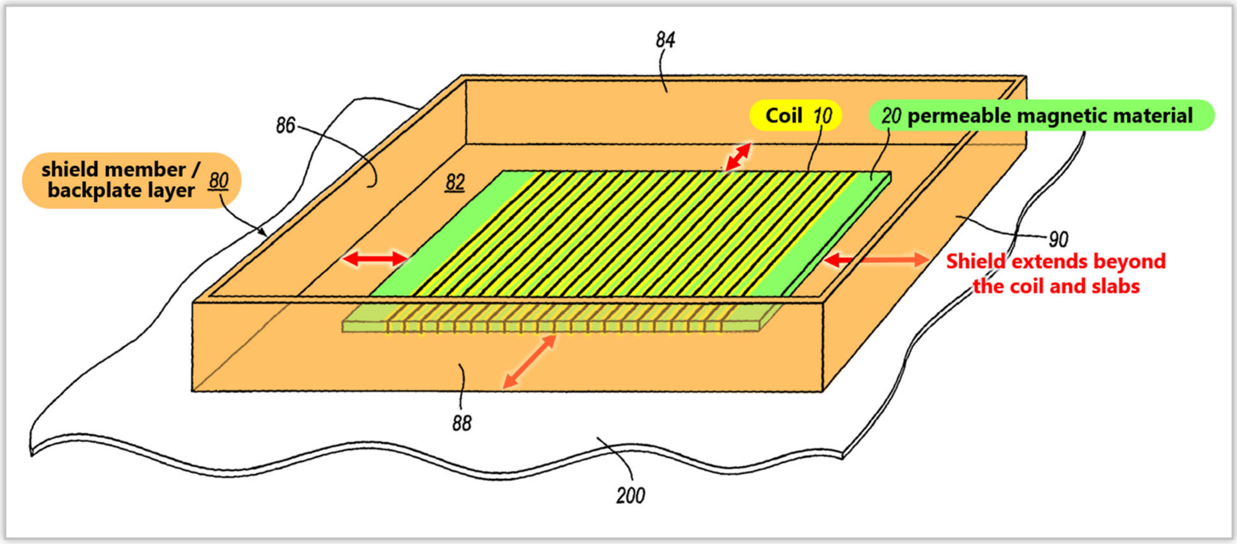
173. These elements are taught by the combination of Hui-910 and Beart for the same reasons explained for Claims 5 and 6 in Ground 1 above. *See* Ground 1, Claims 5 and 6 above. Additionally, Beart taught that "conductive materials, for example **copper and aluminium** . . . can be seen as 'flux-shields' – the lines of flux in any magnetic system are excluded from them." Beart 2:29-3:10. Beart also taught that "[t]he conductive shield is advantageously made of a highly conductive material, for example **copper or aluminium** . . . ." Beart 4:25-30; *see also* Beart Figs. 1, 3, 5-8, 8:6-7, 8:12-13, 8:18-28, 9:14-15. A POSA would understand, therefore, that the

combination of Hui-910 and Beart taught a backplate formed from copper or aluminum, which is a material that substantially inhibits the passage of magnetic flux therethrough, as claimed.

3. Claim 7 – backplate extends beyond coil and slabs

174. Claim 7 depends from claim 1 and recites "wherein the backplate extends beyond coil and slabs." I note that the term "slabs" is not used in independent claim 1. However, for purposes of this proceeding I have assumed that this was a drafting error and that "slabs" to refer to the "one or more permeable magnetic material members" in claim 1. Pursuant to this understanding, Claim 7 is taught by the combination of Hui-910 and Beart.

175. As explained in the Motivation to Combine section and Element 1/13[c], a POSA would have found it obvious to modify Hui-910's flat conductive sheet that forms the "backplate defining a third layer" to include four walls, as taught by Beart's embodiment shown in Figure 7 below. When adding those four walls, Beart further taught that "[t]he base 82 of the flux shield," corresponding to the "backplate," "**extends** between the lower surface of the flux generating unit 50 and the support surface 200," as shown by the annotated red arrows below. Beart 10:8-10.



Beart Fig. 7 (annotated), 8:24-25.

176. Beart also discloses an embodiment without walls in which the flux shield is flat and "extends outwardly by distances e_1 to e_4 beyond each edge of the flux generating unit," where e_1 to e_4 are all approximately 50 mm. Beart Fig. 5, 8:18-19, 9:1-19, 9:26-10:4; *see also* cls. 2-3, 18-19. Beart further explains that the sidewalls in Figure 7 "keep[] the effective reluctance of the desk path high," and as a result, the distances e_1 to e_4 can be reduced to about 4 mm. Beart 10:10-13; *see also* cls. 5-7, 20. As a result, a POSA would understand that Beart teaches, in its Figure 7 embodiment including side walls, that the "backplate extends beyond coil and slabs," as claimed.

4. Claim 8 – permeable magnetic material comprises ferrite

177. Claim 8 depends from claim 1 and further recites "wherein the or each permeable magnetic material member comprises ferrite." This claim is obvious over

Hui-910 in view of Beart for the same reasons as claim 1, and the combination of Hui-910 and Beart taught this claim for the same reasons explained regarding Ground 1 above. *See, e.g.*, Hui-910 ¶¶ 12 ("Preferably, the shielding comprises a sheet of **ferrite material** . . . ."), 80 (disclosing "**ferrite** sheet" in the mobile phone embodiment), 83 (disclosing "**ferrite** sheet" in watch embodiment); *see also* Ground 1, Claim 8 above.

178. The combination of Hui-910 and Beart taught this element for the same reasons explained regarding Ground 1 above. *See* Ground 1, Claim 8 above.

5. Claims 9-12 – backplate controls/directs flux

179. Claim 9 depends from claim 1 and further recites "wherein the backplate is arranged to control the electromagnetic flux substantially perpendicular to the third layer."

180. Claim 10 depends from claim 1 and further recites "wherein the shield member is arranged to control the electromagnetic flux between the inductive power transfer pad and the transmitting pad."

181. Claim 11 depends from claim 1 and further recites "wherein the backplate is arranged to direct electromagnetic flux generated by the transmitting pad."

182. Claim 12 depends from claim 11 and further recites "wherein the electromagnetic flux is directed substantially perpendicular to the third layer."

183. These claims are obvious over Hui-910 in view of Beart for the same reasons as claim 1 and as further explained in the following paragraphs.

184. The combination of Hui-910 and Beart taught these elements for the same reasons explained regarding Ground 1 above. *See* Ground 1, Claims 9-12 above. Specifically, Beart taught that a flat sheet alone controls and directs flux because conductive materials, like copper and aluminum, serve as flux-shields that "shield one part of a system from a magnetic field and consequently concentrate the field in another part." Beart 2:29-3:10. Consistent with well-known principles, Beart explained that the magnetic field "induces eddy currents . . . [that] generate a second field which – in the limit of a perfect conductor – is equal and opposite to the imposed field, and cancels it out at the conductor." Beart 2:31-3:1. As a result, the backplate in Beart controls and directs the flux in the same way the backplate in Hui-910 does—by both inhibiting the passage of magnetic flux through the conductive material and also generating magnetic flux in a direction perpendicular to the backplate.

185. Beart also taught that the addition of side walls only serves to improve that control and direction: "[t]he advantage of such an arrangement is that **it increases still further, as compared to a flat sheet**, the path that flux would have to travel in order to travel through a metal object underneath the flux generating unit." Beart 5:16-18. In other words, Beart's side walls function according to the

same principles as the backplate, but in a direction parallel to the backplate. Flux exiting the IPT pad in a direction parallel to the backplate would be attenuated by Beart's walls, which would also generate a new magnetic field in the opposite direction. As a result, the shield member modified in accordance with Beart would assist in directing and controlling the electromagnetic flux. *See* Ground 2, Motivation to Combine and Element 1/13[c] sections above. This is similar to the '955 patent, where the aluminum strip that forms a side wall around the IPT pad "**assist[s]** in controlling the pattern of the flux generated." '955 patent 9:5-7, 9:15-23 ("More particularly, the backplate 21 and strip 25 are appropriately coupled to **work together** to direct flux generated by the charging pad . . . .").

X. Ground 3: Claims 1-13 would have been obvious over Nakao in view of Beart

186. Claims 1-13 of the '955 patent are also obvious over the combination of Nakao and Beart.

A. Motivation to combine Nakao and Beart

187. As an initial matter, Nakao and Beart are both directed to wireless inductive power transfer systems and are therefore analogous art. Nakao, for example, taught wireless power transfer in a "noncontact coupler comprising a pair of magnetic cores" with a primary coil and a secondary coil in the transmitting and receiving pads respectively, with the "said coupler transmitting AC electric power between said primary and secondary coils." Nakao Abstract, ¶ 16. Beart similarly

teaches an inductive power transfer unit for wirelessly transmitting power through a magnetic field that couples to any secondary devices placed on the surface of Beart's flux generating unit. Beart 1:1-14.

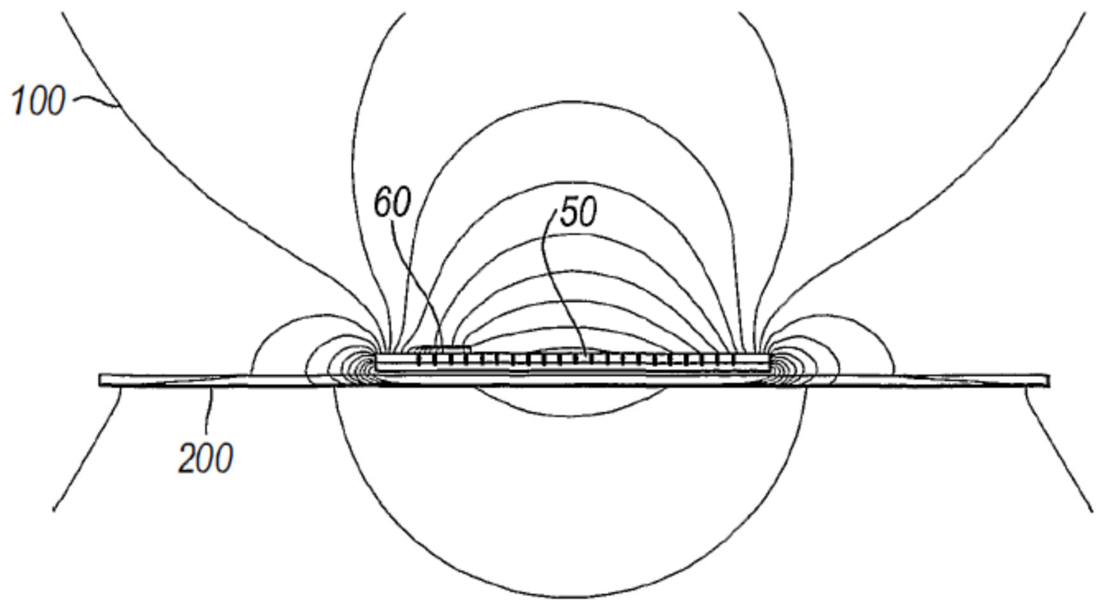
188. It is my opinion that a POSA could have and would have been motivated to combine Nakao and Beart. In particular, a POSA would have been motivated to add Beart's flux shield to Nakao's transmitting and receiving pads because it would, for example, "increas[e] the coupling between" the transmitting pad and receiving pad by "forcing most of the flux to go over the power transfer surface," and, in addition, the shields on the transmitting and receiving pads would protect surrounding components, objects, and people from stray magnetic flux. Beart 4:16-20, 12:7-13:31. A POSA also would have had a reasonable expectation of success implementing Beart's flux shield around Nakao's magnetic core because, as discussed below, Beart explains how its flux shield could be implemented on a circular pad like in Nakao's Figure 7 embodiment.

189. One reason a POSA would have been motivated to implement Beart's flux shield with Nakao's transmitting and receiving pads would be to improve coupling between the pads. As discussed in the Nakao Overview, Nakao's transmitting pad would likely be located in or on the ground, and Nakao's receiving pad would likely be located on the underside of a vehicle. *See* Nakao Overview above. A POSA would have understood that at the parking/charging location of the

transmitting pad there could be "any number of unknown metals of unknown permeability or conductivity" in the floors or walls, any of which could "reduc[e] the field strength of the transmitting coil." O'Brien 139 ("The floor, walls, and equipment located in the vicinity of the source coil system contained metals of unknown permeability and conductivity, reducing the field strength in the operating volume."); *see also id.* at 80-81. For example, the ground of a parking garage may include concrete with steel metal rebar. As to the receiving pad, the vehicle chassis would have imposed similar reductions in field strength. Indeed, as noted by Beart, a vehicle chassis will likely include ferrous material, which can cause reduced power transfer efficiency because the ferrous materials provides a low reluctance path that "suck[s]" flux away from the power transfer system. Beart 2:11-27.

190. A POSA looking to shield Nakao's transmitting and receiving pads would have looked to Beart, which explains how its flux shields "allow[s] the flux to be concentrated in directions in which it is useful, improving the flux-efficiency of the unit, and to be shielded from directions where it can cause side-effects, for example coupling into a metal desk under the unit." *Id.* at 4:11-14. For example, the "flux shield increases the coupling between the flux generating unit and the secondary device(s) by forcing most of the flux to go over the power transfer surface." *Id.* at 4:16-18. Beart further taught, through finite element analysis and sample test results, the effects of shielding the power transfer unit, including

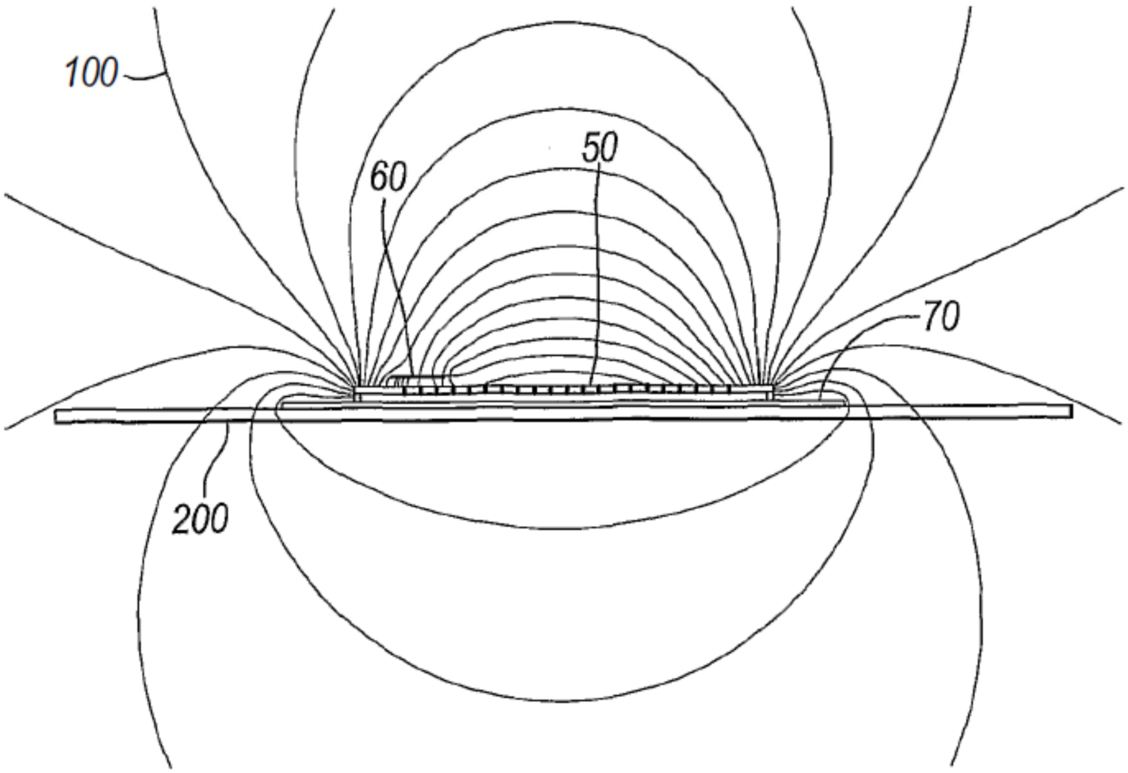
determining that there are at least "two key advantages of a flux shield in reducing the side effects of metal objects: less power delivered into the steel by the generator, and less variation in power seen by the secondary device." Beart Figs. 4, 6, 8, 8:1-16, 8:21-22, 8:27-28, 9:26-10:4, 10:21, 12:1-13:31. For example, Beart illustrates the flux lines of a flux generating unit 50 when placed on or near a ferrous metal desk 200 in Figure 4, without any conductive shielding, where many of the flux lines going "down" are sucked into the desk.



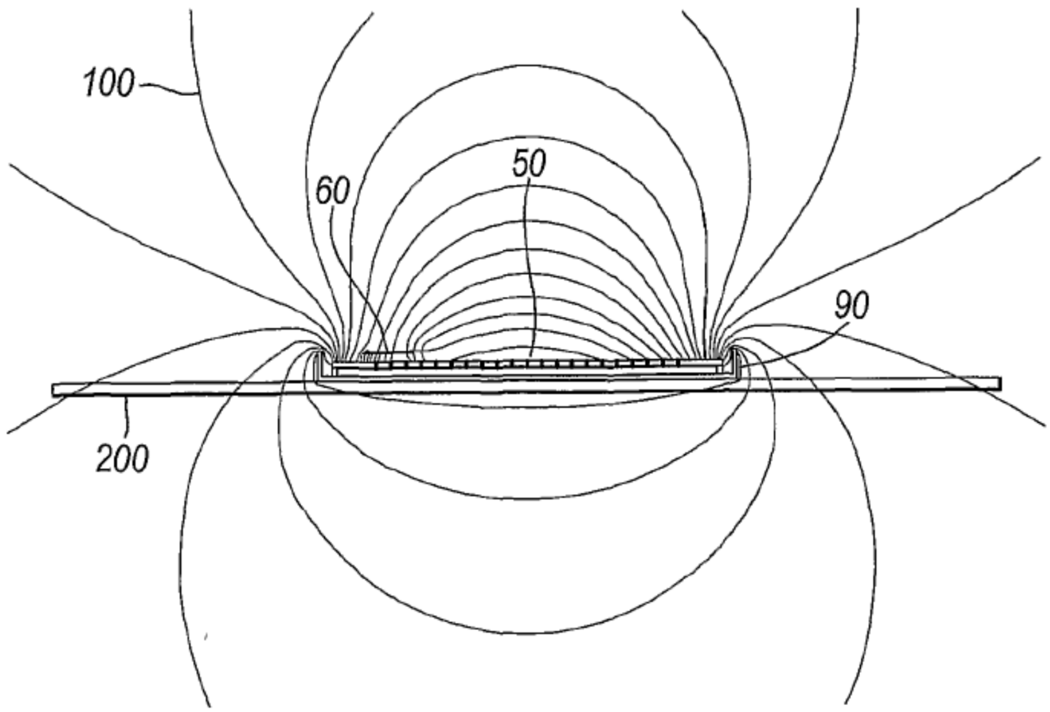
Beart Fig. 4, 2:11-27, 8:15-16.

191. This is in contrast with, for example, Figures 6 and 8 below, which respectively depict the same flux generating unit placed on a ferrous metal desk 200 with (1) a flat conductive sheet 70 that extends beyond the edges of the flux

generating unit, and (2) a flux shield 90 that extends beyond the edges of the flux generating unit **and** includes side walls.



Beart Fig. 6, 8:21-22, 9:26-31.



Beart Fig. 8, 8:26-27, 10:23-29.

192. As depicted, the flux shield prevents flux from flowing into the nearby ferrous surface, instead controlling and directing the flux to be primarily in the area of the power transfer surface. A POSA would have understood that those same benefits would be directly applicable to Nakao, as the flux shields could be used to avoid or reduce the negative effects of any unknown objects in the ground or walls near the transmitting pad, and the impact of the ferrous vehicle chassis near Nakao's receiving pad. Accordingly, coupling between the transmitting and receiving pads would be improved, and less drive current would be necessary to generate the same amount of power at the receiving pad. POSA, therefore, would have been motivated

to add Beart's flux shield to Nakao's magnetic core arrangement to improve the efficiency of power transfer.

193. A second reason that a POSA would have been motivated to shield Nakao's transmitting and receiving pads with Beart's flux shield to protect surrounding objects, components and people from stray flux. As Beart explains, when flux interacts with nearby metal components, which could include components in the floor or ground underneath the transmitting pad or the vehicle chassis above the receiving pad as discussed above, there are "core losses, for example via hysteresis and/or eddy current loss" in those objects, and those eddy currents may heat up and potentially damage those objects. *See* Beart 2:11-27; O'Brien 21 (electromagnetic flux causes "ohmic power dissipated as heat" in conductors), 67; *see also* Ground 2, Motivation to Combine above. As discussed in Ground 2, stray flux could also interfere with medical devices like pacemakers in a passenger of the vehicle being charged, detonation of electro-explosive devices, and fires caused by sparks from induced fields. *See* ICNIRP Guidelines 514-15. Thus, a POSA would have been motivated to implement reasonable "engineering controls" to prevent excess magnetic flux from escaping the power transfer system in Nakao, which Beart's flux shield would provide. *Id.*; Dobbs ¶ 8 (describing that it "is often desired" to shield transmitting and receiving pads because there may be "undesirable

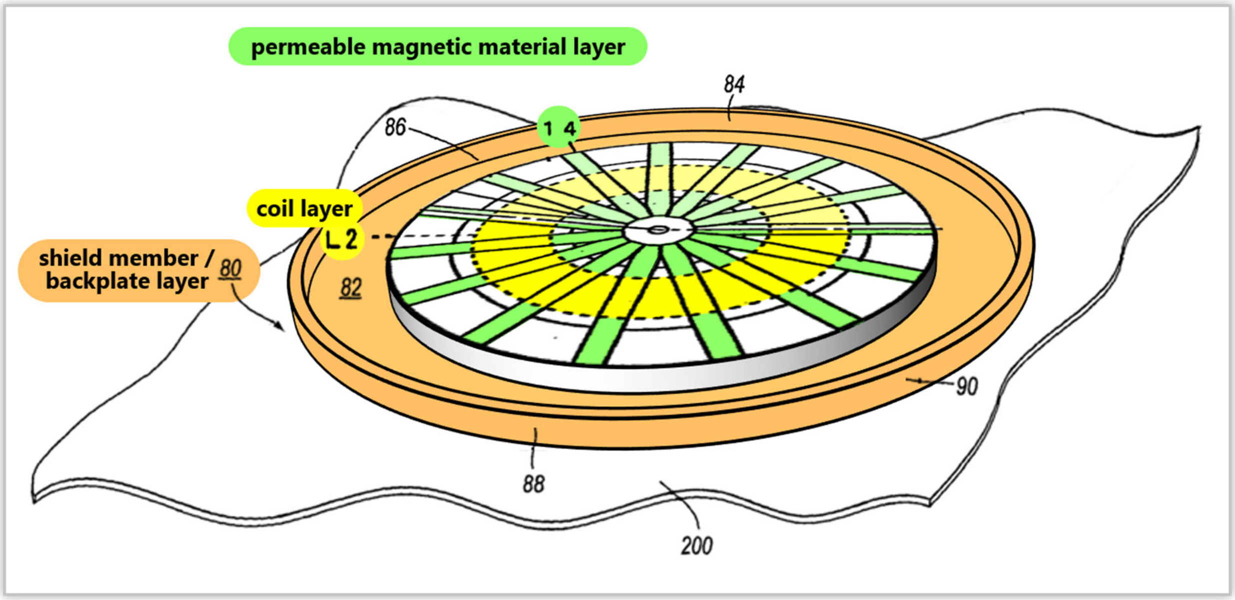
RF emission, increased leakage inductance, and/or reduced power transfer efficiency”).

194. Indeed, as discussed with respect to Ground 2, a POSA would understood that stray magnetic fields can pose a safety hazard to people as well. *See* O’Brien 23-24, 27, 155-60; *see also* Ground 2, Motivation to Combine (describing other well-known international regulations limiting magnetic flux). Those regulations would have been of particular concern in a vehicle charging application, like Nakao’s, for at least two reasons. Nakao ¶ 2. First, the amount of power, and corresponding magnetic field strength, necessary to charge an electric vehicle battery would be relatively high. Second, without shielding of the receiving pad, the passengers in the vehicle could be subject to significant magnetic flux.

195. Thus, in order to protect objects and people from the magnetic flux generated by the transmitting pad, a POSA would have been motivated to add shielding to Nakao’s transmitting and receiving pads, which Beart’s shields provide. Specifically, Beart explains that its flux shields can be used to “shield one part of a system from a magnetic field” and prevent flux from flowing in “directions where [the flux] can cause side-effects.” Beart 3:3-4, 4:11-14, Fig. 8 (showing flux lines); *see also* Beart 13:26-31. Moreover, the flux shields focus the field in the area between the transmitting and receiving pad. Beart 3:3-4, 4:11-14, Fig. 8 (showing flux lines); *see also* Beart 13:26-31. That is because Beart’s flux shields are made

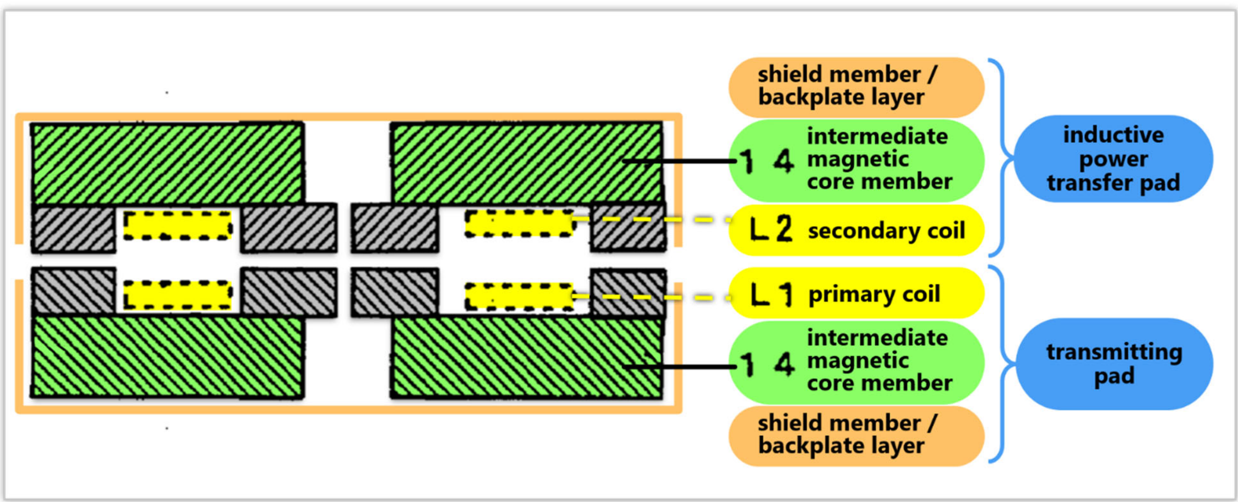
from highly conductive materials, like copper or aluminum, which direct and control flux generated by the transmitting pad by creating an equal and opposite magnetic field that "acts to cancel the field near the shield." Beart 2:29-3:5, 4:4-9, 4:22-5:4. . Thus, a POSA would have understood that applying Beart's flux shields to Nakao's transmitting and receiving pads could help to minimize heating and damage to surrounding objects, as well as to comply with safety regulations for exposure to time varying electric and magnetic fields.

196. A POSA also would have been motivated to combine Beart with Nakao because Beart explained how to implement its flux shield in circular pads like the ones used in Nakao. Although Beart's figures are directed to rectangular shaped pads, Beart explains that the flux shield could be modified to be a cylindrical shape as well. *See, e.g.*, Beart 5:9-16, 10:6-16, Fig. 7. Specifically, Beart taught that, "if the flux generating unit is a substantially flat cylinder, the shield may extend to cover the bottom and cylindrical sides of the unit." Beart 5:14-16. This type of cylindrically shaped shield applied to one of Nakao's pads is illustrated below:



Beart Fig. 7 annotated and modified in view of Nakao Fig. 7B.

197. A POSA would have arranged Beart's flux shield to Nakao's transmitting and receiving pads in an identical manner, resulting in a mirrored structure when the pads are aligned as illustrated in the cross-section below:



Nakao Fig. 7C annotated and modified in view of Beart Fig. 7. Indeed, the configuration above was also referred to as configuring a power transfer system with "half shields" on each pad in other applications using wireless power transfer through magnetic coupling, and had a known benefit of preventing the magnetic fields from having a "substantial component parallel to an imaginary surface" between the two pads during operation. *See also* Dobbs ¶¶ 10-13 ("magnetic field(s) preferably have no substantial component parallel to an imaginary surface bounding the volume of space swept out by shield airgap(s) . . . during operation of the power coupling device"), 78, Figs. 5, 7. Or, put another way, there would not be significant leakage flux out the sides of either pad during operation.

198. A POSA implementing Beart's shield to Nakao's pads as described above would have understood the shield would therefore form an enclosure that is "attached to the outside of" Nakao's transmitting pad and receiving pad, consistent with Beart's teachings. Beart 6:10-24, 11:8-11, Figs. 7-9. By doing so, Beart's shields would "shield[s] objects outside" Nakao's power transfer system from flux generated by the transmitting pad while also increasing "the path that flux would have to travel in order to travel through a metal object underneath the flux generating unit," like a vehicle chassis in the receiving pad or objects in the ground or walls for the transmitting pad. Beart 5:16-18, 6:10-24, Figs. 7-9. Additionally, a POSA would have understood that a shield on both the transmitting and receiving pads would help achieve Nakao's stated objective of "keep[ing] appropriate balance in a magnetic

path and reduc[ing] the core loss" because flux would not be sucked into extraneous objects on either the transmit or receiving side. *See* Nakao ¶¶ 70, 21, cl. 7.

199. For all of the above reasons, a POSA implementing Nakao's wireless power transfer system for an electric vehicle would have incorporated Beart's flux shields on the transmitting and receiving pads.

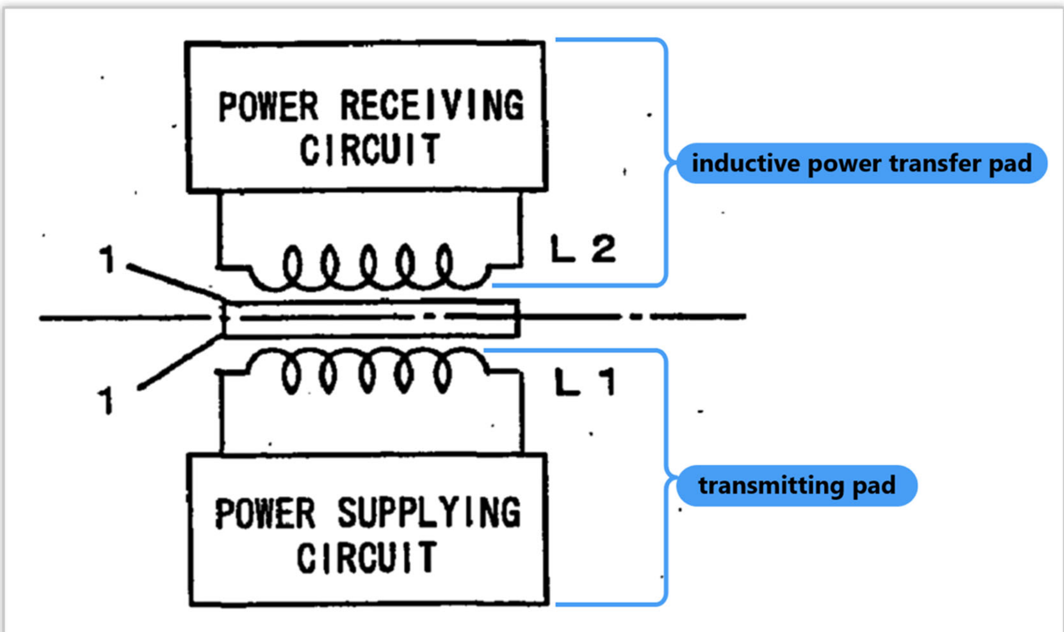
B. Independent claims 1 and 13

1. Preambles

200. The preamble to claim 1 recites "An inductive power transfer pad to receive power from a transmitting pad, the inductive power transfer pad comprising[.]" The preamble to claim 13 recites "An inductive power transfer system comprising a wireless power receiver pad separable from a wireless power transmitter pad, the two said pads each comprising[.]" Both claims are directed to inductive power transfer pads including what I refer to as the "transmitting pad" (the "transmitting pad" in claim 1 and the "transmitter pad" in claim 13) and a "receiving pad" (the "inductive power transfer pad to receive power" in claim 1 and the "wireless power receiver pad" in claim 13). The primary difference between the preambles is that the remaining limitations of claim 1 are directed only to the receiving pad, whereas claim 13 is directed to both pads.

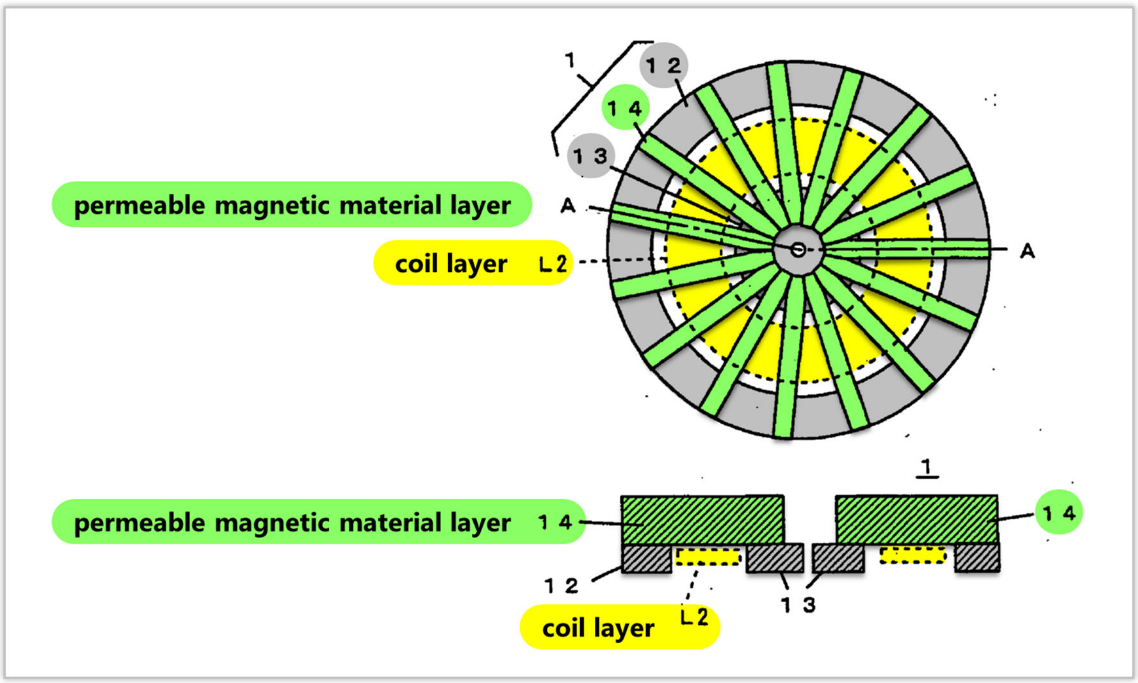
201. To the extent that these preambles are limiting, Nakao discloses them. Nakao taught a "noncontact coupler" comprising a "pair of magnetic cores 1, 1" and

a "primary coil L1 and secondary coil L2." Nakao Abstract. Annotated Figure 12D below shows this configuration at a high level, where the "lower" or "primary" magnetic core 1 includes primary coil L1 (together, the claimed transmitting pad) and the "upper" or "secondary" magnetic core 1 includes secondary coil L2 (together, the claimed receiving or "inductive power transfer" pad). Nakao ¶¶ 51, 78; *see also* Nakao ¶¶ 5, 7, 51-52, 95.



Nakao Fig. 12D (annotated). The secondary coil receives power wirelessly from the primary coil L1, and is therefore an "inductive power transfer system.. *Id.* at 51-52. In particular, the coupler "transmit[s] AC electric power between said primary and secondary coils by means of an annular closed magnetic path." *Id.* ¶¶ 4, 16, 21, 51, 68.

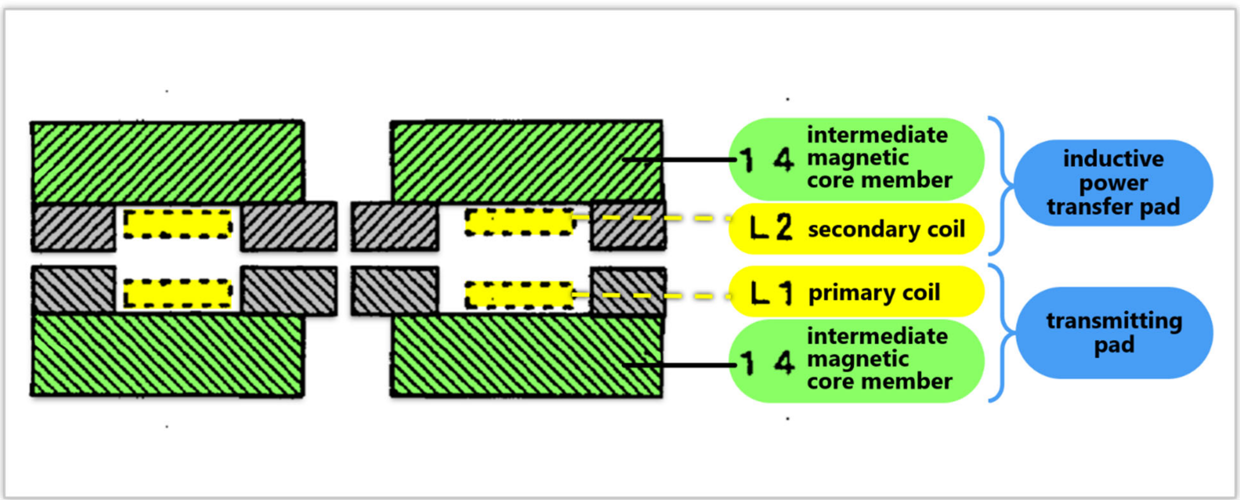
202. Nakao taught several potential magnetic core arrangements, but as discussed in the Nakao Overview above, the "second main technique of the invention" or "third embodiment," or what I refer to as the "Figure 7 embodiment" is particularly relevant. In the Figure 7 embodiment, the "primary and secondary magnetic cores are respectively formed with . . . a number of intermediate core members arranged radially to form a circle," as shown in Figure 7 below. Nakao ¶¶ 21-22, 67-71, cl. 7.



Nakao Figs 7B, 7C (annotated).

203. Figure 7 shows the receiving pad (because L2 is indicated), and a POSA would understand that the transmitting pad would have the same structure. Indeed, Nakao teaches that the transmitting pad comprising the primary coil L1 and its primary magnetic core have the same structure as the secondary coil and secondary

magnetic core. *See, e.g.,* Nakao ¶ 21 (describing noncontact coupler having "a primary coil and secondary coil" and "primary and secondary magnetic cores," where each magnetic core is respectively formed with "intermediate core members arranged radially to form a circle"), cl. 7 (same). The difference in structure would be in terms of their orientation, with the receiving coil L2 facing down, and the transmitting coil L1 facing up. In that way, the "intermediate core members 14" would be arranged under the primary coil L1 (instead of above the secondary coil L2 shown above in Figure 7C), such that the "open magnetic face sides" of the transmitting and receiving pads (i.e., the portions containing the coil) would be "opposing in proximity" as illustrated below:

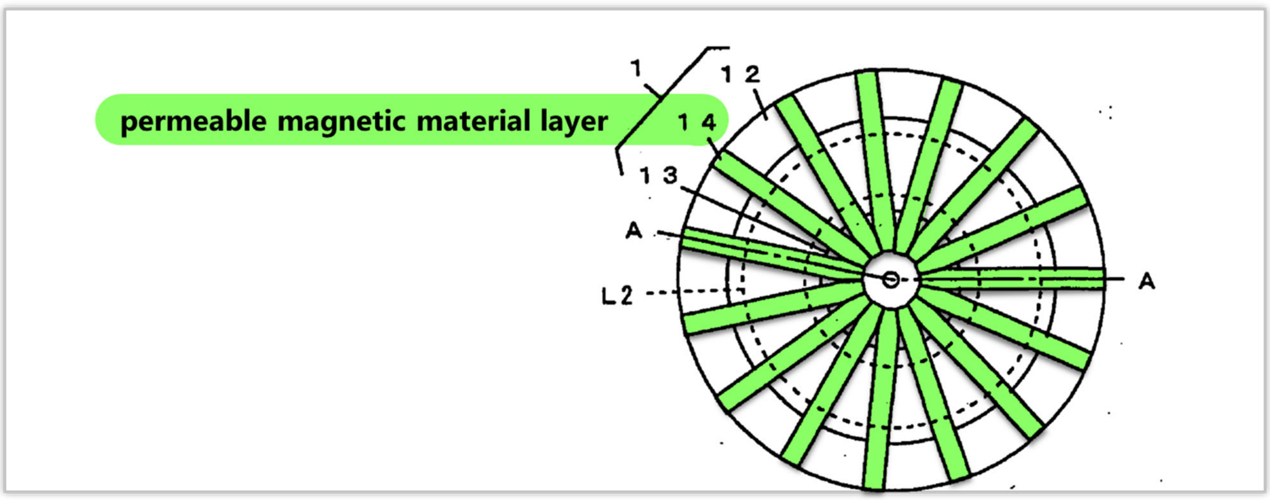


Nakao Fig. 7C (modified and annotated), ¶ 21, cl. 7. As discussed in the Nakao Overview, a POSA would understand that this would permit the receiving pad to be arranged on the underside of a vehicle chassis and the transmitting pad on the ground. *See* Nakao Overview above.

1. Element 1/13[a]: permeable magnetic material layer

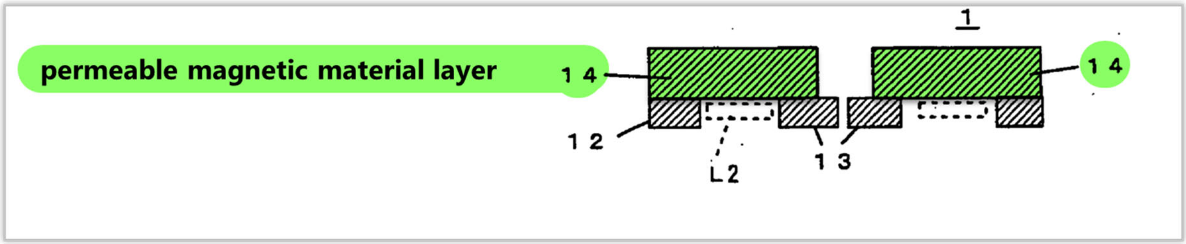
204. This claim element recites "one or more permeable magnetic material members in a first layer" in the receiving pad (claim 1) or in both the transmitting and receiving pads (claim 13).

205. These elements are taught by Nakao. As shown in annotated Figure 7B below, Nakao's receiving pad includes a "secondary core 1" comprising "a number of intermediate magnetic core members 14 arranged radially to form a circle." Those intermediate magnetic core members 14 correspond to the claimed "one or more permeable magnetic material members."



Nakao Fig. 7B (annotated); Nakao ¶ 68.

206. Figure 7C shows a side view of Nakao's secondary core member, showing that the intermediate core members 14 form a first layer, as claimed.



Nakao Fig. 7C (annotated); Nakao ¶¶ 68, 21, cl. 7.

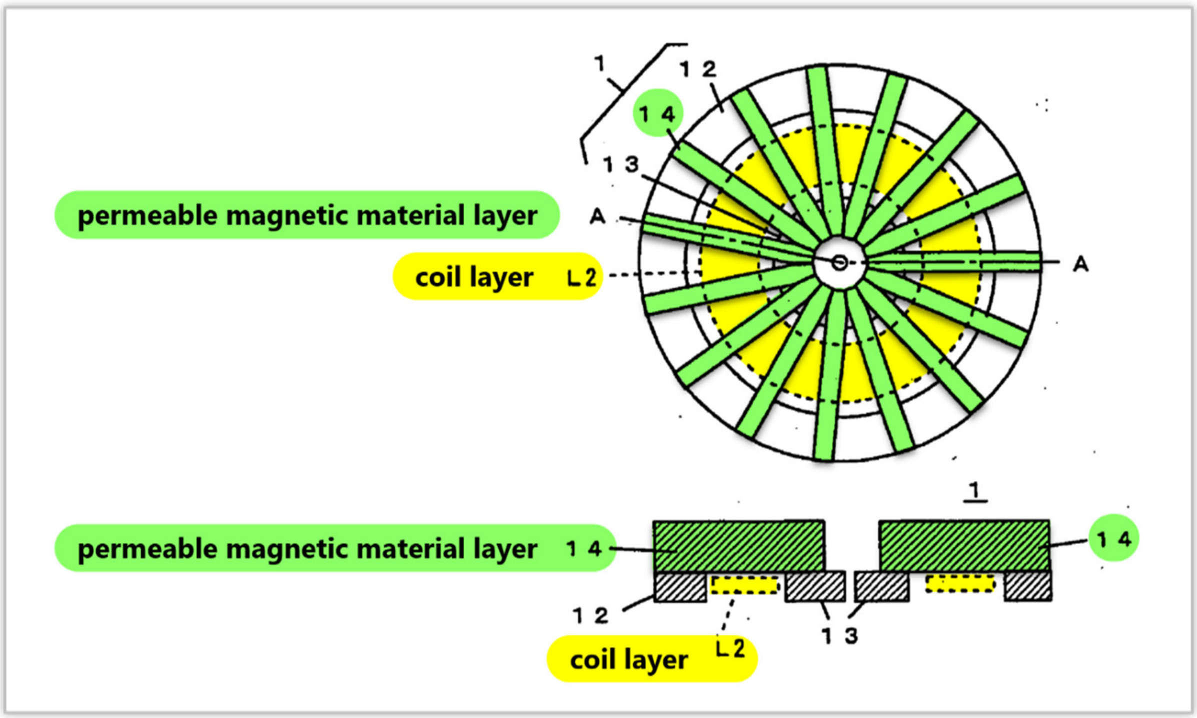
207. As discussed with regards to the Preambles, Nakao's transmitting pad would be arranged to have the same structure as the receiving pad, including intermediate core members 14, arranged as a layer. Nakao ¶ 21 ("noncontact coupler comprising a pair of magnetic cores . . . wherein said **primary and secondary magnetic cores are respectively formed with** . . . **a number of intermediate core members** arranged radially to form a circle"), cl. 7 (same); *see also* Ground 3, Elements 1/13[Preambles] above.

208. Nakao taught that "[t]he magnetic cores can be made of ferrite magnetic material." Nakao ¶¶ 30, 55, 97, 106. As discussed with respect to Element 1/13[a] of Ground 1, a POSA would have understood that ferrite is a "permeable magnetic material." *See* Ground 1, Element 1/13[a] above.

2. Element 1/13[b]: coil layer

209. This claim element recites "a coil having at least one turn of a conductor, the coil being arranged in a second layer substantially parallel to that of said permeable magnetic material members." Claim 1 applies to the coil in the receiving pad, while claim 13 applies to both the receiving pad and the transmitter pad.

210. Nakao taught these elements. As discussed in the Nakao Overview and Element 1/13[Preambles], Nakao taught a transmitting pad with primary coil L1 and a receiving pad with secondary coil L2. *See* Nakao Overview and Ground 3, Element 1/13[Preambles] above. Annotated Figures 7B and 7C below show the receiving pad, where the secondary coil L2 includes "at least one turn of a conductor" and forms a a second layer substantially parallel to the intermediate magnetic core members 14 that form the claimed "permeable magnetic material members."



Nakao Figs. 7B, 7C (annotated), ¶¶ 21, 51 ("secondary coil L2"), cl. 7; *see also* Ground 3, Elements 1/13[a] (discussing permeable magnetic material layer). .

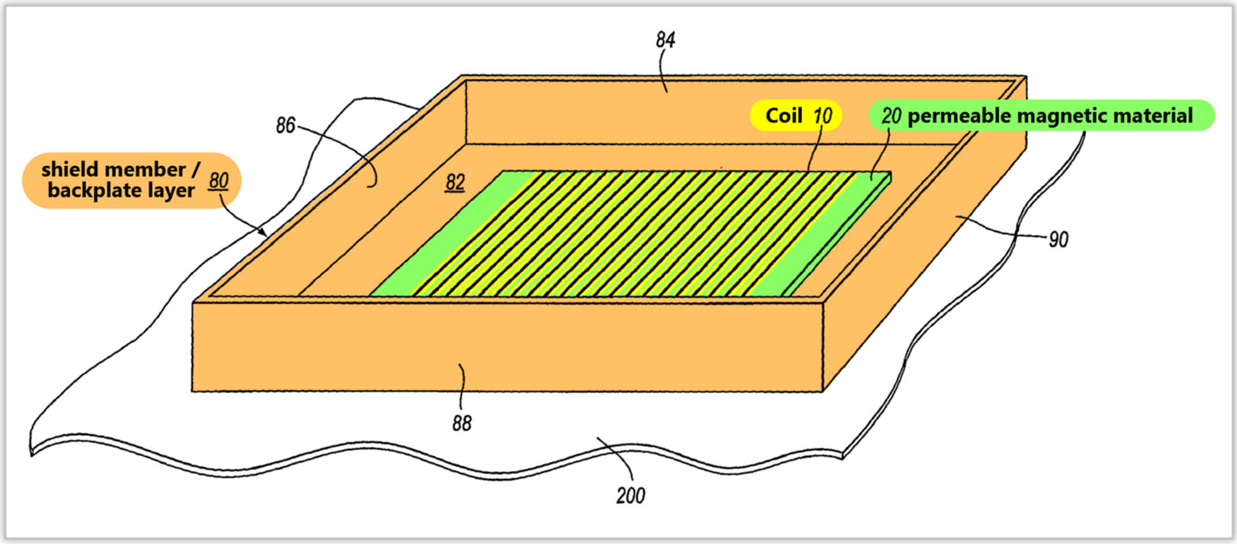
211. Nakao's transmitting pad would be arranged similarly to the receiver pad except that the primary coil L1 would be arranged as a layer above the

intermediate core members 14. *See* Nakao ¶ 21 ("noncontact coupler comprising . . . a **primary coil** . . . wherein said **primary** and secondary **magnetic cores** are respectively formed with . . . a number of **intermediate core members** arranged radially to form a circle"), cl. 7; *see also* Ground 3, Elements 1/13[Preambles] above.

3. Element 1/13[c]: shield member comprising backplate for controlling flux

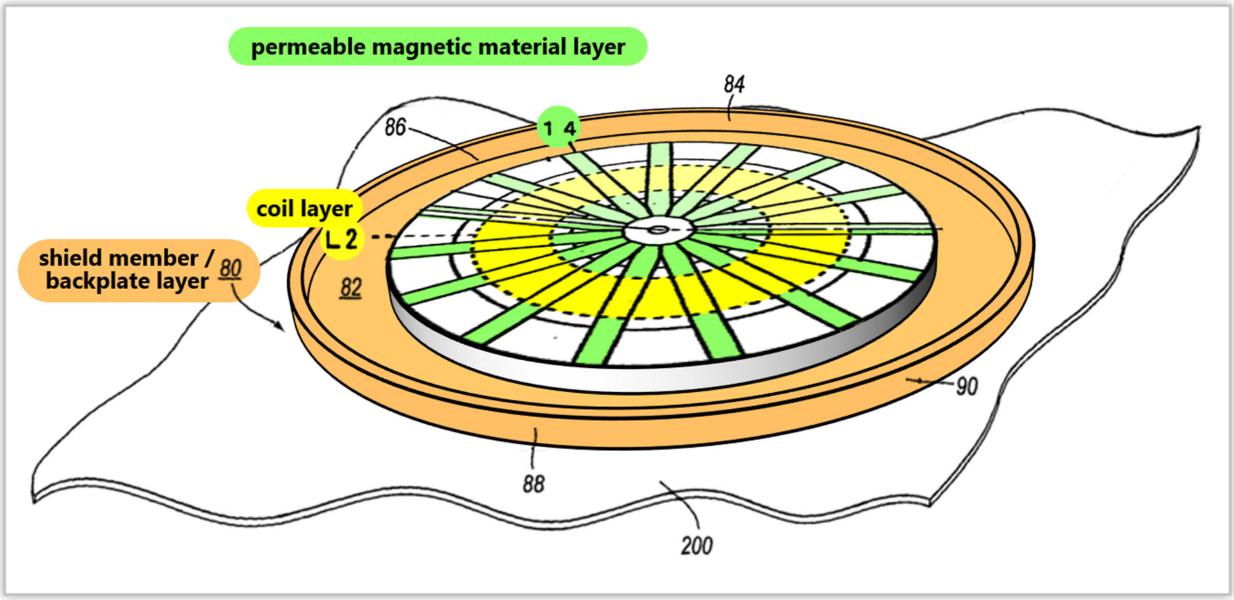
212. In claim 1, this element recites "a shield member comprising a backplate defining a third layer, said backplate arranged to control electromagnetic flux generated by said transmitting pad." Claim 13 is substantively similar as it recites "a shield member comprising a backplate defining a third layer, said backplate arranged to control electromagnetic flux." Claim 1 applies to the backplate in the receiving pad, while claim 13 applies to both the receiving pad and the transmitter pad.

213. These elements are taught by the combination of Nakao and Beart. Specifically, Beart discloses the claimed "shield member comprising a backplate" as shown in annotated Figure 7 below, where Beart taught a flux shield that includes a "base 82 of the flux shield 80" (the claimed backplate) that is located between the "electrically-driven conductors" or "magnetic assembly" of a power transfer pad (i.e., the coil and magnetic material) and a "support surface" that the pad is placed on. Beart 1:16, 4:31-5:4, 10:6-16; *see also id.* at 12:1-13:31.



Beart Fig. 7 (annotated). The base of the flux shield acts as a "backplate" because it is a layer between the support surface and the flux generating coil, and controls and directs flux by "forc[ing] any flux lines flowing" through the support surface to instead travel around the shield, "increasing the path length and thus the effective reluctance" of the alternative flux path through the support surface. Beart 9:26-10:4, 10:6-16. As a result, Beart taught a shield member comprising a backplate that is used to control the electromagnetic flux, as claimed.

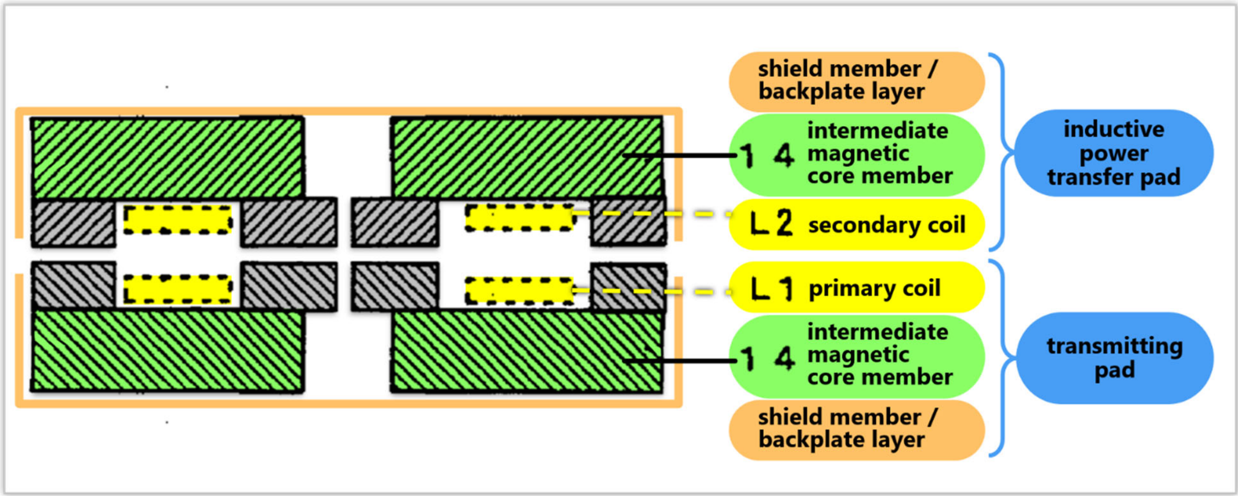
214. A POSA would also be motivated to combine Nakao and Beart such that Beart's flux shield forms a third layer in Nakao's transmitting and receiving pads. As discussed in the Motivation to Combine section, the below figure illustrates how a POSA would have been combined Beart's flux shield and Nakao's transmitting and receiving pads.



Nakao Fig. 7B modified in view of Beart Fig. 7.

215. As discussed above, Beart explains that the shield is located between the magnetic assembly and the support surface, and as discussed in the Nakao Overview section, the support surface could be the vehicle chassis for the receiver pad and the ground for the transmitting pad. *See* Nakao Overview above.

216. The figure below shows a modified side view of Figure 7C of Nakao that includes Beart's improved flux shield. As the figure shows, Beart's base forms the third layer, where the first layer is the coil layer (primary coil L1 or secondary coil L2 in the transmitting and receiving pads respectively) and the second layer is the permeable magnetic material member layer (the intermediate magnetic core members 14). *See* Ground 3, Elements 1/13[a] and 1/13[b] above.



Nakao Fig. 7C modified in view of Beart Fig. 7; *see also* Nakao ¶¶ 21, 68-69, cl. 7, Figs. 7B-7C; Beart Figs. 7-9 (showing top and side views of Beart's flux shield), 8:24-31, 10:6-11:11.

217. A POSA would have reasonably expected that adding Beart's flux shields to Nakao's transmitting and receiving pads would direct and control the flux generated by the transmitting pad. Specifically, Beart's flux shield is formed from a highly conductive material such as copper or aluminum, which cancels out the transmitted flux at the surface of the shield by generating an equal and opposite field. Beart 2:29-3:4; *see also* discussion regarding conducting materials in Ground 1 Element 1/13[c]. By canceling the flux in this way, Beart's backplate on the transmitting and receiving pads of Nakao would "allow the flux to be concentrated in directions in which it is useful, improving the flux-efficiency of the unit," while also shielding the flux from "directions where it can cause side-effects." Beart 3:3-4, 4:11-14, 13:26-31; *see also* Motivation to Combine above; Grounds 1 and 2,

Elements 1/13[c] (discussing effects of highly conductive shielding material on magnetic flux); Dobbs ¶¶ 10-13 ("magnetic field(s) preferably have no substantial component parallel to an imaginary surface bounding the volume of space swept out by shield airgap(s) . . . during operation of the power coupling device"), 78, Figs. 5, 7.

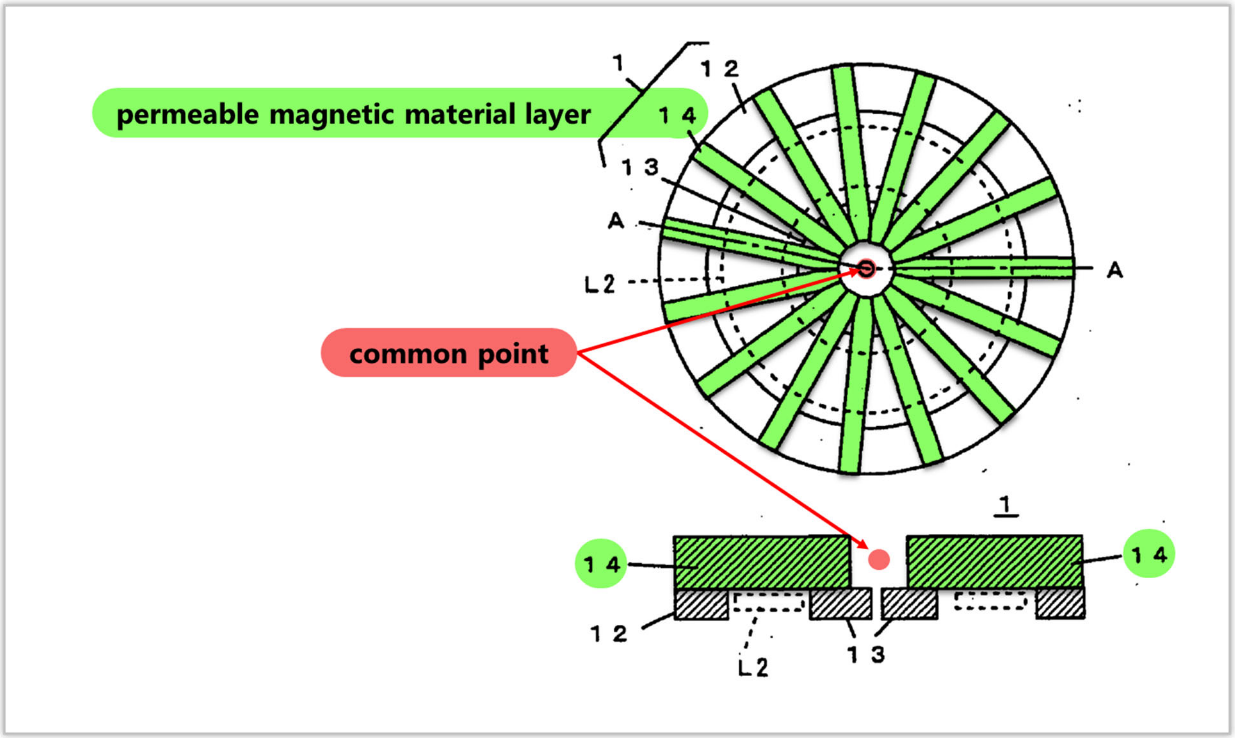
C. Dependent claims 4-12

218. The following dependent claims would have been obvious over the combination of Nakao and Beart for the same reasons as claim 1, and for the additional reasons that follow. Conversely, claim 1 would have been obvious for the following additional reasons. I note that the following dependent claims, because they depend from claim 1, are directed only to the arrangement of the receiving pad.

1. Claim 2 – permeable magnetic material members arranged as bars extending radially from a common point

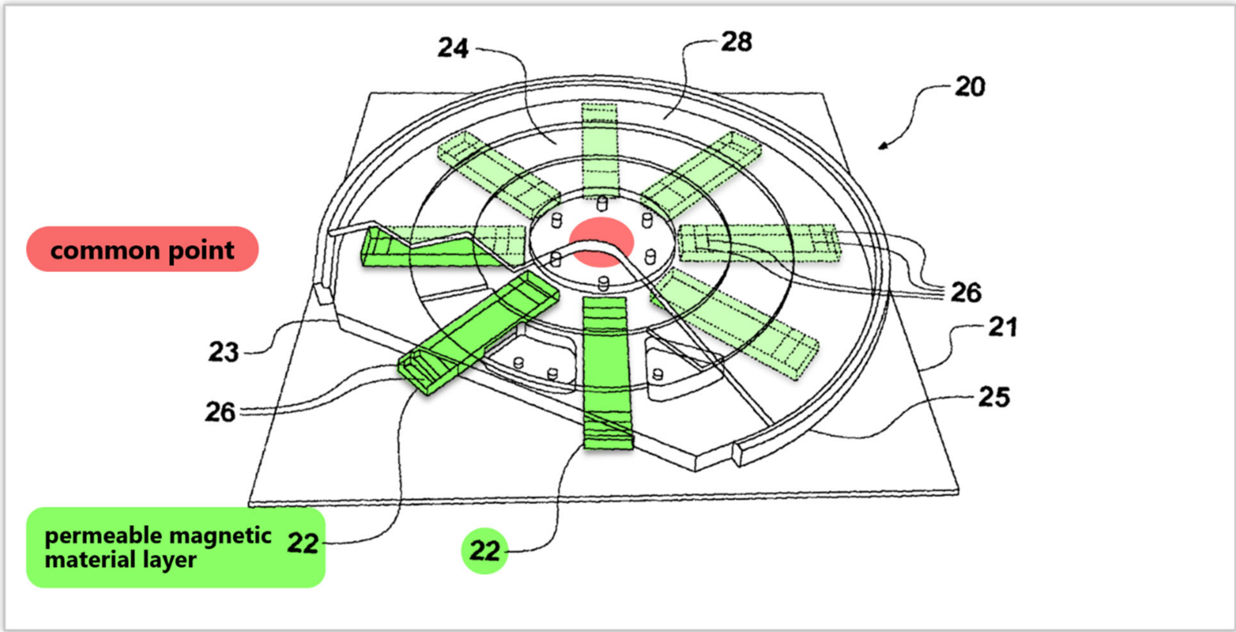
219. Claim 2 depends from claim 1 and recites "having a plurality of permeable magnetic material members in a form of bars each being arranged such that its length extends radially from a common point but spaced apart therefrom."

220. Nakao taught this element. As discussed with respect to Elements 1/13[a] of Ground 3, and as shown below in Figures 7B and 7C, Nakao taught a receiving pad with "intermediate core members 14 arranged radially to form a circle."



Nakao Figs. 7B, 7C (annotated), ¶¶ 68, 19, 21, cl. 7, Figs. 7A-7C. Each core member 14 is also arranged "such that its length extends radially from a common point but spaced apart therefrom" as annotated above. And the intermediate core members 14 are "in a form of bars" because they are generally rectangular and bar-shaped as shown in the Figure, which Nakao refers to as "board-shaped." *See* Nakao ¶ 19.

221. Nakao's arrangement of magnetic material members around a common point is approximately the same as in the '955 patent:

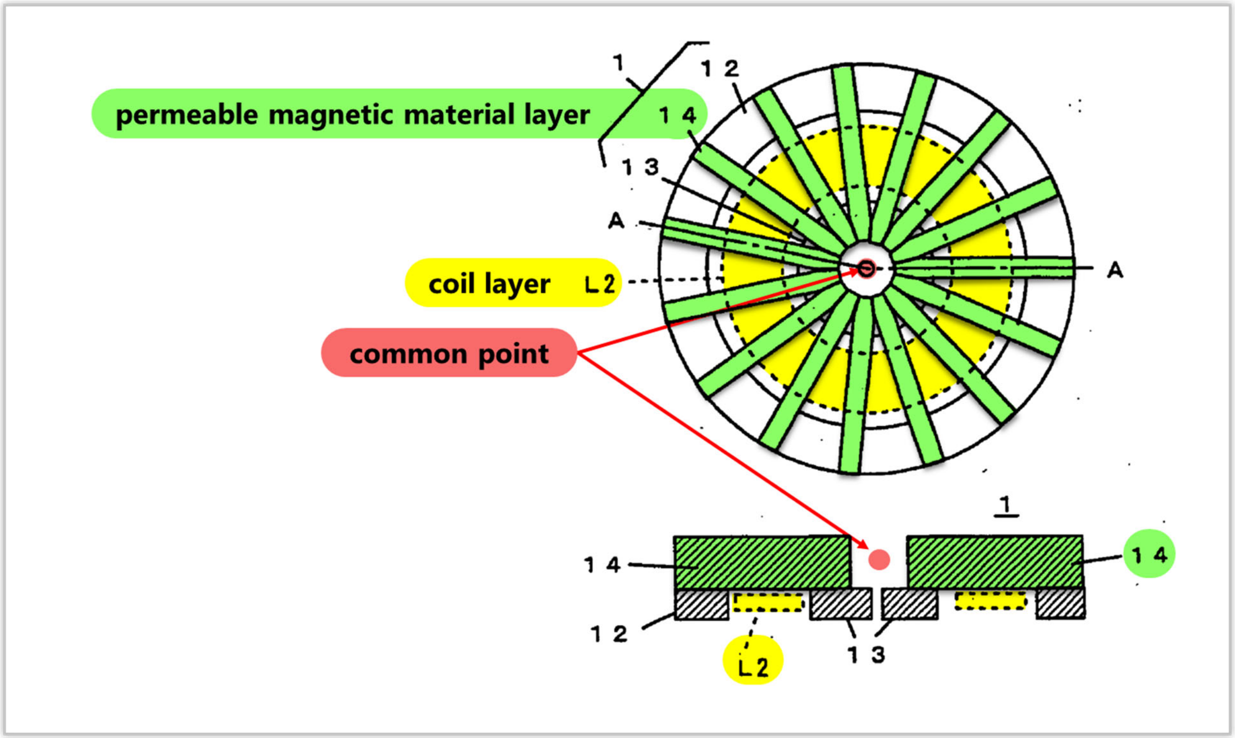


’955 patent Fig. 4 (annotated).

2. Claim 3 – coil passes each permeable magnetic material bar at approximately center of the length of the bar

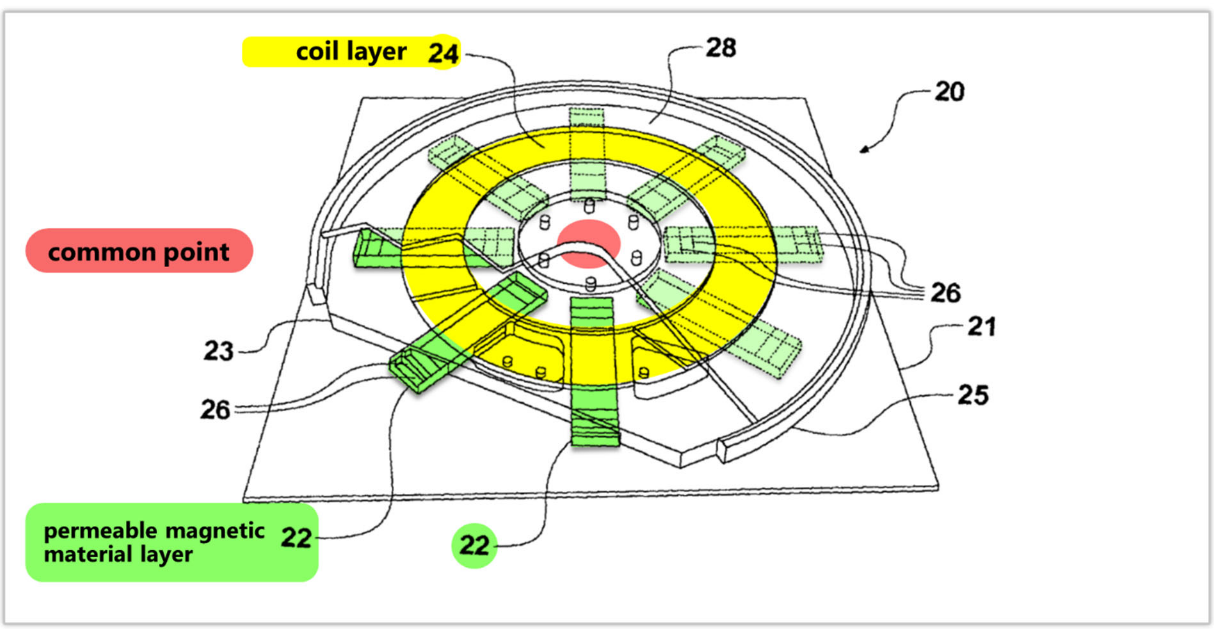
222. Claim 3 depends from claim 2 and recites: “wherein the coil is positioned to wind around the common point such that it passes each bar at approximately a center of the length of each bar.”

223. This element is taught by Nakao. As shown by Figures 7B and 7C below, Nakao’s coil L2 is wound around the common point and passes at approximately the center of each intermediate member 14 (the claimed “bars”).



Nakao Figs. 7B, 7C (annotated); *see also* Nakao ¶¶ 21, 68, cl. 7.

224. As with claim 2 above, this coil arrangement is approximately the same arrangement as in the ’955 patent:

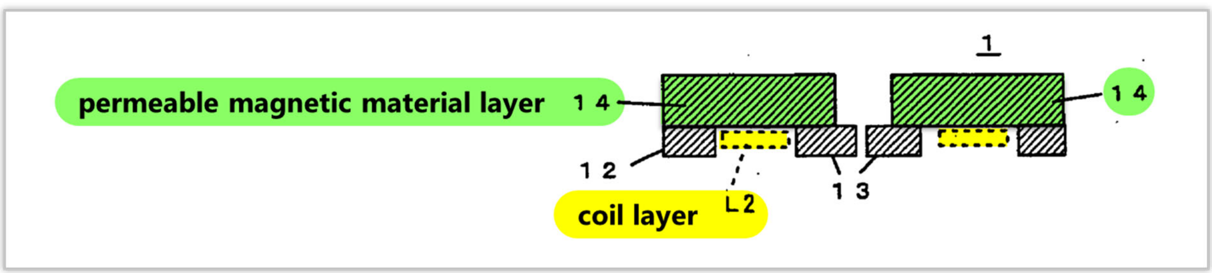


’955 patent Fig. 4 (annotated).

3. Claim 4 – ordered, parallel layers

225. Claim 4 depends from claim 1 (receiver pad) and further recites: “wherein a plane of the backplate is substantially parallel to planes of each of the permeable magnetic material members and the coil, the plane of the or each permeable magnetic material member is located between the plane of the backplate and the plane of the coil.”

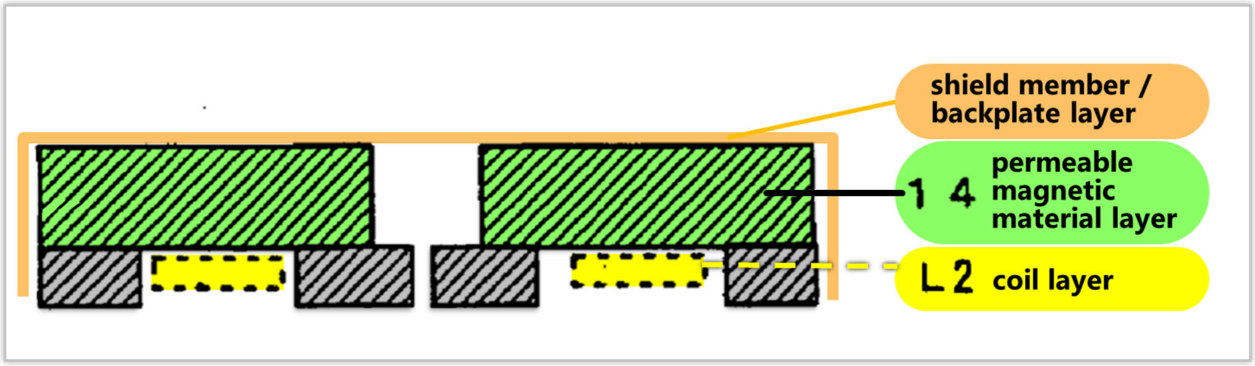
226. This element is taught by the combination of Nakao and Beart. As shown in annotated Figure 7C below, Nakao’s secondary coil L2 and permeable magnetic members 14 are formed as layers in substantially parallel planes, as claimed.



Nakao Fig. 7C (annotated).

227. And as explained with respect to the Motivation to Combine section and Element 1/13[c] of Ground 3, a POSA implementing Nakao’s receiving pad with Beart’s flux shield would have arranged the base of Beart’s flux shield (the claimed “backplate”) such that the base is between the permeable magnetic

material layer and the support surface (e.g., the vehicle for the receiving pad), as illustrated below



Nakao Fig. 7C modified in view of Beart Fig. 7; *see also* Ground 3, Motivation to Combine and Element 1/13[c] above.

228. A POSA would have understood that by arranging the conductive backplate above the permeable magnetic material and coil layers would prevent magnetic flux from passing through Nakao's magnetic core assembly and interacting with the vehicle chassis, where it could heat up other components causing damage, or potentially cause safety concerns with passengers in the vehicle. *See* Beart 2:11-3:4, 4:4-5:7; *see also* Ground 3, Motivation to Combine above.

4. Claims 5 and 6 – backplate made of copper or aluminum

229. Claim 5 depends from claim 1 and recites "wherein the backplate is formed from a material which substantially inhibits the passage of magnetic flux therethrough." Claim 6 depends from claim 5 and recites: "wherein the backplate is formed from one at least one of copper and aluminum."

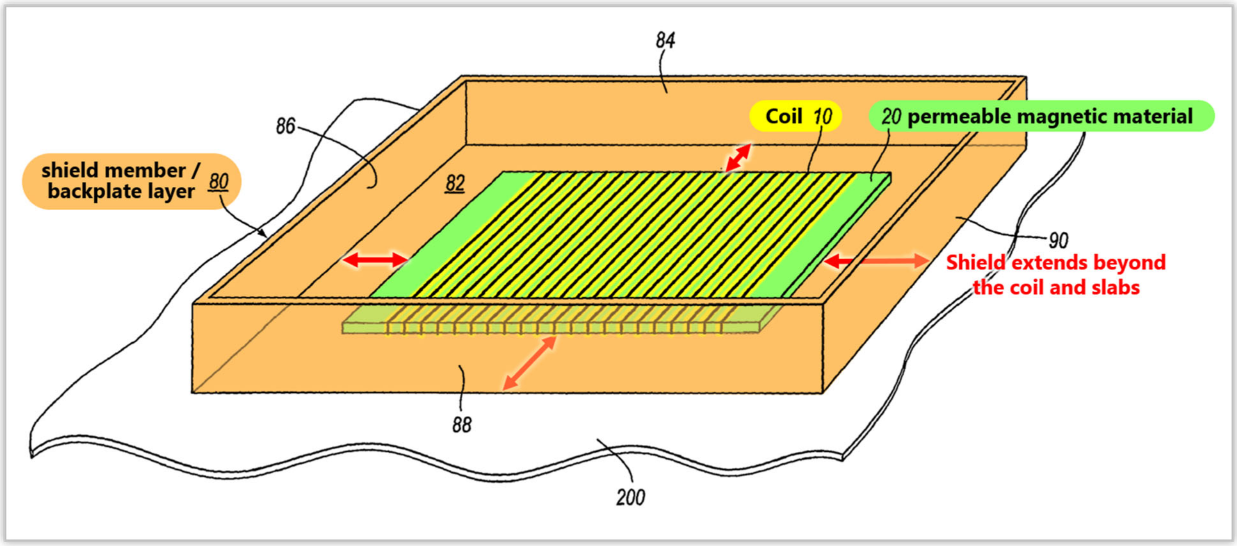
230. As discussed with respect to Claims 5 and 6 in Ground 2 and Element 1/13[c] of Ground 3, these elements are taught by Beart. First, as discussed in Element 1/13[c] of Ground 3, a POSA would have found it obvious to apply Beart's flux shield to Nakao's receiving pad such that it forms the claimed backplate defining a third layer. *See* Ground 3, Element 1/13[c]. Second, as discussed with respect to Claims 5 and 6 in Ground 2, Beart taught that the disclosed flux shields are made of "highly conductive material, for example **copper or aluminium**," and that these conductive materials substantially inhibit the passage of magnetic flux through them because the "lines of flux in any magnetic system are excluded from them." Beart 2:29-3:10, 4:25-30; *see also* Ground 2, Claims 5 and 6 above.

231. The combination of Nakao and Beart, therefore, taught a flux shield made of a conductive material such as copper or aluminum that substantially inhibits the passage of magnetic flux.

5. Claim 7 – backplate extends beyond coil and slabs

232. Claim 7 depends from claim 1 and recites "wherein the backplate extends beyond coil and slabs." As with this claim in Ground 2, I note that the term "slabs" is not used in independent claim 1. However, for purposes of this proceeding I have assumed that this was a drafting error and that "slabs" to refer to the "one or more permeable magnetic material members" in claim 1. Pursuant to this understanding, Beart taught this element.

233. As discussed with respect to Claim 7 in Ground 2, and as shown in Figure 7 below, Beart taught that "[t]he base 82 of the flux 80 shield **extends** between the lower surface of the flux generating unit 50 and the support surface 200," as shown by the annotated red arrows below. Beart 10:8-10; *see also* Ground 2, Claim 7.



Beart Fig. 7 (annotated), 8:24-25.

234. And as discussed with respect to Claim 7 in Ground 2, Beart taught that the purpose of extending the flux shield beyond the ferrite and coil is to "increas[e] the path length and thus the effective reluctance of" an adjacent support structure such as a vehicle chassis, thereby increasing the power transfer efficiency of the system. Beart 2:11-2:27, 4:4-20, 9:14-31, 5:9-18; *see also* Ground 2, Claim 7. A POSA could have and would have similarly found it obvious to extend the flux shield beyond the magnetic core and coil of the receiving pad in Nakao for the same reasons.

6. Claim 8 – permeable magnetic material comprises ferrite

235. Claim 8 depends from claim 1 and recites "wherein the or each permeable magnetic material member comprises ferrite."

236. This element is taught by Nakao. Nakao teaches that its "magnetic cores can be made of **ferrite** magnetic material." Nakao ¶¶ 30, 55, 97, 106.

7. Claims 9-12 – backplate controls/directs flux

237. Claim 9 depends from claim 1 and further recites "wherein the backplate is arranged to control the electromagnetic flux substantially perpendicular to the third layer."

238. Claim 10 depends from claim 1 and further recites "wherein the shield member is arranged to control the electromagnetic flux between the inductive power transfer pad and the transmitting pad."

239. Claim 11 depends from claim 1 and further recites "wherein the backplate is arranged to direct electromagnetic flux generated by the transmitting pad."

240. Claim 12 depends from claim 11 and further recites "wherein the electromagnetic flux is directed substantially perpendicular to the third layer."

241. These elements are taught by Nakao modified in view of Beart. As discussed with respect to Claims 9-12 in Ground 2, Beart's flux shield controls and directs the electromagnetic flux generated by the transmitting pad, and between the

inductive power transfer pad and the transmitting pad, in a direction substantially perpendicular to the backplate. *See* Ground 2, Claims 9-12 above.

XI. Conclusion

242. In view of the reasons set forth above, it is my opinion that claims 1-13 of the '955 patent are anticipated by and/or rendered obvious by the prior art.

243. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further 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.

Date: June 11, 2021

Mark Allen