

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INDUCTEV, INC.,
Petitioner,

v.

WITRICITY CORPORATION,
Patent Owner.

Case IPR2024-00140
Patent 8,466,654

**Second Declaration of Dr. Mark N. Horenstein In Support of
Patent Owner's Preliminary Sur-Reply**

I. INTRODUCTION

I, Dr. Mark N. Horenstein, declare as follows:

1. I am over the age of 18 years and am fully competent to make this declaration. I make the following statements based on personal knowledge and, if called to testify to them, could and would do so.

2. I have been retained on behalf of WiTricity Corporation to provide my opinions regarding U.S. Patent No. 8,466,654 (“the ’654 patent”) and the patentability of the claims challenged by Petitioner InductEV. In this declaration, I provide my opinions regarding Petitioner’s Reply to Patent Owner’s Preliminary Response filed on March 28, 2024. I provide my opinions in consideration of the state of the art at the time of filing of the ’654 patent and the knowledge that a person having ordinary skill in the art (PHOSITA, or “person of skill”) would have had at the time of the claimed inventions. I previously submitted a declaration entitled, “Declaration of Mark N. Horenstein Regarding Certain Claim Terms Found in U.S. Patent No. 8,466,654” filed on February 22, 2024 (Ex. 2001).

3. My opinions and views set forth in this declaration are based on my education, training, and experience in the field of electrical engineering, including inductive energy transfer, battery-powered electric vehicles (“EV”) and related technical areas, as well Petitioner’s Exhibits 1001-1029 and other materials that are cited and discussed herein.

4. On February 22, 2024, as part of the current IPR proceedings, I submitted a declaration entitled, “Declaration of Mark N. Horenstein Regarding

Certain Claim Terms Found in U.S. Patent No. 8,466,654” (“heretofore “Prior Declaration”). My prior declaration is herein incorporated by reference.

I. BACKGROUND & QUALIFICATIONS

5. My background and qualifications, including my curriculum vitae (Ex. 2002), are summarized in my previous declaration (Ex. 2001), which were submitted in connection with this proceeding, and are incorporated by reference herein.

6. The opinions proffered in this declaration are based on the documents I have reviewed, my experience and background in the field, my knowledge of electrical engineering, and my professional judgment.

7. In the course of conducting my analysis and forming my opinions, I have reviewed the references and materials cited herein, including those listed below.

8. I am being compensated for services provided in this matter. I was recruited for this engagement by Cahn Litigation Services who is billing my time at a rate of \$400 per hour. I am also being reimbursed for reasonable expenses, such as travel expenses, should any arise. My compensation is not contingent on my opinions, on the outcome of any aspects of this matter, or on any of the technical positions that I explain in this declaration. I have no financial interest in Petitioner InductEV, the Patent Owner (who I understand to be WiTricity Corporation), or the '654 Patent.

II. EXHIBITS CONSIDERED

Exhibit No.	Description
1001	U.S. Patent No. 8,466,654 to Cook et al (“the ’654 patent”).
1002	Prosecution History of the ’654 patent.
2001	Declaration of Mark N. Horenstein Regarding Certain Claim Terms Found in U.S. Patent No. 8,466,654 (filed February 22, 2024)
2002	Curriculum Vitae of Mark Horenstein.
2003	Excerpts from Wiley Electrical and Electronics Engineering Dictionary, IEEE Press, 2004 – Part 1
2004	2004 McGraw-Hill Dictionary of Scientific and Technical Terms (5th Ed., 1994) (selected pages)
2006	Excerpts from Wiley Electrical and Electronics Engineering Dictionary, IEEE Press, 2004 – Part 2
2007	S. S. Lau, “Practical Design of 13.56MHz Near Field Communication (NFC) and Radio Frequency Identification (RFID) Antenna using Ferrite Sheet on Metallic Surface by Network Analyzer”, <i>Proceedings of the 2015 IEEE IEEM</i> . (“Lau”)
2008	X. Chen, Y. Lieu, W. Lu, and Y. Dong, Optimal Simulation Study for Wireless Charging Coils with Magnetizers, DOI 1109/PEDG Conference, Aug, 2019. (“Chen”)
2009	W. Lee et al, " A Simple Wireless Power Charging Antenna System: Evaluation of Ferrite Sheet", <i>IEEE Transactions on Magnetics</i> , 53(7) July 2017. (“Lee”)

III. BASES FOR OPINIONS EXPRESSED

9. The opinions set forth in this declaration are my own. My opinions are based on my review of the materials cited throughout this Declaration as

itemized in the “Exhibits Considered” list provided above; my educational background; my experience working in the areas of inductive coupling and wireless charging, and my experience as a technical consultant providing expert testimony in numerous cases involving similar and/or related technology.

IV. THE CHALLENGED CLAIMS

10. Petitioner is challenging claims 1-18 of the '654 patent, including independent claims 1, 8, and 13, plus dependent claims 2-7, 9-12, and 14-19. As outlined in my prior declaration of February 22, 2024, it is my opinion that Petitioner and Dr. Allen have failed to show that each and every element of the challenged claims appear in the cited prior art. In particular, Petitioner has failed to show where the cited prior art of Ground 1 discloses the transmitting antenna and receiving antennas recited in the challenged claims.

11. Independent claims 1, 8, and 13 of the '654 patent read as follows (emphasis added):

Claim 1

A transmitter system for wireless power, comprising:

a *transmitting antenna* including an inductive element and a capacitor, said transmitting antenna being resonant at a first frequency, said *transmitting antenna* being configured to generate a wireless field for charging a device including a *receiving antenna*;

a charging control system coupled to said *transmitting antenna* and configured to generate a signal at said first frequency and provide said signal to said *transmitting antenna* and

an alignment controller configured to test coupling of said *transmitting antenna* to the *receiving antenna* in the first alignment position and based on a degree of

the coupling, the alignment controller further configured to adjust an x-y alignment of the *transmitting antenna* relative to the *receiving antenna* from the first alignment position to a second alignment position having a finer alignment between the *receiving antenna* and the *transmitting antenna* than the first alignment position to improve said coupling.

Claim 8

A receiver system for wireless power, comprising:

a *receiving antenna* coupled to a device, the *receiving antenna* including a coil and capacitor that are resonant at a first frequency;

a guidance controller configured to guide the *receiving antenna* of the device to a first alignment position relative to a *transmitting antenna* that is not physically connected to said device coupled to the *receiving antenna*;

a lifting device for said *receiving antenna* configured to lift and lower said *receiving antenna*; and

an alignment controller configured to sense a degree of coupling of said *receiving antenna* and the *transmitting antenna* based on a detection of the coupling that is measured at the *receiving antenna*, the alignment controller being further configured to move said *receiving antenna* from the first alignment position to a second alignment position to better align the *receiving antenna* with the *transmitting antenna*.

Claim 13

A method, comprising:

guiding a *receiving antenna* of a vehicle to a first alignment position relative to a *transmitting antenna*;

responsive to detecting a degree of coupling in the first alignment position between the *receiving antenna* and the *transmitting antenna* that is measured at the *receiving antenna*, moving one of the *receiving antenna* and the *transmitting antenna* from the first alignment position to a second alignment

position to improve alignment of the *receiving antenna* with the *transmitting antenna* and improve the degree of coupling.

12. On Page 1 of their Reply to Patent Owner's Preliminary Response, Petitioner states that, "...Patent Owner does not dispute ...that Odachi discloses the claimed "transmitting antenna" and "receiving antenna" under their plain meanings, i.e. an antenna that transmits energy, and an antenna that receives energy." Petitioner also cites the Allen Declaration at ¶¶58-59 and 103-105. I disagree with this assertion. First, the '654 patent specifies that the claimed antennas are resonant by the addition of a capacitor to the inductance of the magnetic loop. (*See*, for example, '654 patent 1:15-22). There is no mention whatsoever in Odachi (Ex. 1007) regarding enabling resonance by the disclosed transformer structure.

13. Of note, the receiver antenna disclosed in the '654 patent is located "a distal position" from the transmitting antenna (*Id.*), where "distal" means "a distance from". The distal relationship between the transmitting and receiving antennas enables the receiving antenna to couple to the near field component of the transmitting antenna, rather than to the local induction field, as is the case in a transformer. This concept is further explained below.

14. The meanings of "antenna" and "transformer" in electrical engineering would have been abundantly clear to a person of skill at the time the '654 patent was filed. As I explained in my previous declaration, a pair of antennas achieves their coupling without the use of core material that would contain the magnetic field lines produced by the transmitting antenna. *See e.g.*, Ex. 2001, ¶¶22-24. Rather, the fields from the antenna are emitted into the space around the antenna. *Id.* In contrast, a transformer achieves coupling by way of a

solid magnetic core structure, such as ferrite. The core, which comprises a magnetic circuit, confines and guides lines of magnetic flux produced by the primary so that they all can be linked to the secondary. (*See Id.* at ¶27).

15. The distinction between antenna and transformer are made evident by their respective definitions found in the authoritative *Wiley IEEE Electrical and Electronics Engineering Dictionary* (Wiley):

antenna - A device that **radiates and/or receives radio waves**. The same antenna can usually be used for both transmission and reception. There are many types of antennas, their selection depending on the uses and operating frequencies desired. *See Ex. 2006 at 2* (emphasis added).

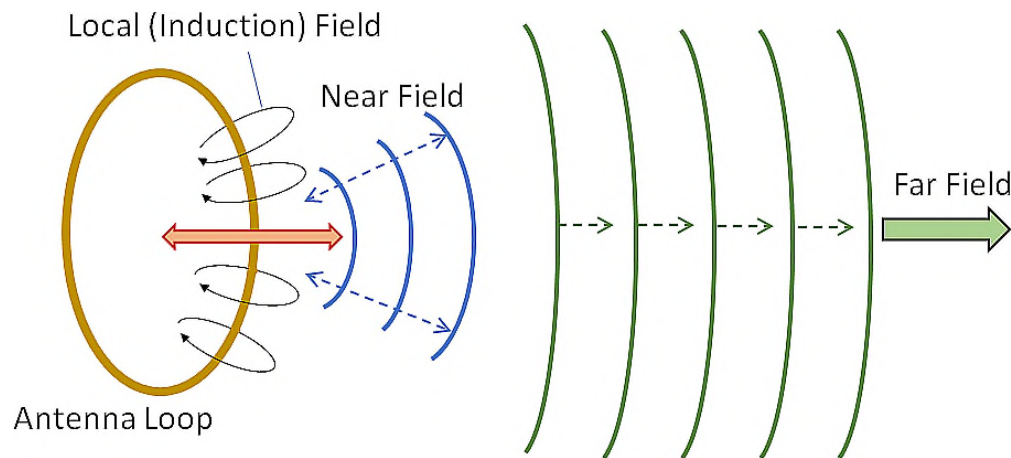
transformer - A component or device which is utilized to transfer electrical energy from one circuit to another via magnetic or **electromagnetic induction**. A transformer has no moving parts and consists of two or more coils of wire separately **wrapped around a magnetic core**. **The coils are inductively linked by magnetic lines of force**, and do not come into physical contact. *See Id.* at 8 (emphasis added).

These definitions show that an antenna operates by field radiation, whereas a transformer operates via field confinement and the linking of coils via a magnetic core.

16. As a person of skill would have known, an energized loop antenna produces magnetic fields found over three regions relative to the antenna; these are the *local* or *induction field*¹, the *near field*, and the *far field*. The far field is also known as the “radiation field”. These three regions are depicted in the figure

¹ Sometimes called the “static” or “quasistatic” field

below.



17. The induction field is produced by the current circulating around the loop antenna, and it is confined to the antenna structure. If the coil surrounds a closed ferrite core, as in the Odachi patent, the local field will be captured and confined within the core; no near or far field will be produced.

18. In an antenna, the near field lines separate from the antenna; however after each half cycle of the *ac* current oscillation, the field collapses back into the antenna. Thus, the near field never propagates, instead remaining in the free-space vicinity of the antenna. The near field is available, however, to couple to a receiving antenna located distal to the transmitting antenna for the purpose of transferring power.

19. The far field of the antenna is also produced by the antenna current but does *not* collapse into the antenna after each half cycle. Rather, the far field carries fields lines away from the antenna, permanently propagating their energy away from the antenna into the world, as occurs with a radio-broadcast or cell phone antenna. The loop-antenna structures of the '654 patent are such that the far-field radiation is not used and carries only negligible energy from the system.

20. The three field regions of the antenna – induction, near field and far field - are defined in detail in the Wiley IEEE Dictionary. Referring to the diagram above, and moving left to right, these definitions read as follows:

induction field

1. The portion of an electromagnetic field that is associated with the AC component, and which is responsible for any **self or mutual inductance**.

2. For a radiator, such as a transmitting antenna, the portion of the electromagnetic field which behaves as if **permanently associated with said radiator**. This contrasts with the radiation field, which is the portion that is propagated outward as electromagnetic waves. *See Id.* at 4 (emphasis added).

near-field region

For a transmitting antenna, the electromagnetic field extending no further than a distance of $2D^2/\lambda$ where D is the maximum overall dimension of said antenna, and λ is the wavelength considered. *Beyond this distance, the far-field region begins. See Id.* at 6 (emphasis added).

far-field region

the region in which the transmitted energy from an antenna behaves as if it were emanating from a point source in the vicinity of said antenna. Such a region usually begins at a distance of $2D^2/\lambda$ from the antenna, where D is the maximum overall dimension of said antenna, and λ is the wavelength considered. *The region of space closer to the antenna than the far field is the near-field region. See Id.* at 3 (emphasis added).

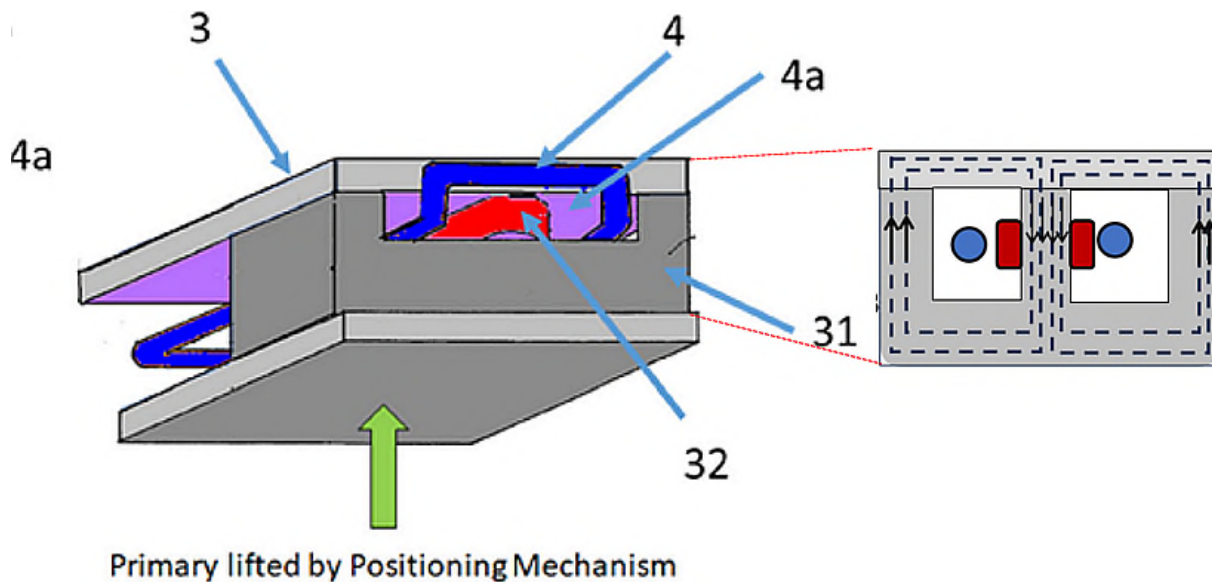
radiation field

For a radiator, such as a transmitting antenna, the portion of the electromagnetic field which is propagated outward as electromagnetic waves. This contrasts with the induction field (2), which behaves as if permanently associated with said radiator. *See Id.* at 7 (emphasis added).

21. The near field and far field, and their relevance to the claimed resonant antennas, are mentioned several times in the '654 specification. *See, e.g.,*

'654 patent at 2:25, 2:32-338, 3:20-22, 4:62. In contrast, the terms “near field” and far field” do not appear at all in Odachi, because they are completely irrelevant to the transformer structure disclosed in Odachi. The near and far fields are relevant only to antenna structures, but are not even considered when discussing transformers, largely because if they are present at all, they are too small to measure.

22. As I explained in my prior declaration, the structure disclosed in Odachi is an E-core transformer that produces only the induction-field component, but no near field or far field. *See e.g.*, Ex. 2001, ¶¶29-33. This induction field is shown below in an adaptation of Odachi Fig. 12. The magnetic field lines circulate around the core; no flux linking or field radiation occurs outside the core.



Adaptation of Odachi Fig. 12

23. Odachi refers to the structure of Fig. 12 as a *magnetic circuit*:

“...the axes of their coils 14 and 4 substantially in line with each other so

that a **magnetic circuit** is formed thereby.” (Odachi, 4:39-41; emphasis added).

“... thus the coupler positioning being completed and a **magnetic circuit** being formed by the primary coupler and the secondary receptacle.” *Id.*, 7:24-26 (emphasis added).

“...so that the former coil may be accommodated within the cavity when the primary inductive coupler 230 is engaged with the secondary inductive receptacle 230 for form a **magnetic circuit**. *Id.*, 8:45-48 (emphasis added).

24. As any PHOSITA knows (and would have known), a transformer is a magnetic circuit, but an antenna is not:

magnetic circuit - A **closed path** described by magnetic lines of force. A magnetic circuit is analogous to an electric circuit in that the magnetomotive force corresponds to the electromotive force, reluctance to resistance, and magnetic flux to electric current. Ex. 2006 at 5 (emphasis added).

Given all of the above, I find the position of Petitioner that Odachi discloses primary and secondary antennas to be without merit.

25. Petitioner also makes note of the leakage flux explained in my prior declaration. Specifically, Petitioner claims, in reference to my prior statement, that “ ‘leakage flux ... may be produced by the primary but not be contained in the core,’ **thus being transmitted into free space**”. (Petition at pg. 4; emphasis by Petitioner). In truth, leakage flux constitutes an imperfection in a transformer. It has nothing to do with field transmission; rather, it is simply primary coil flux that spills out of the primary coil and fails to couple to the secondary coil. There is nothing about leakage flux that invokes transmission “into free space”, and it is

not part of the near-field or far-field radiation. Rather, leakage flux is simply defined as follows:

leakage flux

Magnetic flux which does not pass through a useful or intended part of a magnetic circuit. Also called flux leakage. Ex. 2006 at 4.

Moreover, the flux leakage of a primary coil corresponds to its self-inductance:

Leakage inductance

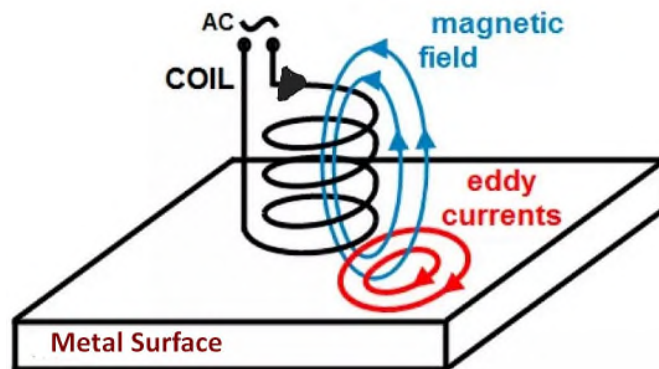
Self-inductance, especially in a transformer, due to leakage flux (*Id.*)

Thus, leakage flux is not “transmitted into free space” as petitioner asserts, because it is not transmitted anywhere at all.

26. In my prior report, I explained the concept of leakage flux for the sake of completeness in explaining how a transformer works. Leakage flux is not mentioned anywhere in Odachi, and thus was evidently not a concern of the inventor. (In fact, many users of inductors and transformers simply ignore leakage flux, because its effect is but a small perturbation.) I also note that the term “leakage flux” does not appear anywhere in the ’654 patent. This omission is expected, because the concept of leakage flux is irrelevant to resonant loop antennas. Only when there is a magnetic core structure meant to contain magnetic flux, as in a transformer, can there be any “leakage” of the flux outside the core. In the resonant loop antennas of the ’654 patent, there is no structure outside of which any magnetic flux can “leak.”

27. Petitioner also takes note of the concept of ferrite cores in the context of the antennas disclosed in the ’654 patent: “...the ’654 patent expressly states that the invention may use ‘magnetic’ antenna[s]’ with a ‘ferrite core[s].’”

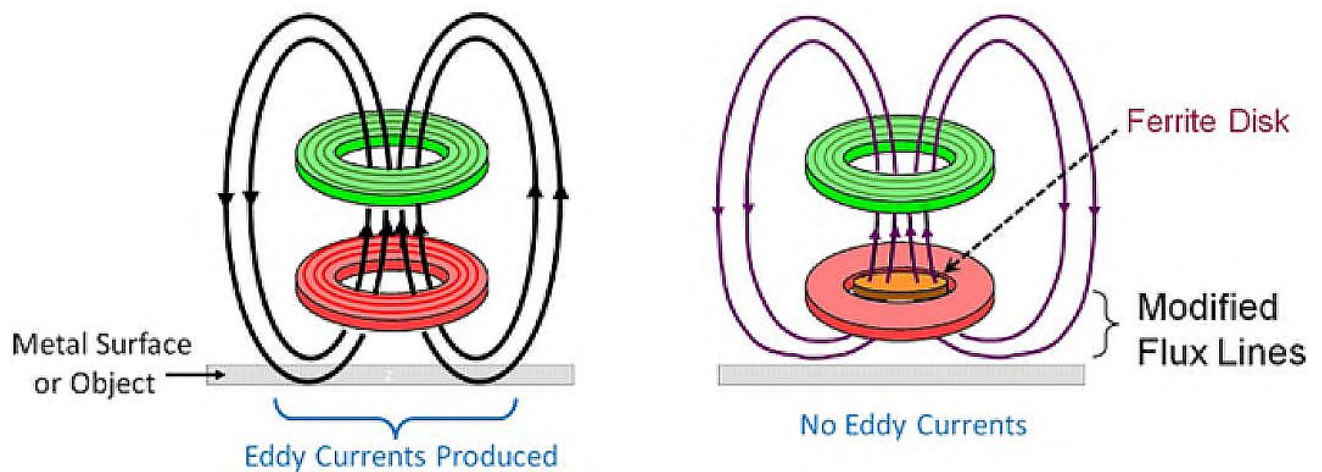
(Petition at pg. 4). The term “ferrite” does, in fact, appear in one small excerpt of the ’654 patent. Petitioner totally misses the point of the ferrite cores disclosed in the ’654 patent. As a PHOSITA would have known, and as practitioners know today, a thin ferrite disk is sometimes placed beneath or inside a transmitting coil when the mounting structure is made from metal or some other conductor. As a PHOSITA would know, a time-varying magnetic field incident on a metal or other conducting surface induces unwanted “eddy currents” within in the metal. These eddy currents flow in a circular pattern around the metal surface, perpendicular to the incident magnetic field. The phenomenon of eddy currents is shown conceptually in the following figure:



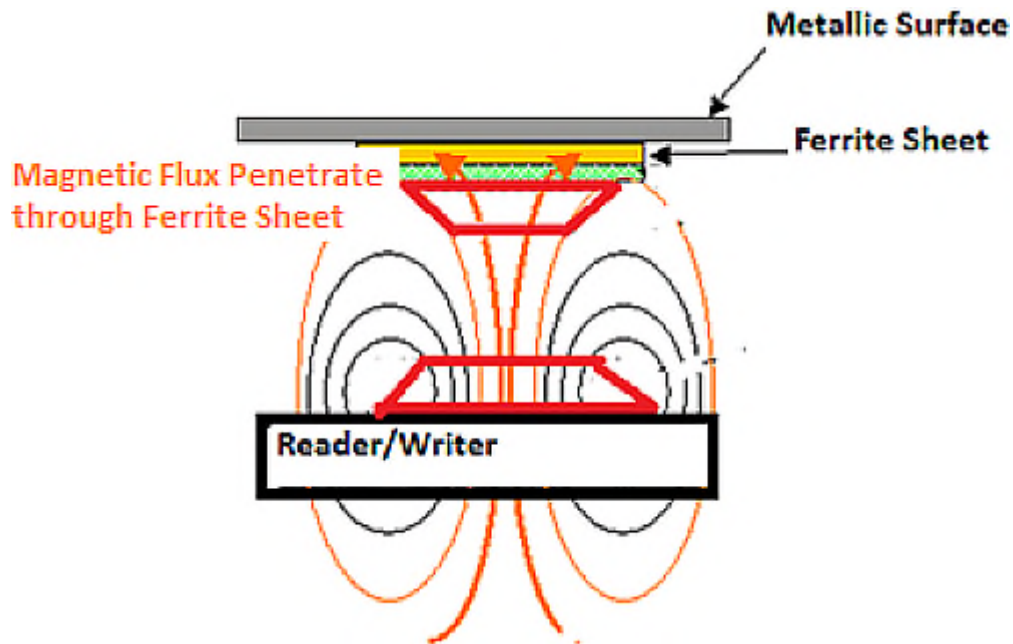
28. Eddy currents flowing in the metal adjacent to the coil dissipate power and thus contribute to overall power loss and a reduction in wireless transmission efficiency. To help alleviate the eddy current effect, thin ferrite disks or tiles are often placed inside or under loop antennas to distort and redirect magnetic field lines so that their penetration into the metal is minimized. This is what the ’654 patent means when it says, “Using a ferrite core may decrease **the effect of extraneous objects.**” (’654 patent, 1:63-64) and “LF [low frequency] Ferrites may be used as magnetic shield (sic) to **prevent fields generating eddy currents in metallic parts** of the antenna surrounding” *Id.*, 3:1-3 (emphasis

added).

29. The figure below illustrates how a ferrite disk placed inside the transmitting antenna in a wireless power-transfer system distorts the lower part of the magnetic flux, reducing field penetration into the underlying metal surface and thus greatly reducing the eddy-current effect. The receiving and transmitting antennas in no way share this ferrite disk, nor does such the eddy-reducing ferrite disk constitute the core of a magnetic transformer.



30. Journal articles in the scientific literature can be found which further explain and analyze the use of underlying ferrite disks or tiles as a means to reduce the eddy current effect. One such article by Lau (Ex. 2007) shows the following figure which illustrates the use of a ferrite tile to reduce magnetic field penetration into the metal surface supporting a loop antenna:



Lau – Figure 3

31. The use of ferrite disks (gray) to reduce eddy currents is similarly shown in Chen (Ex. 2008):

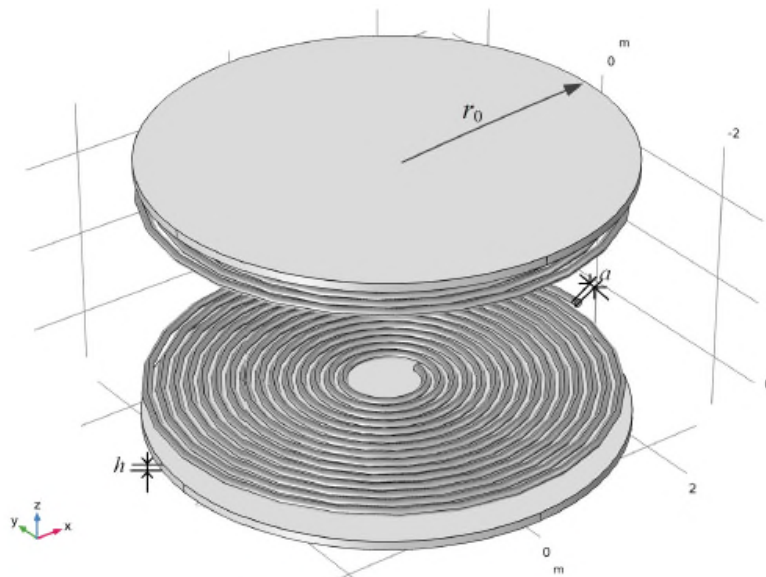
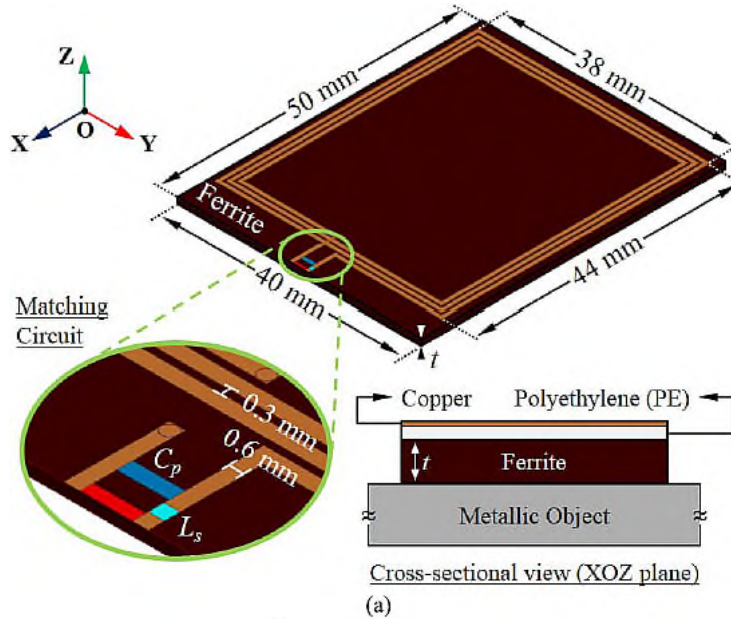


Fig. 3. Planar spiral coil model with disc type magnetizer

Chen – Fig. 3

Similarly, the use of a ferrite placed beneath a coil antenna is shown in Lee (Ex. 2009):



32. Given all of the reasons discussed above, as well as those set forth in my prior declaration (Ex. 2001), it is my opinion that Petitioner has failed to show where the cited prior art of Ground 1 discloses the transmitting antenna and receiving antennas recited in the challenged claims.

Executed on April 11, 2024, in the city of Boston, Massachusetts.

Dr. Mark N. Horenstein