

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ADVANCED MICRO DEVICES, INC.,
Petitioner

v.

REALTEK SEMICONDUCTOR CORPORATION,
Patent Owner

CASE: IPR2023-00789
U.S. PATENT NO. 7,936,245

DECLARATION OF JOSHUA PHINNEY, PH.D.

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I, Dr. Joshua Phinney, do hereby declare and say:

I. INTRODUCTION

1. I am over the age of twenty-one (21) and competent to make this declaration. I am also qualified to give testimony under oath. The facts and opinions listed below are within my personal knowledge.

2. I have been engaged in this matter to provide my independent analysis of certain issues I understand arise in connection with the above-mentioned *Inter Partes* Review of U.S. Patent No. 7,936,245 (which I refer to as “the ’245 Patent”) (Exhibit 1001). I have received no compensation for this declaration beyond my normal hourly rate of \$725 per hour plus reimbursement of reasonable expenses. I will not receive any added compensation based on the outcome of any proceeding related to the ’245 Patent, and I have no other interest in this case or the parties thereto.

3. I have considered the documents cited throughout this declaration, including the ’245 Patent, and have been asked to provide my opinions on how those skilled in the art (as defined herein) would understand those documents. I provide my conclusions regarding the disclosures of these documents below.

4. I have also not formulated any opinions regarding patent validity in light of any prior art other than that cited by Petitioner Advanced Micro Devices, Inc. (“AMD” or “Petitioner”). For the cited prior art, I have examined that art in light of the arguments made by AMD, the opinions expressed by Dr. Paul Prucnal, and the preliminary determination by the Patent Trial and Appeal Board (“Board”) in instituting this *inter partes* review.

5. I am not offering any conclusions as to the ultimate determinations that I understand the Board will make in this proceeding. I am simply providing my opinion on the technical aspects

of the documents.

II. BACKGROUND

6. A summary of my experience, qualifications, and current employment are included in my CV (Exhibit 2004). The following is a brief summary of my relevant qualifications and professional experience.

7. I am a Principal Engineer in the Electrical Engineering and Computer Science practice at Exponent, an engineering and scientific consulting firm headquartered at 149 Commonwealth Drive, Menlo Park, California 94025. I received a Ph.D. in Electrical Engineering from the Massachusetts Institute of Technology (“MIT”) in 2005. I also earned S.M. and B.S. degrees in Electrical Engineering from MIT and the University of Illinois, Chicago (“UIC”), respectively.

8. My master’s thesis at MIT focused on the miniaturization of power converters, by reducing the energy storage and improving the performance of inductors. As part of this work, I designed, tested, and constructed ferrite, iron powder, and air-core inductors, while minimizing magnetic losses. During this time, I invented with my advisor, Dr. David Perreault, an electrical component with a capacitive impedance and an inductance-cancellation feature provided by magnetically coupled windings. This work was later extended to a second patent, with magnetically coupled windings used to improve EMI filters and common-mode chokes.

9. My doctoral work at MIT centered on miniaturization of power converters and magnetics. As part of my doctoral work, I constructed and modeled planar magnetic systems, including magnetically coupled, printed magnetic coils that were part of LC (inductor-capacitor) resonators. By incorporating such compact LC resonators into power converters, the resulting converter enjoyed multiple benefits, including waveform-shaping and reduction of switch stresses.

Through the modeling associated with this dissertation, I become proficient in methods for analyzing the inductances of packages and interconnects, especially planar or filamentous systems of conductors.

10. For my publications related to both my Master's and Ph.D. thesis, I received the William M. Portnoy Prize Paper Award (2003) and the IEEE Power Electronics Society Transactions Prize Paper Award (2004).

11. After earning my Ph.D., I joined Exponent and have led technical investigations to portable electronic devices, microcomputers, as well as industrial and consumer devices with embedded controllers. My job functions include analyzing hardware and software of these devices to understand their modes of failure, and testifying regarding these devices in legal matters involving patents and trade secrets.

12. As part of my employment at Exponent, I have performed design, design reviews, and failure analysis for wireless charging and communication systems. The focus of this work has been (1) coupling between transmitter and receiver coils from the standpoint of efficiency and magnetic-field exposure to users, in particular for the Power Matters Alliance; (2) coupling of interrogators and transponder coils in printed magnetic cards; and (3) integrated-circuit and coil failures due to wear, dimensional changes, and triboelectric charging. In addition to testifying regarding resonant and inductive wireless-power transfer, I have consulted for industry regarding coil design, RFID and near-field communication (NFC) integrated circuits, modulation methods, and on-metal RFID tags.

13. I have testified regarding the software-defined features, internal circuitry, and physical embodiments of electronic equipment. Regarding electronics, I have testified regarding power electronics in communication systems, wind turbines, grid-scale photovoltaic plants, and

consumer electronics. In addition, I have testified regarding control and compensation in industrial controllers, voltage regulators, and switched-mode power converters. My experience with wireless RF circuitry includes failure analysis of amplifiers, power supplies, matching networks, and multiplexers in satellites, semiconductor processing equipment, and medical devices. In addition, I have performed board- and die-scale root-cause failure analysis for low-power mobile designs centered around SoCs (system-on-a-chip) and PMICs (power-management integrated circuits).

14. Regarding the mechanical elements of electronic equipment, I have testified regarding buttons and touch interfaces, connectors, linear and rotary actuators, position-measuring devices, and the design and construction of modular housings for computerized equipment and peripherals. In particular, I have testified regarding detachable components as they are constructed in relation to the housing and underlying electronic assemblies, including printed circuit boards, flex printed circuits, and other connector assemblies within the housing of electronic equipment.

15. In addition to the forgoing, I perform electromagnetic assessment of utility and communication infrastructure. These issues include permitting, interference, and environmental impact of radar, AC and HVDC transmission lines, substations, photovoltaic installations, generators, broadcast antennas, and electrified mass transit systems.

III. RELEVANT LEGAL STANDARDS

16. I am not a lawyer, and have relied upon counsel to explain the relevant legal tests. I express no opinion regarding whether counsel's explanation was correct. For purposes of forming my opinions, I have assumed that such explanation was correct.

A. Obviousness

17. I understand that for a patent claim to be found obvious, it must be shown that the claim would have been obvious to a person of ordinary skill in the art ("POSITA") at the time of

the invention.

18. I understand that obviousness may be shown by considering one or more pieces of prior art and/or the knowledge of a POSITA.

19. I understand that the following factors should be evaluated to determine whether the claimed subject matter is obvious: (1) the scope and content of the prior art; (2) the difference or differences, if any, between each claim of the patent and the prior art; (3) the level of ordinary skill in the art at the time the patent was filed; and (4) the objective evidence of non-obviousness, sometimes called “secondary considerations.”

20. I understand that to establish the inherent existence of a claim limitation in the prior art in an obviousness analysis—the limitation at issue necessarily must be present, or the natural result of the combination of elements explicitly disclosed by the prior art.

21. I understand that obviousness requires a reason to modify or combine the teaching of the prior art references to achieve the claimed invention, and that the POSITA must have had a reasonable expectation of success in doing so. Thus, it is my understanding that simply showing that each of several claimed elements was independently known in the prior art is not enough.

22. Additionally, I understand that prior art disclosures must be considered as a whole and the teachings are to be viewed as they would have been by one of ordinary skill in the art. I understand that when the prior art teaches away from a modification or combining certain known elements, discovery of a successful means of combining them is more likely to be non-obvious. I have been informed that if a modification to the prior art would render it inoperable for its intended purpose or the modification would be inconsistent with the prior art’s stated goal, the modification is likely to be non-obvious.

23. I further understand that in determining whether a claimed invention would have

been obvious to a POSITA, it is necessary to avoid distortion caused by hindsight bias, which is likely to be present where the asserted motivation to modify or combine does not provide a sufficient reason, supported by rational underpinnings, for modifying a reference or combining the references in the claimed manner. I understand that the determination of obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention. Rather, I understand that there must be a teaching or suggestion within the prior art, or within the general knowledge of a POSITA in the field of the invention, to look to particular sources of information, to select particular elements, and to combine them in the way they were combined by the inventor.

24. I have been informed that relevant considerations for combining references include at least the following:

- (A) Combining prior art elements according to known methods to yield predictable results;
- (B) Simple substitution of one known element for another to obtain predictable results;
- (C) Use of known techniques to improve similar devices, methods, or products in the same way;
- (D) Applying a known technique to a known device, method, or product ready for improvement to yield predictable results;
- (E) “Obvious to try” – choosing from a finite number of identified, predictable solutions with a reasonable expectation of success;
- (F) Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; and
- (G) Some teaching, suggestion, or motivation in the prior art that would have led one of

ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

25. I was asked to assess combinability without using “hindsight” reasoning. Instead, I was asked to consider the feasibility and combinability of the asserted prior art references through the eyes of a POSITA as of the time of the invention, May 19, 2009.

26. I understand that “secondary considerations” are also to be considered when assessing obviousness, including commercial success; long-felt but unresolved need; failure of others to solve the problem; unexpected results; copying of the invention by others; and industry praise. I also understand there must be a nexus between the secondary considerations and the claimed subject matter.

27. I have kept these considerations in mind when offering the opinions below regarding combinability.

B. Claim Construction

28. I have been informed that the challenged claims are generally given their “plain and ordinary” meaning, which is the meaning they would have to a POSITA at the time of the invention, in light of the claims, specification, and prosecution history.

29. I understand that many sources can be used to ascertain the meaning of claims, including “intrinsic” evidence—claims, specification, prosecution history; and “extrinsic” evidence—expert testimony, dictionary definitions, and other evidence external to the patent itself.

30. I understand that claims have a preamble, which is the initial language of the claims and often ends with a term of inclusion, such as “comprising.” The preamble is often on the substantive elements of the claim are recited.

31. I understand, from counsel, that preambles of claims are generally not limiting, but

can be in certain circumstances such as when it supplies antecedent basis for other claims, is necessary to give meaning and vitality to the claims, or it was relied upon to distinguish prior art during the application process for the patent.

32. I understand that in an order dated July 25, 2023, in an ITC investigation involving these same parties and this same patent, Administrative Law Judge Cameron Elliot construed “[a] structure of a spiral inductor” in claim 1 of the ’245 Patent as limiting. Ex. 2001, 17.

33. I understand that the Board seemingly agrees “that the term ‘spiral inductor’ recited in the preamble is limiting.” Decision (Paper No. 9) at 11.

34. It is my opinion that the preamble should be limiting because it provides antecedent basis for the claims, and recites an important structural limitation, “a spiral inductor,” that is critical to the invention.

IV. LEVEL OF SKILL IN THE ART

35. In my opinion, a POSITA of this technology at the time of the invention would have had at least a bachelor’s degree in electrical engineering or an equivalent field and at least 3–4 years of professional experience in the field of integrated circuit design. Someone with additional education but less professional experience may qualify as a POSITA, such as someone with a master’s degree in electrical engineering and 1–2 years of professional experience in the field of integrated circuit design or someone with a Ph.D. in electrical engineering. This is consistent with the definition of a POSITA that AMD’s expert, Dr. Prucnal, has offered.

36. I satisfied the definition of a POSITA long before the filing date of the application leading to the ’245 Patent. I now consider myself an expert in the relevant field of technology for the ’245 Patent.

37. In forming my opinions for this declaration, I have used the perspective of one of

ordinary skill in the art as defined above. My opinions, however, would not be affected if a POSITA is defined as someone who has slightly more or slightly less experience than described above.

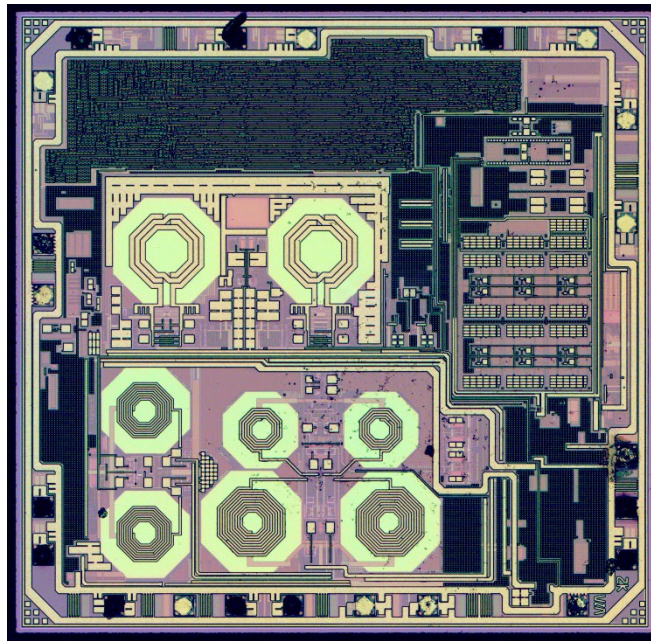
V. OVERVIEW OF THE TECHNOLOGY

38. An inductor is a passive, two-terminal electrical component that stores energy in the form of a magnetic field. Ex. 1008, 4. An inductor typically consists of an insulated wire or metal trace wound into a coil. Inductors serve to oppose changes in current flow. When an electric current is applied from a power source, an inductor stores energy in its magnetic field. When the current flow changes, the magnetic field induces a voltage that opposes the current change. Inductance (also denoted by the letter “ L ”, and measured in Henries) quantifies how strongly an inductor opposes changes in current. Inductance is defined as the ratio between flux linkage and current $L = \frac{\lambda}{i}$, where flux linkage λ increases when the inductor’s magnetic field passes through (or “links”) additional turns in the inductor’s winding. An inductor with more turns, for example, will have a higher flux linkage for the same current, and can better impede the flow of current since it has higher inductance.

39. Integrated inductors are important components in radio frequency integrated circuits (RFICs). RF inductors handle radio frequency signals (20 kHz – 300 GHz), which are much higher in frequency than typical alternating current (50 or 60 Hz, for either Global or U.S. respectively) used by electric utilities. Along with capacitors and resistors, RF inductors are essential components of resonant (and tunable) circuitry in radio communication devices. Inductors are also critical for isolating DC power supplies from RF signals.

40. As devices such as smart phones have become more advanced, space on chips has become increasingly more valuable. Inductors are necessary, but can be quite large and take up a

lot of valuable real estate on a chip as illustrated in the exemplary die photograph below, where the inductors are shown as octagonal spiral windings. It has long been recognized in the field that inductors are difficult to implement on-chip, owing to fundamental tradeoffs between inductor physical size, value of inductance realized, and substrate losses that reduce “quality factor”, or “Q”. *See* Nikenejad Ex-1009, p. 6.



Ex. 2006.

41. Q is an important figure of merit for an inductor. Ex. 1009, 16; Ex. 1011, 2. For an inductor, only the energy stored in the magnetic field is of interest, and Q is defined as the ratio of maximum energy stored in the inductor to the energy dissipated per cycle:

$$Q = 2\pi \times \frac{\text{energy stored}}{\text{energy dissipated per cycle}}$$

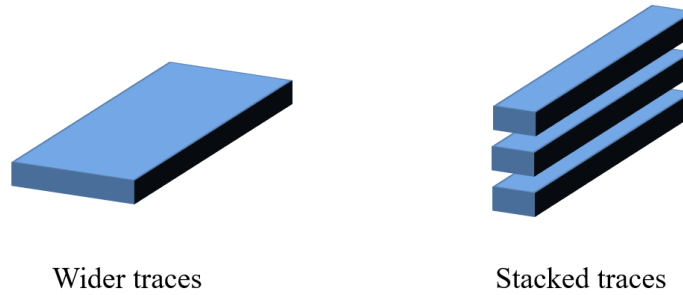
See Ex. 1009, 16; *see also* Ex. 1010, 50.

42. Q describes how well an inductor performs as an energy-storage element. Ex. 1009, 16. Ideally, an inductor should work as a pure energy-storage element (Q approaches infinity),

while in reality parasitic resistance (dissipation) and capacitance of the inductor reduces Q . Ex. 1009, 16–17; Ex. 1011, 5. This is because the parasitic resistance dissipates stored energy and parasitic capacitance reduces inductance. Ex. 1009, 16–18. From a design perspective, Q is directly related to the series resistance (R_s) of the equivalent circuit of an inductor. Metal losses contribute to R_s , and it is always desirable to reduce the resistance in order to improve Q . *See* Ex. 1009, 16; Ex. 1017, 41:21–22.

43. One way to improve Q of an inductor is to decrease the resistance of the metal traces that form the winding. In an off-chip setting, it may be possible to use wiring made of less-resistive metal for an immediate resistance reduction. Material re-selection is generally not possible on-chip, however, as the metals used in the layer stack of a given chip manufacturing process are pre-determined by the foundry and cannot be changed by the individual designer. Further, the vertical thicknesses of the metals are also pre-determined by the foundry, so the designer only has control of the width and length of the wires he or she uses. Thus, the designer is left with two options to reduce the resistance of a wire: make the wire wider, make the wire shorter, or both.

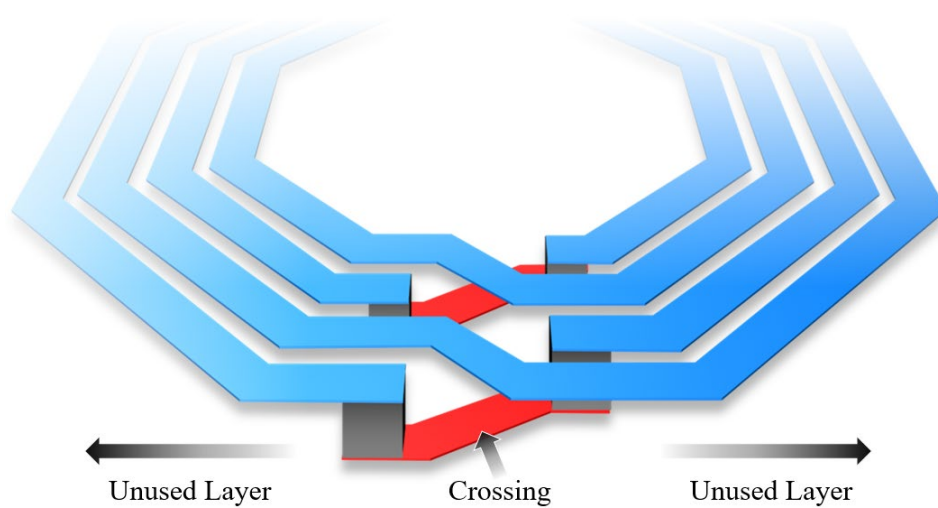
44. Widening a wire or trace is akin to adding lanes of traffic to a road, which increases the number of vehicles that can travel on the roadway simultaneously at a given speed: the additional width of wire introduces more room for charge carriers to flow, thus reducing resistance. In addition, while the actual thickness of each individual metal layer cannot be changed, traces in multiple layers can be stacked and connected together vertically through vias in order to create an effectively thicker, and thus less resistive, trace. In keeping with the roadway traffic analogy, this would be like building a multi-layer bridge, thus allowing for more lanes of traffic.



45. Reducing the length of wire used can be difficult, because achieving a target value of inductance will requires some minimum length of wire in order to capture sufficient magnetic flux, but the result is that inductors should, as a general principle, be wound in such a way that each turn of the inductor circumscribes as much area as possible. Shapes with poor area-to-perimeter ratios should, in general, be avoided. *See* Nikenejad Ex. 1010, p. 66.

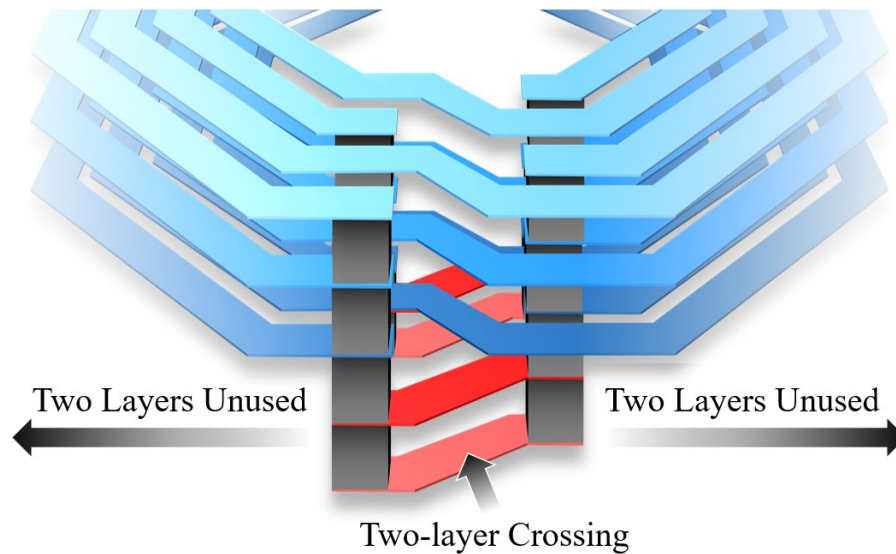
46. As the background of the '245 Patent acknowledges, stacking metal traces as a way to improve Q was known in the prior art. Ex. 1001, 1:31–36. However, a recognized drawback of this Q-enhancement method was that this stacking could not be implemented in places where the inductor needed to cross over itself. *Id.* 1:36–41. In effect, prior art inductors could not achieve their full potential because of the way that they handled the crossings. *Id.*

47. Inductors in the prior art handled crossings using structures such as a single-layer underpass or bridge, which would utilize a separate metal layer to cross under the layer used for the winding, as shown in the image below in red. *Id.*, 1:22–28; see also Ex. 1013, 1:55–58, Fig. 2.

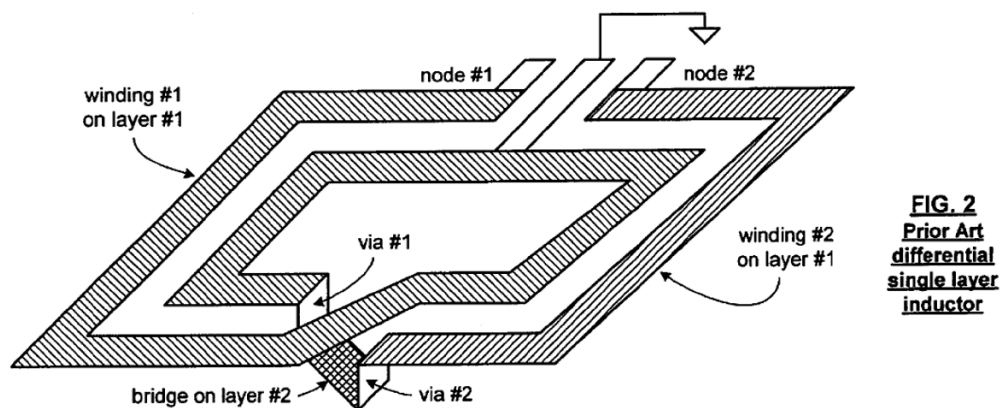


48. One problem with the underpass or bridge taught in the prior art is that the inductor does not fully utilize the available layers, particularly the separate metal layer utilized solely for the underpass, i.e. the lower (red) layer in the illustration above. Utilizing an underpass on a separate metal layer results in unused space that could have been filled with another metal layer for each of the blue traces shown in the above figure. As previously explained, space on chips is very valuable, and because the layers of metal are being created anyway, it is extremely wasteful to have layers that do not contribute to optimize performance of the inductor. An analogy would be: you are building a parking garage anyway, but because of the design, you are unable to park any cars on an entire level because it is solely used to connect levels of the parking garage.

49. Stacked inductors of the prior art also included multiple layered crossings. *See* Ex. 1018, ¶ [0006]. Shown below is an example of a stacked spiral inductor of the prior art with two-layer crossings on separate layers than the windings. This design utilizes two separate metal layers as underpasses, both of which are underutilized, i.e., two levels of the parking garage are unavailable for parking cars.

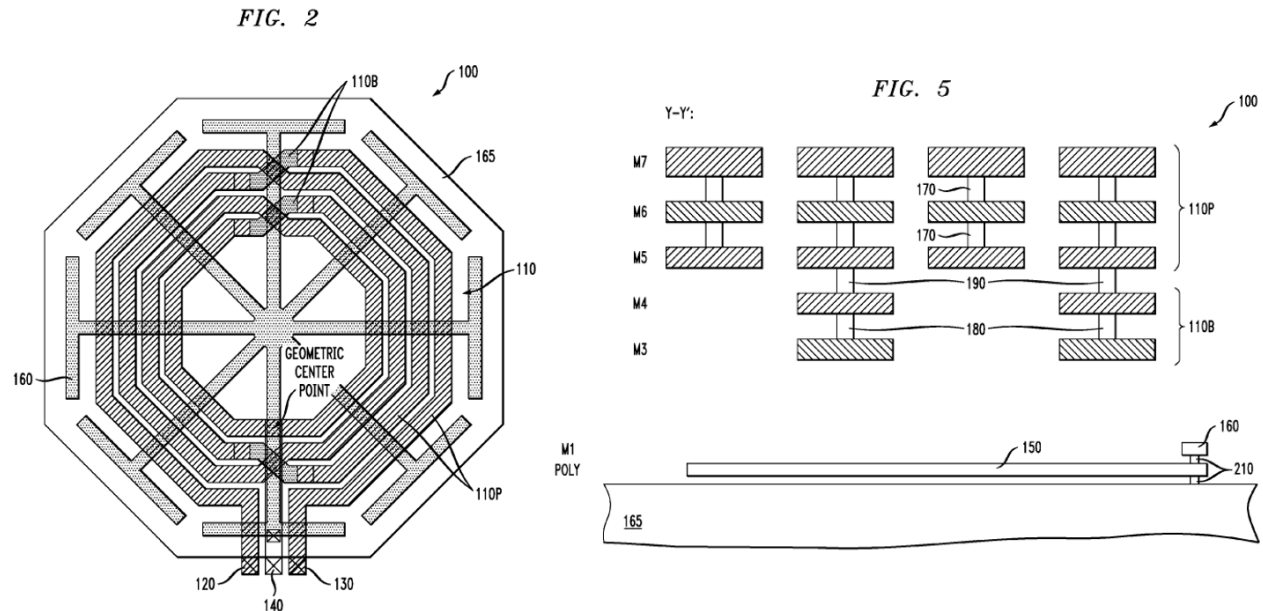


50. The structures of the inductors described in the Petition's Background of the Technology section are single or multi-layer inductors utilizing bridges or underpasses on separate metal layers than the windings for crossovers, similar to the stacked inductors and crossover designs described in the background section of the '245 Patent as problematic (and as illustrated above). For example, U.S. Patent No. 6,759,937 to Kyriazidou, filed in 2002, discloses a single-layer inductor (shown below) that uses a bridge or underpass on a separate layer from the main winding in order to accomplish a crossover. *See* Petition, 15–16; Ex. 1013, 1:55–58; Fig. 2.



51. Additionally, U.S. Patent Pub. No. 2008/0074229 A1 to Moinian et al., filed in 2006 and cited as prior art in the '245 Patent, discloses a stacked inductor 100 (shown below) with

primary winding portions 110P, located on three metal layers (M5–M7) and bridge portions 110B, located below on two separate metal layers (M3–M4). Ex. 1018, ¶¶ [0021]–[0022]; Figs. 2, 5.



See also *Petition*, 20 (citing Ex. 1009, Figs. 2–10, 2–11), 15 (citing Ex. 1011; *see id.*, 3 (“An underpass contact at a lower metal level and a via connection are used to bring the inner end of the coil to the outside.”)), 17–18 (citing Ex. 1017, Fig. 28d; *see also id.*, 39:5–6 (“A pass through track 2854 is disposed in a layer to provide access to the end of an inner turn.”)).

52. The background inductor art references cited by Petitioner or Dr. Prucnal do not utilize the metal layers of the windings for the crossings nor do they utilize the metal layers of the crossings to construct shunting windings.

VI. OVERVIEW OF THE '245 PATENT

53. The '245 Patent changed the legacy tradeoff between area and performance by using crossing layers to create parallel paths for current. These parallel paths—called “shunt windings” in the Challenged Claims of the '245 Patent—improve Q because they decrease the resistance of the inductor winding. The inductor structure of the Challenged Claims of the '245

Patent allowed for (1) smaller inductors that have the same performance (measured as Q) as larger inductors; or (2) the same size inductors with enhanced performance (increased Q).

54. Regarding prior art inductors, the '245 Patent explains that whether an inductor has a single metal layer structure or a structure with multiple metal layers in parallel, Q cannot be optimized because the metal layers of crossover regions are different from the metal layers of the windings. Ex. 1001, 1:36–41. In contrast, the inductor structure of the Challenged Claims of the '245 Patent optimizes Q by using the metal layers of the crossover region to construct shunt windings. Ex. 1001, 1:7–10; 6:1–5.

55. More specifically, the '245 Patent changed the tradeoff between area and performance by making use of the metal layers of the crossover region as shunt windings, rather than utilizing a separate layer to form an underpass or bridge. Ex. 1001, 9:22–24. Thus, the structure of the stacked inductor claimed in the '245 Patent allowed for smaller inductors, which could achieve better performance and higher Q.

56. I understand Petition challenges the validity of claim 1 of the '245 Patent, which recites:

A structure of a spiral inductor, comprising:
a first metal layer, comprising:
 a first segment;
 a second segment; and
 a third segment, connected to the first segment, wherein a layout direction of the third segment is different from a layout direction of the first segment and a layout direction of the second segment;
a second metal layer, being positioned under the first metal layer, the second metal layer comprising:
 a fourth segment;
 a fifth segment; and
 a sixth segment, connected to the fifth segment, wherein a layout direction of the sixth segment is different from a layout direction of the fourth segment and a layout direction of the fifth segment;
a first set of vias, for connecting the first segment with the fourth segment; and
a second set of vias, for connecting the second segment with the fifth segment;

wherein the first segment, the fourth segment and the first set of vias construct a first shunt winding; the second segment, the fifth segment and the second set of vias construct a second shunt winding; and the third segment and the sixth segment construct a crossover region.

57. I also understand Petitioner challenges the validity of the following dependent claims of the '245 Patent:

2. The structure of the spiral inductor of claim 1, wherein the third segment is positioned between the first segment and the second segment; and the sixth segment is positioned between the fourth segment and the fifth segment.
3. The structure of the spiral inductor of claim 1, wherein a first thickness of the first metal layer is greater than a second thickness of the second metal layer.
4. The structure of the spiral inductor of claim 3, wherein the spiral inductor further comprises a third metal layer being positioned under the second metal layer, a structure of the third metal layer is the same as a structure of the second metal layer, and the first thickness of the first metal layer is greater than a third thickness of the third metal layer.
5. The structure of the spiral inductor of claim 1, wherein a first thickness of the first metal layer is equal to a second thickness of the second metal layer.
8. The structure of the spiral inductor of claim 1, wherein the spiral inductor is a symmetric spiral inductor.
9. The structure of the spiral inductor of claim 1, wherein a shape of the first shunt winding and the second shunt winding is Substantially a rectangle, an octagon, or a circle.

VII. FUNDAMENTAL DIFFERENCES BETWEEN INDUCTORS AND TRANSFORMERS

58. An inductor is an impedance device with two terminals that is part of a single circuit. An inductor impedes changes in current, since a change in current will produce a voltage response that opposes the change in current. In an IC context, inductor designers generally seek to efficiently utilize scarce available area to maximize Q within a given footprint. *See* Niknejad, EX-1010, p. 66.

59. Transformers, on the other hand, are electrical devices used to transfer energy between two or more circuits. A basic transformer consists of two magnetically coupled windings

that share magnetic flux. AC in one winding (called the “primary”) creates a changing magnetic field that induces a current in the other winding (the “secondary”). A core made of iron or ferrite can connect the two coils, but higher frequency devices in IC’s work without a magnetic core. Transformers have two main roles: transformation and isolation. As an example of transformation, the voltage of the secondary can be higher or lower than the voltage that drives the primary and is determined by the ratio of turns in the primary and secondary coils. Isolation means that there is no direct-current between the primary and secondary windings, which are said to be “galvanically isolated” when they do not touch. Isolation allows a shift in DC voltage level between the primary and secondary circuits.

60. Key design goals for transformers include symmetry and coupling. Symmetry is especially important when a transformer is intended to operate in a balanced manner, where voltage and/or current on one terminal is equal and opposite with respect to another terminal. In such applications, symmetric layout preserves the match between electrical characteristics viewed from different terminals.

61. The magnetic coupling between two coils of a transformer—quantified by the coupling coefficient k —also is an important parameter to evaluate the performance of the transformer. *See* Nikenejad, Ex. 1010, p.100. Greater overlap area and tighter packing of the primary and secondary coils of a transformer result in a larger coupling coefficient. A simple formula for coupling coefficient k is given as follows:

$$k = \frac{M}{\sqrt{L_p L_s}}$$

where, M is the mutual inductance between the primary and secondary coils, and L_p and L_s are the self-inductances of the primary and secondary windings.

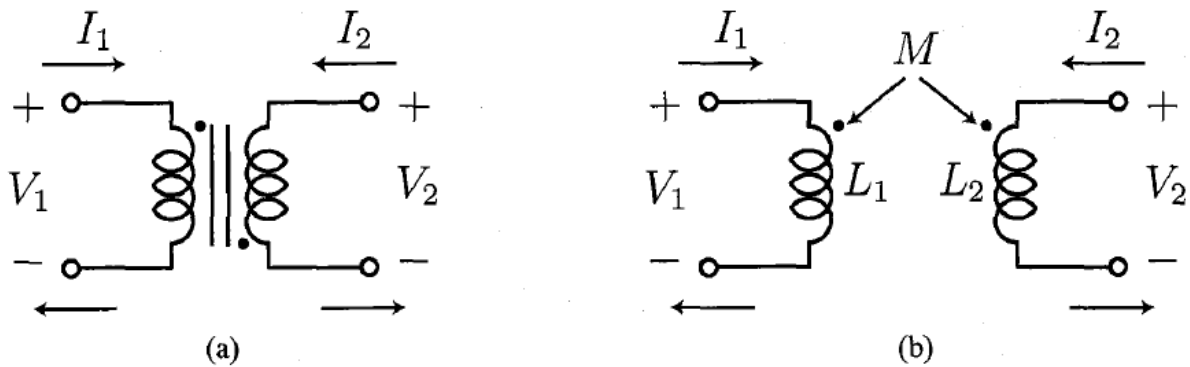


Figure 10.1 (a) Schematic symbol for an ideal transformer. (b) Two coupled inductors form a non-ideal transformer.

Ex. 1010, 98.

62. Based on figures like the conceptual schematics shown above, Dr. Prucnal opines that a transformer is merely two inductors coupled together. Ex. 1003, ¶¶ 55–57. I disagree. When transformer windings are intermingled to improve coupling, each winding includes structural modifications particular to its use as transformer windings. These structural modifications to the windings of a transformer run counter to the goals of inductor design because the modifications do not optimize Q. Stated another way, a POSITA seeking to design an inductor would not commandeer from a transformer one of its windings because the isolated winding of a transformer does not exploit available metal layers to maximize Q. Furthermore, a POSITA would already know how to design a better performing inductor than one could ascertain from the isolated winding of a transformer that is structurally modified for coupling. Dr. Prucnal's opinion to the contrary is akin to saying you can arrive at the optimal design for a motorcycle by cutting a car down the middle and utilizing the design of its two halves.

63. The only inductor reference on which Dr. Prucnal opines as a ground for invalidity (Yang) does not disclose any crossings, let alone the crossover region of the Challenged Claims of the '245 Patent. Moreover, the background inductor references cited in the Petition and by Dr.

Prucnal, only teach underpass crossings as described in the background section of the '245 Patent, where one or more metal layers are dedicated solely to crossings but are not used to create parallel paths for current. This further supports my opinion that the crossings of the intermingled windings of the planar transformers, taught and disclosed in *Ho-Hsiang* and *Christensen*, on which the Petition relies, are transformer-specific (a result of intermingling symmetric windings) and a POSITA would not find it obvious to adapt these transformer structures to the inductor arts.

64. Further support for my opinion is found in Exhibit 1010 to the Petition, *Electromagnetics for High-Speed Analog and Digital Communication Circuits*, (2008), by A. Niknejad. Exhibit 1010 to the Petition includes two chapters (Chapters 5 and 6) dedicated to the discussion of inductance and the practical implementation of inductors, and yet another separate chapter (Chapter 10) dedicated entirely to the theory and design of transformers. Consistent with the chapter-by-chapter organization of Ex. 1010, transformers are subject to design considerations distinct from and irrelevant to inductors. Here, I call attention to the structural modifications that must be made to individual windings in order to allow them to couple and function together as a transformer. Many of these structural modifications are disclosed within Chapter 10 of Exhibit 1010. Critically, these structural modifications result in reductions in the performance of each of the individual windings of the transformer. Chapter 10 of Exhibit 1010 is silent on this point, and for good reason: this chapter intends to teach transformer design and does not contemplate that any reader would consider these teachings as a basis for design of a standalone inductor. This would amount to utilizing the teachings of Chapter 10 in order to arrive at the teachings of Chapters 5 and 6; only a POSITA that *already knew* the teachings of Chapters 5 and 6 would not reasonably expect to glean any teachings about inductors from Chapter 10. Exhibit 1010 does *not* teach that the path to designing a good inductor is to first design a good transformer and then isolate its

windings to design an inductor.

65. Further, the structural modifications necessary to the windings of a transformer are not disclosed by the conceptual diagram of Figure 10.1 (*see figure, above*); indeed this figure is used by the author early in the chapter to introduce the circuit models for transformers. Ex. 1010, 98. The details of implementation are not addressed until “Section 10.5: Transformer design and layout”, wherein multiple candidate layouts for integrated transformers are shown. *Id.*, 103. In each of these layouts, both of the coils feature structural modifications in service of the primary goal of allowing these coils to intertwine, such that the coupling coefficient k between the coils is maximized. Of note, underpass structures have to be introduced to allow the primary and secondary coils to cross over each other, and increased spacing must be introduced between the turns of each coil such that the other coil can thread through the evacuated routing lane. These are exactly the structural modifications of the windings necessary to construct the planar transformers taught and disclosed by *Christensen* and *Ho-Hsiang*. These modifications to the windings result in compromised flux linkage in of each *individual* winding, thus reducing the inductance each winding realizes relative to the costs of its parasitic resistance and capacitance, which in turn results in inferior Q of each winding. In sum, the Q of the individual coupled windings has been sacrificed in order to achieve acceptable coupling (k) for the transformer structure, which in this respect places the goals of inductor and transformer design in opposition.

66. Further, a POSITA would understand individual inductors must be substantially modified, in a manner deleterious to their function as inductors, in order to be used as one of the coils in a transformer. Indeed, Mohan states that “interleaved transformer...is best suited for four-port applications that demand symmetry...the interleaving of the two inductances permits moderately high coupling ($k = 0.7$) to be achieved at the cost of reduced self-inductance. This

coupling may be increased at the cost of higher series resistance by reducing the turn width (w) and spacing (s).” Ex. 2007, p. 1. As described here, the modifications required to allow interleaving substantially *degrade* the performance of each individual winding, and as such a POSITA would not be inclined to consider the teachings of a transformer design when seeking to improve the design of an inductor.

VIII. OVERVIEW OF THE ASSERTED PRIOR ART REFERENCES

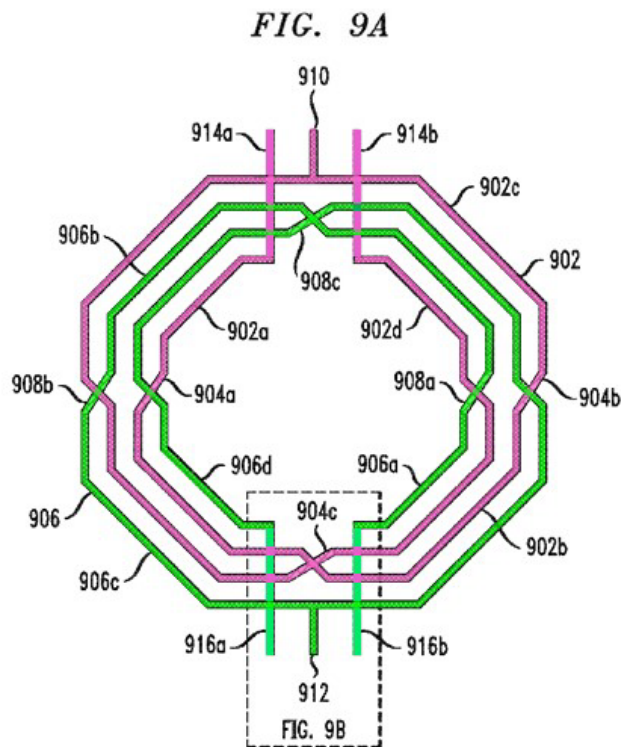
A. *Ground 1: Ho-Hsiang*

67. *Ho-Hsiang* is directed to planar “transformers and balanced-to-unbalanced (BALUN) devices. More specifically, the disclosed system and method relate to on-chip symmetrical transformers and BALUN devices.” Ex. 1005, 1:6–9. A balun is a transformer configured to convert between a balanced signal and an unbalanced signal. Ex. 1010, 6. Baluns share performance parameters with RF transformers.

68. *Ho-Hsiang* explains that conventional, coplanar symmetric transformers of the prior art include two windings (a primary and a secondary) that are intermingled but reside on the same metal layer. Ex. 1005, 1:24–28. The crossings of these windings are accomplished by bridges or underpasses on a separate metal layer than the layer of the windings. *Id.*, 1:28–31. *Ho-Hsiang* explains that while these “conventional coplanar interleaved transformers reduce[d] the size and resistance, they suffer[ed] from low quality (Q) factors and small coupling coefficients.” *Id.*, 1:38–41.

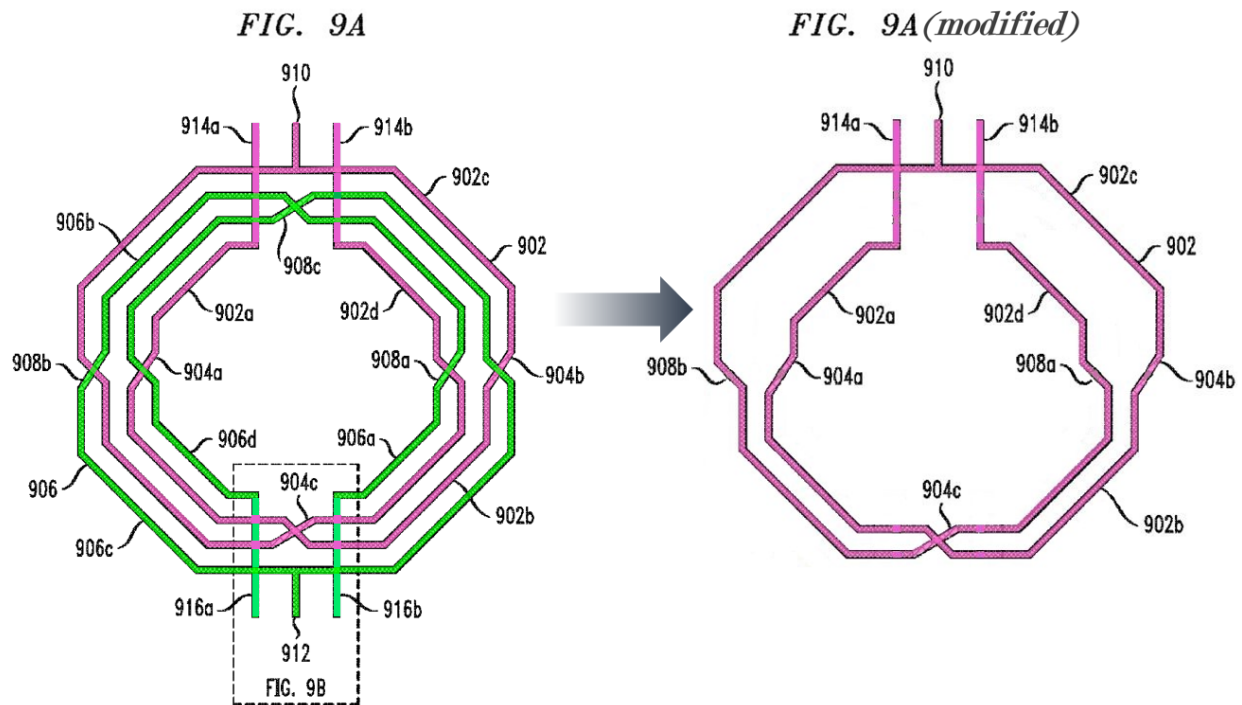
69. As discussed above, there are fundamental differences between inductors and transformers. Transformers such as the planar transformer disclosed in *Ho-Hsiang* include two coils or windings that are closely intermingled, as shown below. *Ho-Hsiang* teaches nothing about the structure or function of inductors or how to design an inductor to lower its resistance and

optimize its Q while not increasing its size.



Id., Fig. 9A (annotated; individual windings identified in green and pink).

70. There is nothing in *Ho-Hsiang* to suggest that a POSITA would be motivated to modify the transformer of *Ho-Hsiang* (illustrated below on the left) by separating the windings of the planar transformer, and then only utilizing a single, isolated winding as a spiral inductor (illustrated below on the right).



Id., Fig. 9A (annotated and modified).

71. *Ho-Hsiang* is directed to “[a]n improved system and method of on-chip symmetrical transformers/BALUNS devices.” Ex. 1005, 3:12–13. A POSITA would look to the structures disclosed in *Ho-Hsiang* in order to improve the functioning of a planar transformer, not an inductor.

72. For example, *Ho-Hsiang* teaches improvements to the function and flexibility of planar transformers such as:

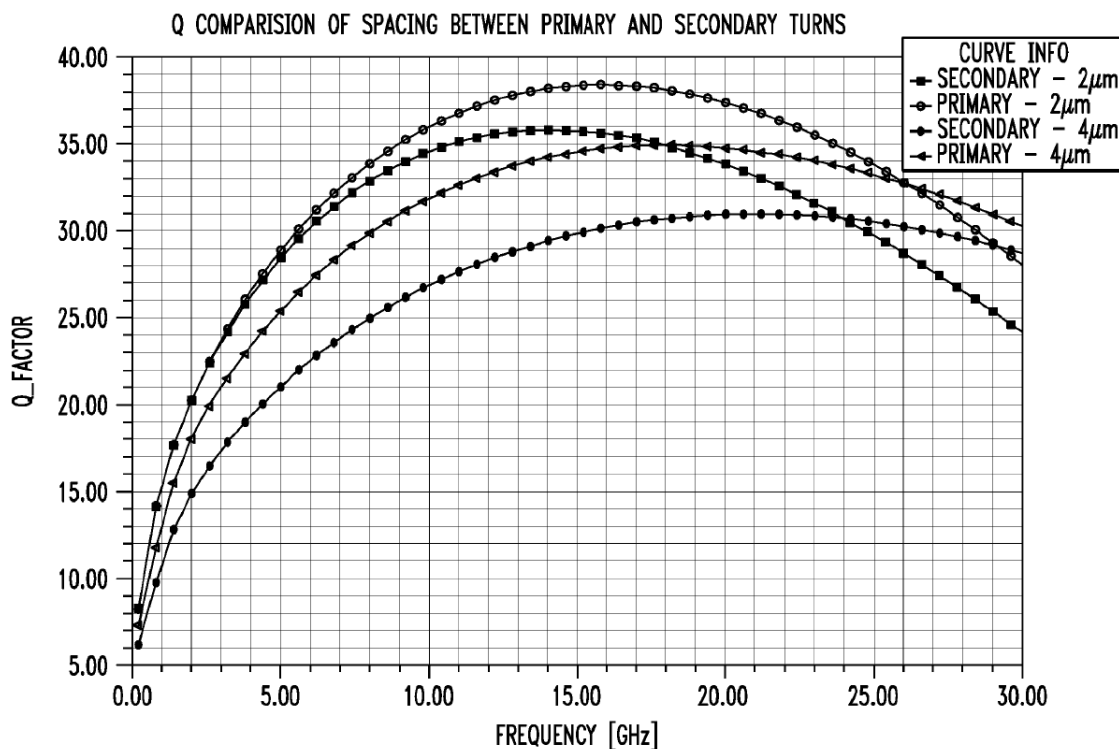
In some embodiments, the transformers and BALUNS have ***improved reliability*** as the current density at the center of the devices which in turn reduces the likelihood of electromigration. In some embodiments, the transformers and BALUNS enable the ports of the primary and secondary windings to be located at various angles from one another providing ***improved flexibility*** with respect to where the transformers or BALUNS may be located on a chip in relation to other circuits. Additionally, the transformers and BALUNS may include windings with non-integer numbers of turns ***enabling the voltage to be stepped up or down at various increments*** using fewer windings and chip space.

Id., 6:56–67 (emphasis added).

73. Importantly, *Ho-Hsiang* teaches away from the claimed '245 Patent invention because it presents a means to improve the Q_s of both the primary and secondary windings by increasing the thickness of the metal layers on which both windings are formed:

The Q-factor of a transformer or BALUN improves as the thickness of the metal layer on which the windings are formed is increased. FIG. 10 is a graph showing both the Q-factor versus frequency and the inductance versus frequency for primary and secondary windings made using metal layers having different thickness in a transformer having a 2:2 turn ratio. The thin metal layer plot was created with metal layers having a thickness of 1 micron, and the thick metal layer plot was created with metal layers having thickness of microns [*sic*]. As shown in FIG. 10, the Q-factor is higher for the thick metal layers than for thin metal layers for all frequencies.

FIG. 10



Id., 3:36–46, Fig. 10.

74. A POSITA would have recognized that the thickness of metal traces in an integrated circuit manufacturing process is mandated by the foundry and cannot be ‘tuned’ on a device-by-device basis by the individual designer. However, *Ho-Hsiang* teaches the designer to perform

exactly this tuning, as the above excerpt and figure make clear, by laying out the benefits that come from thickening the metals used to make *Ho-Hsiang*'s transformer. A POSITA would not have recognized a reasonable expectation of success in implementing this teaching, as a POSITA would have known that simply thickening the metals in a standard IC process is not an option available to the individual designer. Moreover, a POSITA would not have recognized the disclosures of two windings of a planar transformer in *Ho-Hsiang* as reasonably addressing the stated problem and objective of the '245 Patent—reducing the footprint and R_s of an inductor while improving Q.

75. I understand that the Federal Circuit has clarified that a proposed modification is not obvious when the modification renders the prior art reference inoperable for its intended purpose. An isolated winding of the *Ho-Hsiang* transformer would not function as a transformer, let alone “[a]n improved . . . on-chip symmetrical transformers/BALUNS device[.]” Ex. 1005, 3:12–13.

76. By contrast, *Ho-Hsiang* identifies a specific problem in the prior art:

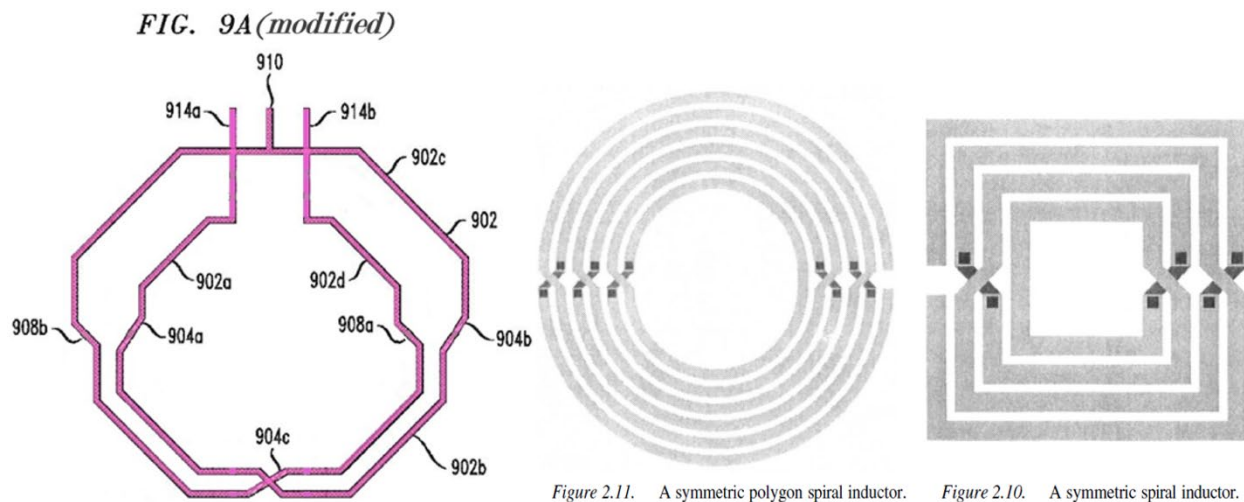
the center taps 160 and 162 are connected at the inner-most portion of the BALUN 150 and extend to the outer-most portion. ***This center tap location is an undesirable location as it may result in high current density on the center taps 160, 162, which may have a detrimental affect on the reliability of the circuit due to electromigration.*** For example, the reliability of a transceiver circuit as illustrated in FIG. 12 would be detrimentally affected if a BALUN 150, as illustrated in FIG. 1B, were implemented as the BALUN in FIG. 12 as the location of the center tap 160, *e.g.*, CTP in FIG. 12, would have a high current density. Additionally, if the BALUN illustrated in FIG. 12 included a center tap on the secondary winding (CTS) as shown in FIG. 1B, *e.g.*, center tap 162 in FIG. 1B, the reliability of the transceiver circuit would be reduced.

Ex. 1005, 1:59–2:6 (emphasis added).

77. *Ho-Hsiang* discloses a planar transformer structure that “advantageously enables current to flow from the inside of the device to the outside of the device thereby reducing the current density at the center of the device and reducing the likelihood of electromigration.” *Id.*,

4:8–14. Therefore, isolating a winding of the planar transformer structure of *Ho-Hsiang* in the manner proposed in the Petition would render the device useless for its intended purpose.

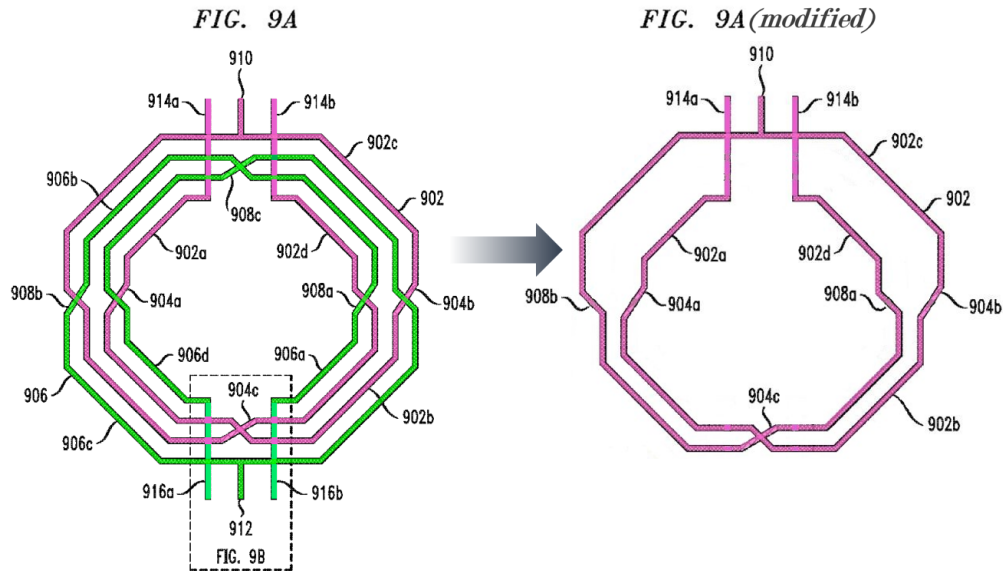
78. The isolated winding of *Ho-Hsiang*, as shown below, reveals a structure with a somewhat unusual, meandering geometry as compared to the geometry of inductors disclosed in the prior art, which were typically more compact and uniform as shown below from Exhibit 1009.



Compare Ex. 1005 (Fig. 9A, modified and annotated) with Ex. 1009, 26–27 (Figs. 2.10–2.11).

79. The isolated winding from *Ho-Hsiang* (shown above) has non-uniform spacing between the turns of the windings and is implemented over a larger footprint than necessary, especially when compared to a typical circular, polygonal, or even square prior art inductors (also shown above). *See also* Ex. 1003, 38 (citing Ex. 1016, Fig. 3.1). A POSITA, at the time of the '245 invention, would understand that these structural irregularities are the result of the intermingling required by the two windings to increase coupling necessary to construct a balanced planar transformer with rotational or mirror symmetry. In addition to the increased surface area of the isolated winding, the large unoccupied area between the turns will result in a loss of flux linkage from the outer winding. Not only does the irregular geometry not fully utilize the surface

area, but it also negatively impacts potential inductance.

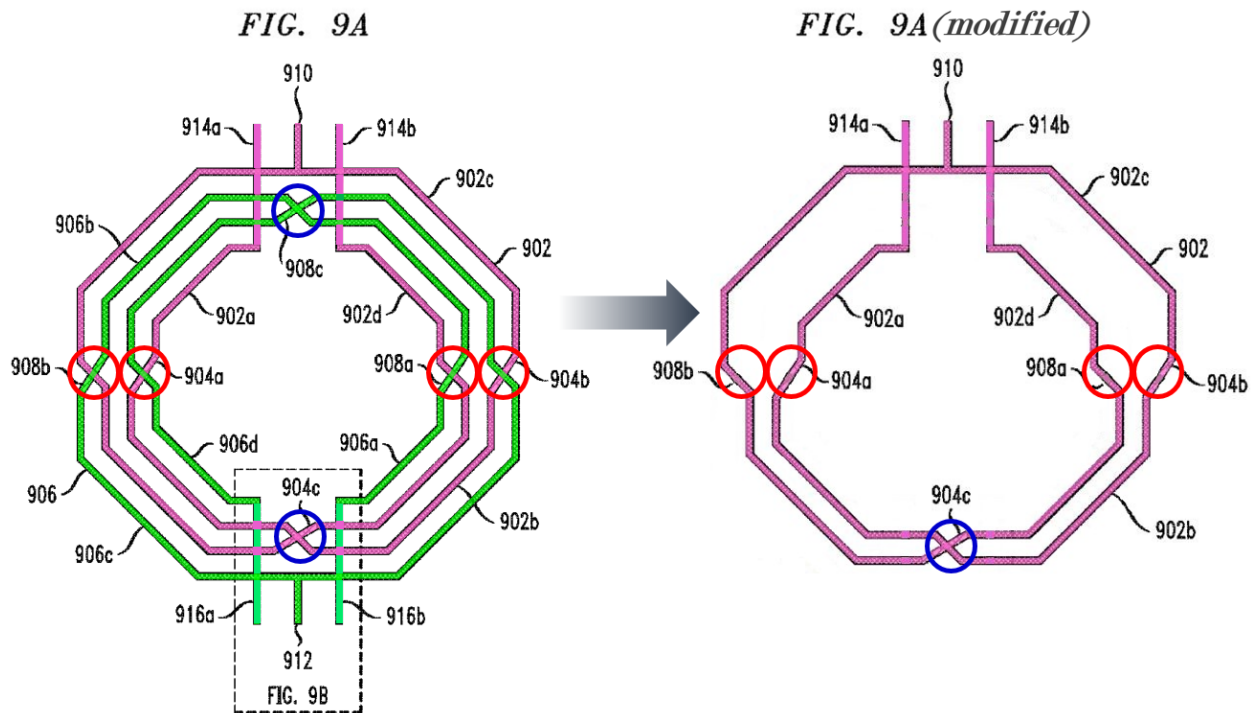


Id., Fig. 9A (annotated and modified).

80. A POSITA would expect that a modified or isolated winding from a planar transformer structure, such as those disclosed in *Ho-Hsiang*, will possess an irregular geometry that negatively impacts the footprint and inductance, and therefore, would not achieve the goals of the '245 Patent to reduce surface area, lower resistance, and optimize Q.

81. The Petition and Dr. Prucnal also fail to address the fact that even if a POSITA did modify the *Ho-Hsiang* transformer, separate the windings, and then only utilize a single isolated winding as a stacked “inductor,” it would not result in the '245 Patent inductor structure that is able to achieve low R_s and high Q because the isolated windings possess unnecessary gaps.

82. Specifically, the proposed modification of the *Ho-Hsiang* planar transformer structure (shown below) results in a single isolated winding with four locations designed to accommodate the crossovers between the transformer's two windings, 908b, 904a, 908a, 904b (red circles), as well as one self-crossing 904c (blue circle).



Id., Fig. 9A (annotated and modified).

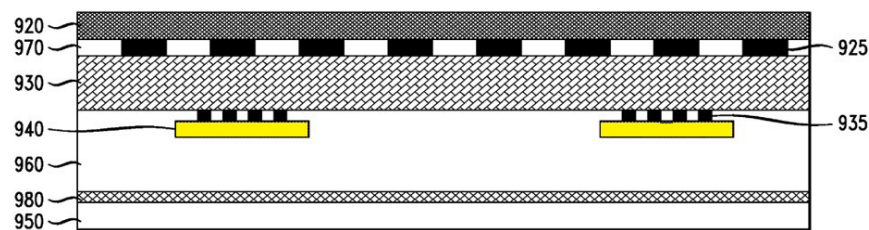
83. Importantly, *Ho-Hsiang* explains that the individual windings (e.g., 902 shown in pink above) are located on both the first metal layer 920 and the second metal layer 930, but ***at the bridges or crossings 904a, 904b, 904c, 908a, 908b, and 908c*** (red or blue circles above), ***comprise only one metal layer***, the second metal layer 930. Ex. 1005, 6:13–29. Therefore, as modified by Petitioner, the isolated winding of *Ho-Hsiang* would have gaps in the second metal layer 930, at certain locations, namely 904a, 904b, 908a, and 908b. These gaps in the second metal layer 930 prohibit the modified transformer from being shunted at those locations. By incorporating unnecessary gaps in each isolated winding that prevent it from being shunted along its length, *Ho-Hsiang* teaches away from the stated goal of the '245 Patent—optimizing Q. Faced with the goal of designing an improved inductor with low R_s and high Q, a POSITA would not begin with *Ho-Hsiang*, or arrive at the isolated winding design modified by Petitioner, both of which incorporate these unnecessary gaps that would degrade the performance of the winding as a standalone

inductor and decrease its Q.

84. Isolating the windings of the planar transformer of *Ho-Hsiang* would result in a poorly functioning inductor that goes against the stated objective of the claimed invention, an optimized inductor structure that is able to achieve low R_s and high Q.

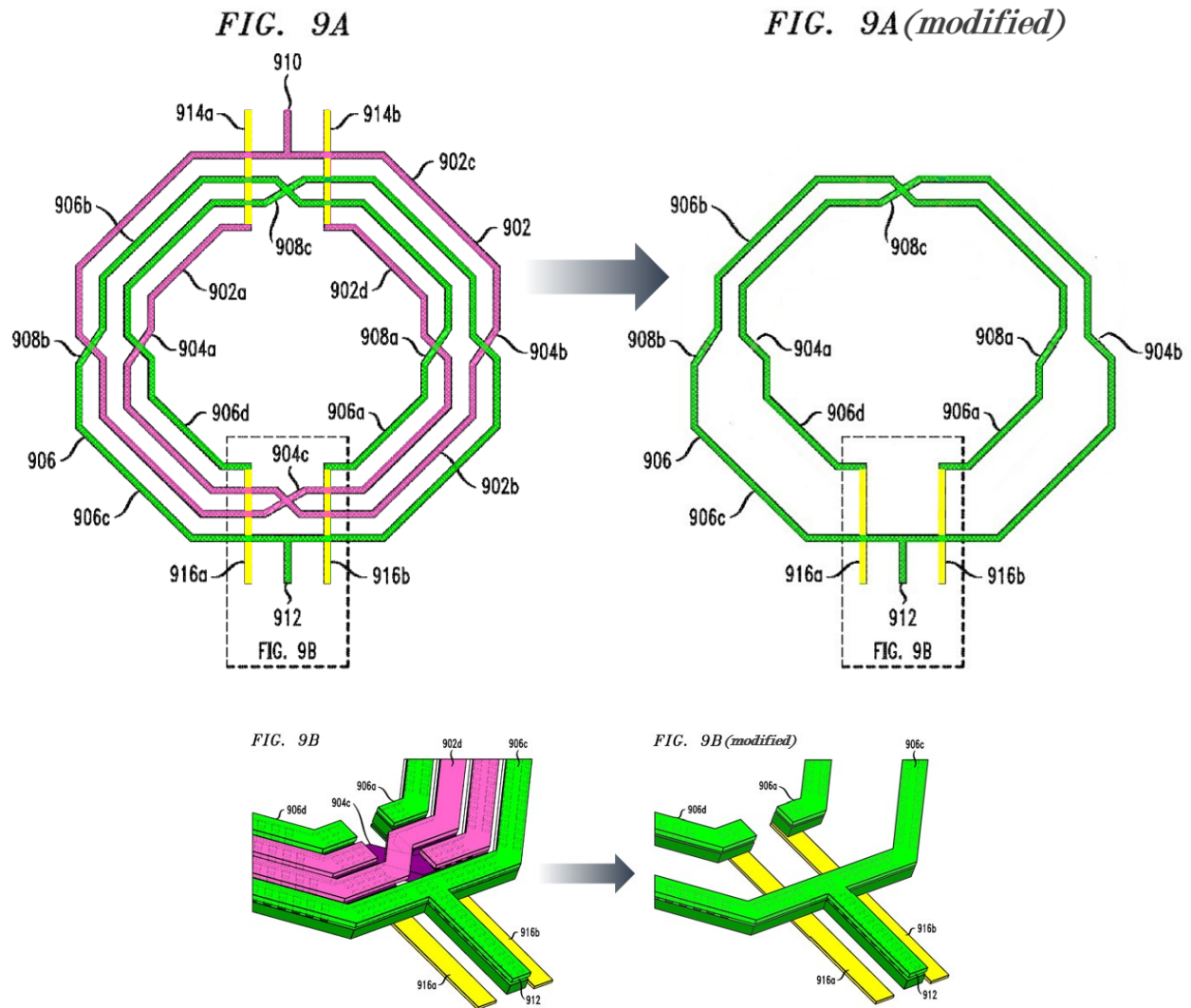
85. In addition, the planar transformer of *Ho-Hsiang* presents other structural problems that were known in the prior art, but absent in the '245 Patent's claimed inductor structure, namely, underutilized metal layers. Specifically, *Ho-Hsiang* explains, "FIG. 9A is a top plan view of a transformer 900 having a 2:2 turn ratio that utilizes three metal layers." Ex. 1005, 6:11–13.

FIG. 9C



Id., Fig. 9C (annotated; third metal layer 940 shown in yellow).

86. The portions of the *Ho-Hsiang* transformer that are located on the third metal layer 940 are identified as input ports 914a, 914b for the primary winding 902 and input ports 916a, 916b, for the secondary winding 906. *Id.*, 6:24–29. These input ports or leads are shown in yellow in the figures below and are the only structures present on the third metal layer 940.



Id., Figs. 9A–9B (annotated and modified).

87. The input leads of *Ho-Hsiang* are formed on a dedicated metal layer that is otherwise unutilized and further supports my opinion that the structure of *Ho-Hsiang*'s planar transformer is designed for symmetry and coupling coefficient, but not to fully utilize available metal layers to increase Q.

88. In addition, if *Ho-Hsiang* was modified as suggested by the Petition, the result would be one winding with underutilized layers due to the placement of the self-crossing of 904c at one end and on the opposite side, the self-crossings 908c of the input ports 916a and 916b. Thus,

similar to the prior art inductors described previously, there is an underutilized metal layer, which negatively impacts Q and would ultimately undermine the stated objective and structure of the Challenged Claims of the '245 Patent, which is to utilize the layers of the crossover region to construct shunt windings. A POSITA, at the time of the invention, would not be motivated to modify a transformer to obtain an “inductor structure” that resembles the very prior art structures with low Q that the inventors of the '245 Patent sought to improve.

89. A POSITA would acknowledge the characteristics of planar balun transformers that affect the structural features of the individual windings themselves run counter to the goals of the '245 Patent, i.e., reduced footprint, lower resistance, and optimized Q.

90. These undesirable structural features of the windings isolated from the transformers of *Ho-Hsiang* are readily apparent in the isolated windings upon review of the isolated windings illustrated and annotated by Petitioner.

91. The structural modifications required to be made to the individual windings of the planar transformer in *Ho-Hsiang* serve of the primary goal of allowing the windings to intertwine, such that the coupling coefficient k between the windings is maximized in the planar transformer. These modifications to the windings structure result in compromised flux linkage of each individual winding, thus reducing the inductance each winding realizes relative to the costs of its parasitic resistance and capacitance, which in turn results in inferior Q of each winding, which runs counter to the stated objectives of the '245 Patent.

92. Ultimately, the Q of the individual windings of the planar transformer in *Ho-Hsiang* has been sacrificed in order to achieve acceptable coupling (k) for the transformer structure, which places the goals of the transformer design in *Ho-Hsiang* in opposition to the goals of the inductor design of the '245 Patent.

93. A POSITA would understand individual inductors must be substantially modified in a manner deleterious to their function as inductors in order to be used as one of the windings in a transformer, and the modifications required to allow interleaving substantially degrade the performance of each individual winding. As such, a POSITA would not be inclined to consider the teachings of *Ho-Hsiang*'s planar transformer structures when seeking to improve the design of a multi-layer inductor with optimized Q.

94. In conclusion, it is my opinion that a POSITA would not have been motivated to consider the teachings of *Ho-Hsiang* to improve the design of a multi-layer inductor to optimize Q, and the Challenged Claims are not obvious based on *Ho-Hsiang*.

B. Ground 2: Christensen

95. *Christensen* teaches and discloses improvements in planar transformer designs for use in integrated circuits. Ex. 1006, 1:31–33.

96. The planar transformers taught and disclosed in *Christensen* are specifically designed with interwoven windings that share the same metal layers. These planar transformers are designed to perform the function of changing voltage levels, which is not relevant to the stated objectives of the inventors of the '245 Patent, of arriving at an optimized multi-layer inductor design with a reduced footprint and optimized Q.

97. *Christensen* describes several problems with transformer designs in the prior art. For example, Christensen explains that conventional layout techniques, such as those that stacked identical primary and secondary windings in different interconnect layers, did achieve a level of symmetry since the primary and secondary parts were identical. *Id.*, 9–14. However, Christensen states that stacked identical primary and secondary windings were not balanced. *Id.*, 14–15.

98. In addition, *Christensen* describes symmetrical transformers or Simburger

transformers of the prior art that “comprises inward and outward spiraling paths which cross twice in all but the outer and inner turns which contain only one crossing.” *Id.*, 1:16–26. However, *Christensen* further explains that these transformers “have a complex layout[,] are undesirably lossy[, and that] it is difficult to match the electrical properties of the windings.” *Id.*, 1:26–28.

99. To purportedly address these problems in the prior art, *Christensen* teaches toward an improved on-chip planar transformer formed by two substantially intertwined windings, a primary winding 3 and a secondary winding 4, shown below. *Id.*, 1:31–45, 2:53–55.

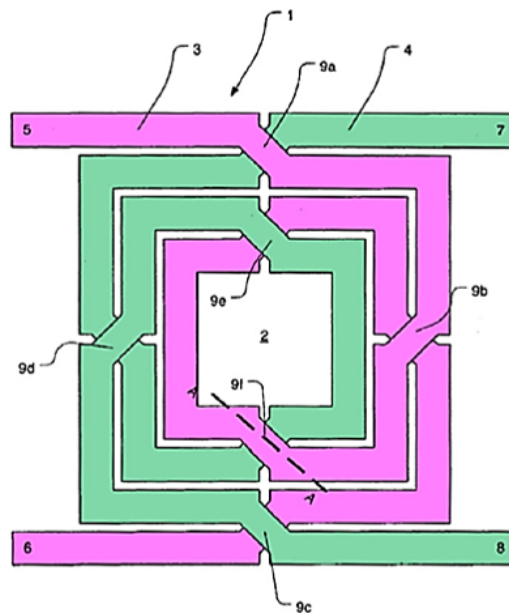


Figure 1

Id., Fig. 1 (annotated to highlight the primary winding 3 in pink and the secondary winding 4 in green).

100. *Christensen* teaches that the intermingled windings having the same number of turns and that each full turn of the intermingled portion is effected by one self-crossing and two inter-winding crossings. *Id.*, 1:38–45.

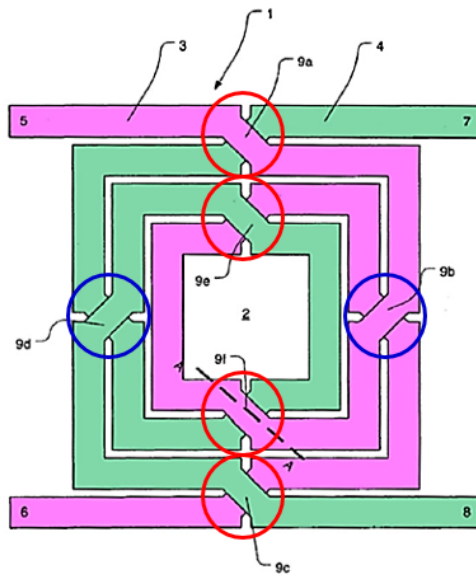


Figure 1

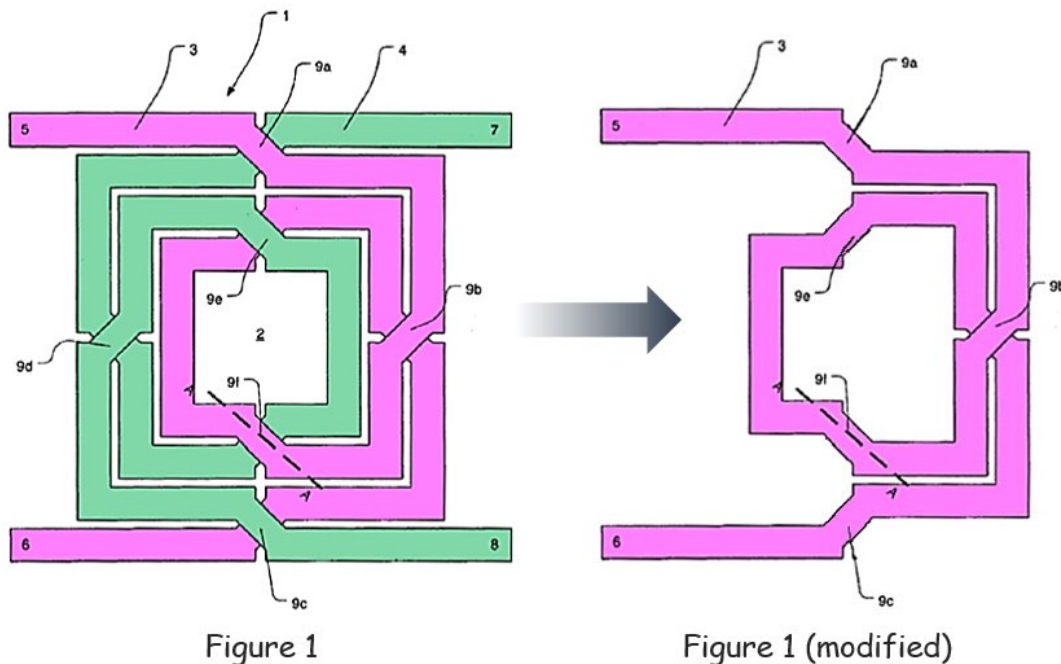
Id., Fig. 1 (annotated; blue circles indicate a self-crossing and red circles indicate an inter-winding crossing).

101. With respect to the crossings, *Christensen* further teaches, “the crossings should be positioned so as to *assist in balancing the electrical properties of the windings*. Arrangements having *rotational or mirror symmetry are preferred* for this reason.” *Id.*, 4:60–63 (emphasis added).

102. None of these teachings, or any other statements in *Christensen*, suggest to a POSITA that the planar transformer structures would be useful for improving the design of an inductor to reduce its footprint while optimizing its Q through the use of a crossover region to construct shunt windings.

103. *Christensen* teaches nothing about the structure or function of inductors or how to design an inductor to reduce its footprint and resistance while optimizing Q. Nothing in *Christensen* would motivate a POSITA to consider or rely on the design choices taught to improve the function of a planar transformer in order to achieve the stated objectives of the '245 Patent.

104. Furthermore, nothing in *Christensen* suggests that a POSITA would be motivated to separate the windings of the planar transformer, and then utilize a single isolated winding as an “inductor.” In fact, *Christensen*’s teachings are counterintuitive to and teach away from the objectives of the ’245 Patent—to design an inductor with a reduced footprint, lower resistance, and optimized Q—because the isolated windings contain structural modifications that are necessary to maximize coupling in a planar transformer but that in isolation increase the footprint of the winding, degrade the performance of the winding, and decrease the quality factor of the winding as a standalone inductor.

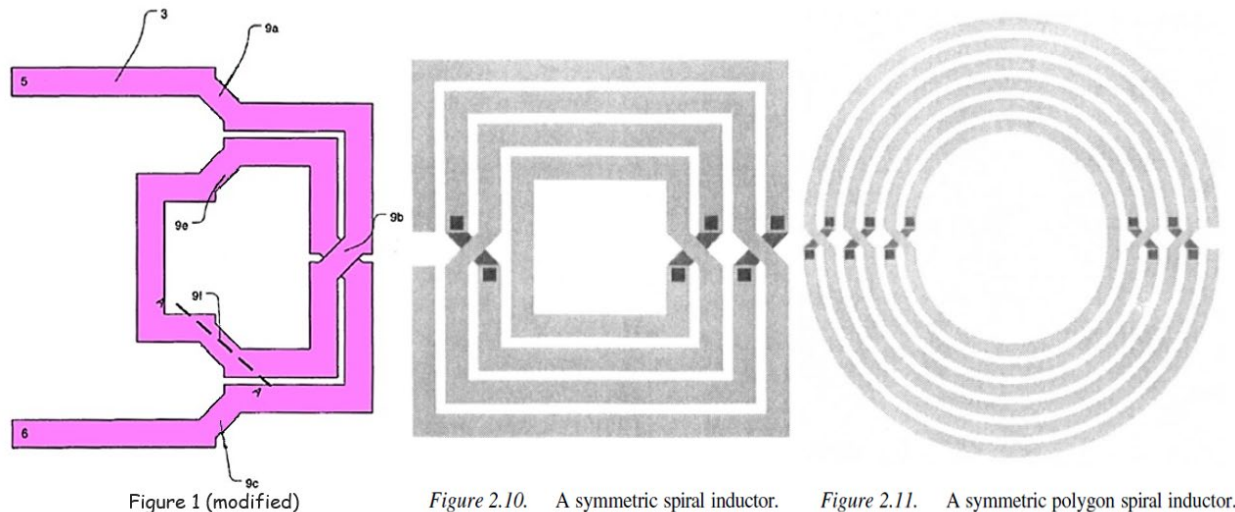


Ex. 1006, Fig. 1 (modified and annotated); *see also id.* Figs. 2–3.

105. Moreover, Dr. Prucnal fails to address the fact that even if a POSITA did separate the windings and utilize a single isolated winding as a stacked “inductor,” it would not result in the ’245 Patent inductor structure having all of the claimed elements, nor would it address the stated objectives of creating an inductor with low resistance and high Q.

106. *Christensen*’s on-chip planar transformer is formed by two intertwined windings, a

primary winding 3 and a secondary winding 4. Ex. 1006, 2:53–55. There are six crossings identified in Fig. 1 (identified below), namely, primary winding 3's self-crossing 9b (blue circle), secondary winding 4's self-crossing 9d (blue circle), and four crossings of the two windings 9a, 9e, 9f, and 9c (red circles).



Compare Ex. 1006 (Fig. 1, modified and annotated) with Ex. 1009, 26–27 (Figs. 2.10–2.11).

107. The isolated winding from *Christensen* has non-uniform spacing between the turns of the windings, particularly on the left side (shown above), and an overall larger footprint than a typical circular or even square prior art inductors (also shown above). A POSITA, at the time of the '245 invention, would understand that these structural irregularities are the result of the intermingling required by the two windings to increase coupling necessary to construct a balanced planar transformer with rotational or mirror symmetry. In addition to the increased surface area of the isolated winding, the large unoccupied area between terminals 5, 6 of the isolated winding and the innermost winding will result in a loss of flux linkage from the outer winding. Not only does the irregular geometry not fully utilize the surface area, but it also negatively impacts potential inductance.

108. These undesirable structural features of the windings isolated from the planar transformers of *Christensen* are readily apparent in the isolated windings upon review of the isolated windings illustrated and annotated by Petitioner.

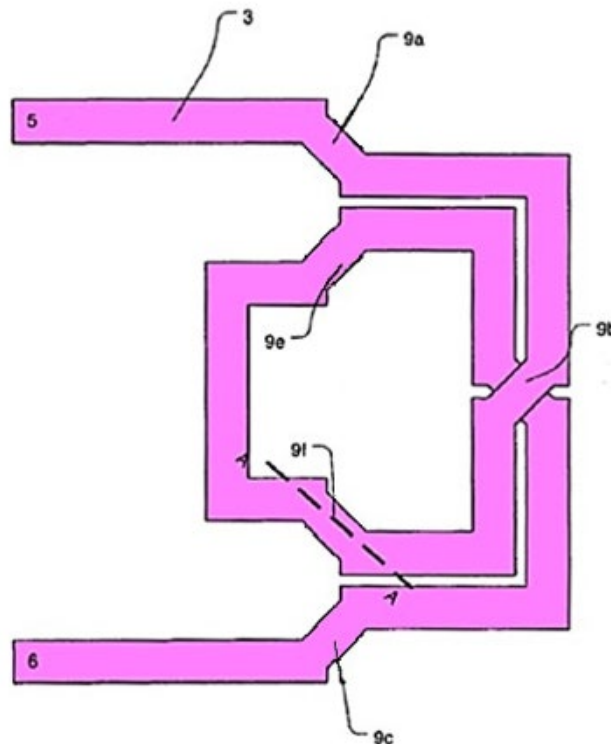


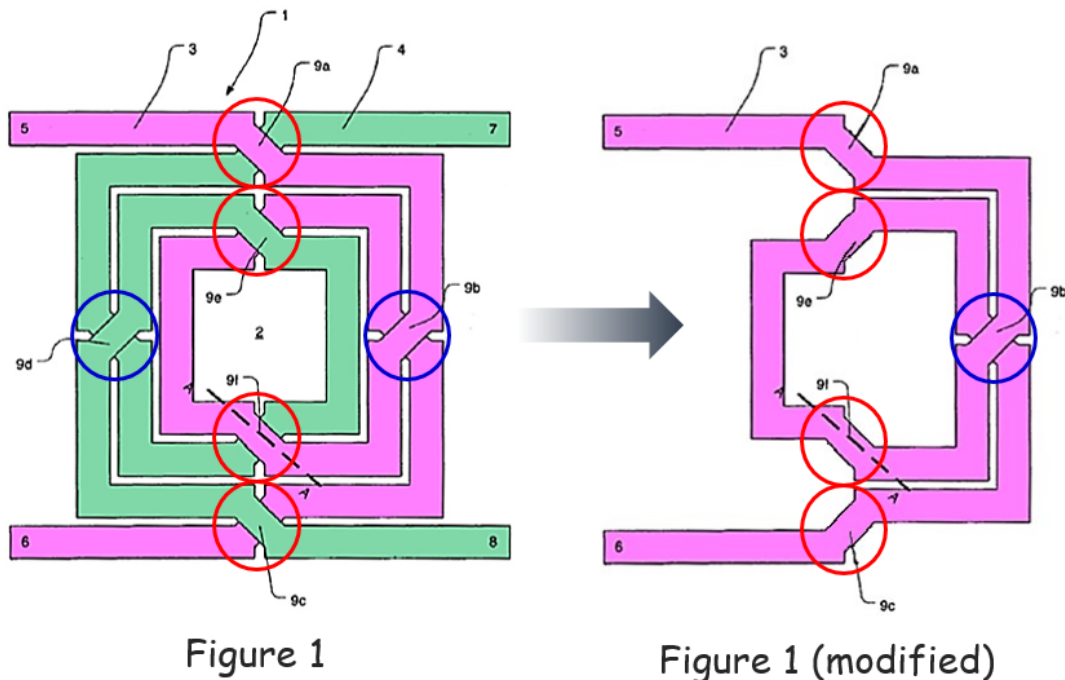
Figure 1 (modified)

Ex. 1006, Fig. 1 (modified and annotated; *see also* Fig. 2).

109. The structural modifications required to be made to the individual windings of the planar transformer in *Christensen* serve the primary goal of allowing the windings to intertwine, such that the coupling coefficient k between the windings is maximized in the planar transformer. These modifications to the windings result in compromised flux linkage of each individual winding, thus reducing the inductance each winding realizes relative to the costs of its parasitic resistance and capacitance, which in turn results in inferior Q of each winding, which runs counter to the stated objectives of the '245 Patent.

110. A POSITA would expect that a modified or isolated winding from a planar transformer, such as those disclosed in *Christensen*, will possess an irregular geometry that negatively impacts the footprint and inductance, and therefore, would not achieve the goals of the '245 Patent to reduce surface area, lower resistance, and optimize Q.

111. *Christensen* is focused on the crossings of the two windings (red circles below) in its effort to achieve an improved planar transformer with rotational or mirror symmetry and balanced electrical properties of the windings, and does not explicitly teach or disclose anything about the self-crossings of the individual windings, 9d or 9b (blue circles below), aside from briefly mentioning their location and labeling them in Figs. 1–3 and 11. *See id.*, 3:14, 22, 31, 39.



Id., Fig. 1 (modified and annotated; *see also* Fig. 2).

112. Dr. Prucnal applies *Christensen*'s Figs. 4–6 to the self-crossings 9d and 9b in an effort to incorporate structural features not explicitly disclosed, when *Christensen* does not teach or disclose the structure of the self-crossing. Petition, 71–93. Figs. 4–6 are specific to the inter-

winding crossing at 9f. Ex. 1006, 2:25–34, 3:34–55, 3:62–4:8.

113. The only description of the metal layers at the two self-crossings of the transformer are as follows:

The primary winding 3 then passes through one quarter turn and over itself at the second crossover 9b [and t]he secondary winding 4 then passes through one quarter turn, in the opposite direction to the primary winding 3 as described above, and under itself at the fourth crossover 9d.

Id., 3:12–14, 3:28–31. In addition, a POSITA would appreciate that balanced electrical properties of the windings only dictate that crossing 9b and 9d be the same, but do not preclude the use of the third metal layer or underlying metal layers at these self-crossings. Indeed, the figures of Christiansen depict, and the specification of Christiansen states, that the winding 4 passes “under itself.” *Id.*

114. Lastly, similar to the modified transformer of *Ho-Hsiang*, the isolated winding of *Christensen* would not result in the '245 Patent inductor structure that is able to achieve low R_s and high Q because it possesses unnecessary gaps in the winding layers. *Christensen* teaches that “at the crossovers, the currents of the primary and secondary windings 3, 4 are carried in respective **single conductor layers** 10c, 10b[,]” **as opposed to its three layers** 10a–10c. *Id.*, 4:4–8, 3:44–61 (emphasis added); *see also* Figs. 4–5. This means that the isolated winding from *Christensen* will consist of gaps in metal layers of the winding, similar to *Ho-Hsiang* (*see supra* Section VI.A.3). Because Petitioner’s proposed modification of *Christensen* is an isolating single winding whose design still maintains four locations to accommodate crossovers of the transformer’s other winding, 9a, 9e, 9f, 9c (identified below in red), the three metal layer trace (10a–10c) of primary winding 3 goes down to **only a single metal layer** at these locations, which would degrade the performance of the isolated winding as a standalone inductor. *Id.*, 4:4–8, 3:44–61.

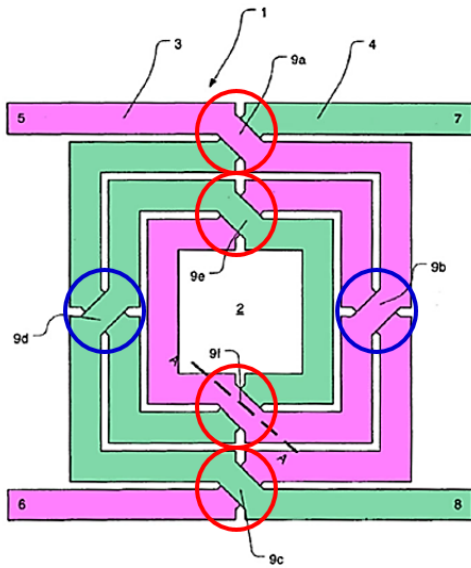


Figure 1

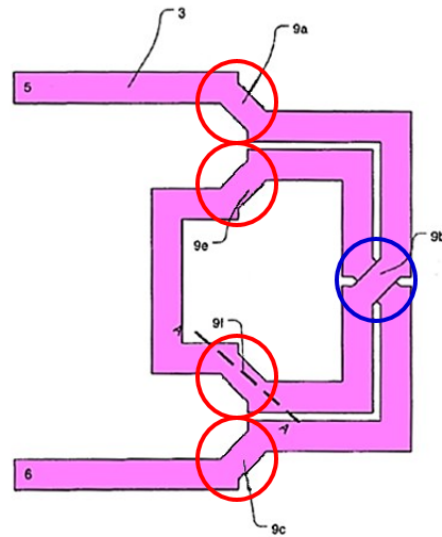


Figure 1

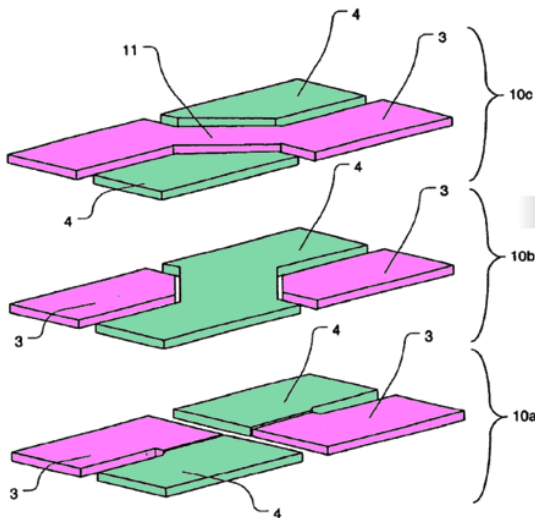


Figure 5

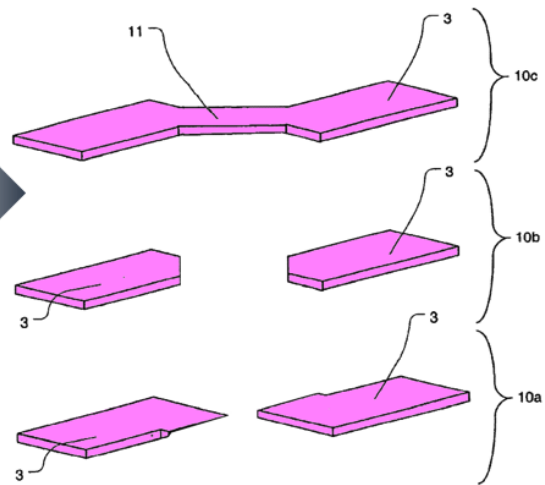


Figure 5 (modified)

Id., Figs. 1, 5 (modified and annotated; *see also* Fig. 2).

115. These gaps in the second metal layers 10a and 10b (shown above) for isolated primary winding 3, prohibit the modified transformer from being shunted at those locations and consequently prevent the isolated winding from being shunted along its length. Thus, the Dr. Prucnal's proposed modification of the *Christensen* teaches away from the stated objective of the

claimed invention, an optimized inductor structure that is able to achieve low R_s and high Q , by its inclusion of these unnecessary gaps in the isolated windings that degrade performance of the isolated winding as an inductor and decrease its Q .

116. A POSITA would acknowledge the characteristics of planar transformers that affect the structural features of the individual windings themselves run counter to the goals of the '245 Patent, i.e., to reduce the footprint, lower resistance, and optimize Q .

117. Ultimately, the Q of the individual windings of the planar transformer in *Christensen* has been sacrificed in order to achieve acceptable coupling k for the transformer structure, which places the goals of the transformer design in *Christensen* in opposition to the goals of the inductor design of the '245 Patent.

118. A POSITA would understand individual inductors must be substantially modified in a manner deleterious to their function as inductors in order to be used as one of the windings in a planar transformer, and the structural modifications required to allow interleaving substantially degrade the performance of each individual winding. As such, a POSITA would not be inclined to consider the teachings of *Christensen*'s planar transformer structures when seeking to improve the design of a multi-layer inductor with optimized Q .

119. Similar to *Ho-Hsiang*, the isolated winding of the *Christensen* transformer would no longer function as a planar transformer that would "assist in balancing the electrical properties of the windings." *Id.*, 4:61. Indeed, it is clear that the whole premise of *Christensen* is to "intermingle" the two windings and utilize not only self-crossings, but crossings of the intermingled windings in order to achieve "rotational or mirror symmetry." *Id.*, 1:37–41, 4:60–63. These coupling goals can never be realized with Petitioner's proposed modification, and an isolated winding would not achieve the intended purpose of *Christensen*.

120. In conclusion, it is my opinion that a POSITA would not have been motivated to consider the teachings of *Christensen* as a whole to improve the design of a multi-layer inductor to reduce its footprint while optimizing Q through the use of a crossover region to construct shunt windings. For the same reasons, it is my opinion that a POSITA would not have been motivated to modify the planar transformer of Christensen by separating the interwoven windings to arrive at the claimed invention. Therefore, it is my opinion that the Challenged Claims are not obvious in view of *Christiansen*.

C. Ground 3: Yang

121. *Yang* generally discloses a differential inductor with multi-turn windings. Ex. 1007, Abstract, ¶ [0018]. *Yang* includes only two drawings (both reproduced below). Fig. 1 shows a top view of an exemplary differential inductor 10 with multi-turn windings, and Fig. 2 is a sectional perspective view taken along line I-I' of Fig. 1.

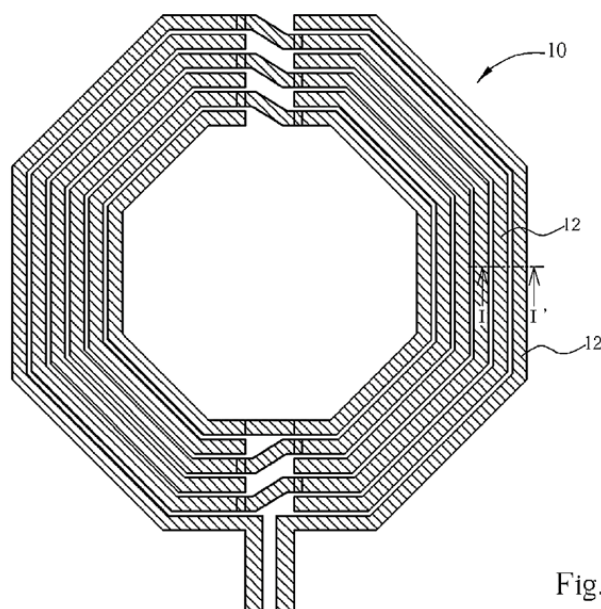


Fig. 1

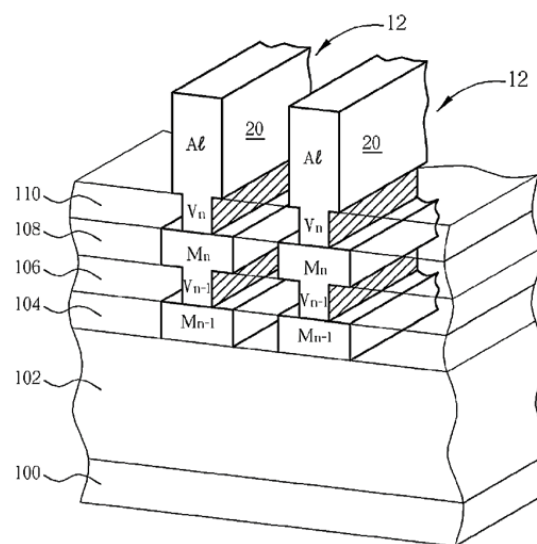


Fig. 2

122. *Yang* is silent with respect to at least the sixth segment and the crossover region of the Challenged Claims.

123. The Challenged Claims also require that “a layout direction of the sixth segment is different from a layout direction of the fourth segment and a layout direction of the fifth segment,” (claim 1) and that “. . . the sixth segment is positioned between the fourth segment and the fifth segment . . .” (claim 2). Because *Yang* does not teach or disclose a second metal layer having a sixth segment, *Yang* also fails to teach or disclose such a sixth segment having a layout direction different from the layout direction of the fourth and fifth segments.

124. The Challenged Claims require that the third segment and the sixth segment construct a crossover region. Because *Yang* does not teach or disclose a sixth segment, *Yang* also fails to teach or disclose a crossover region.

125. In order to address some of these missing elements, Petitioner annotates *Yang*’s Fig. 1 to add the missing sixth segment of the second metal layer to the lone top view image of the inductor disclosed in *Yang* (annotated images reproduced below). Petition, 114–15.

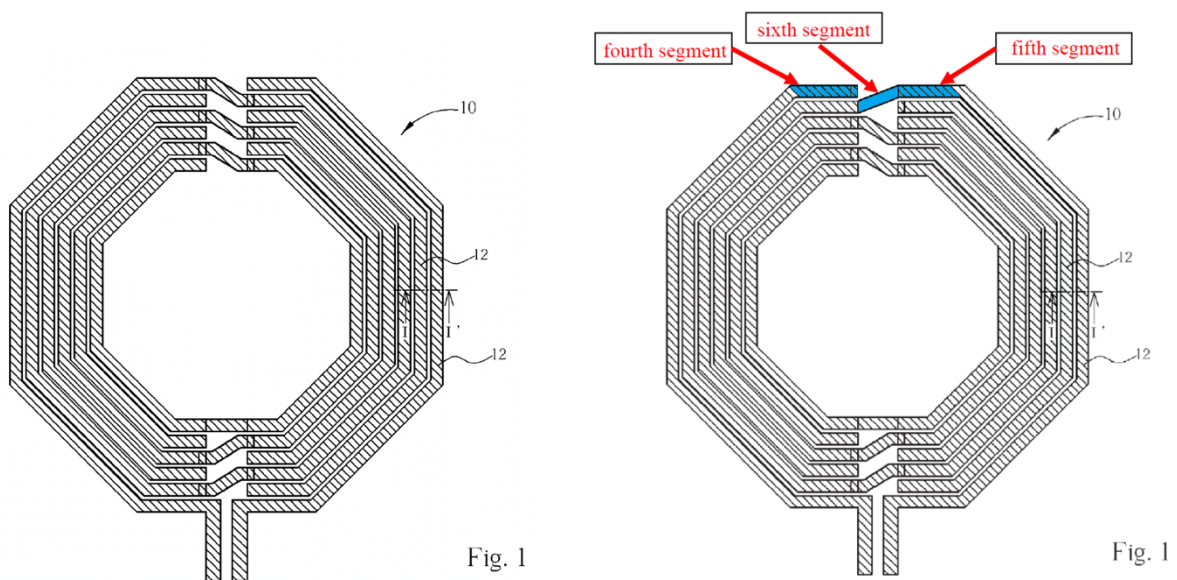
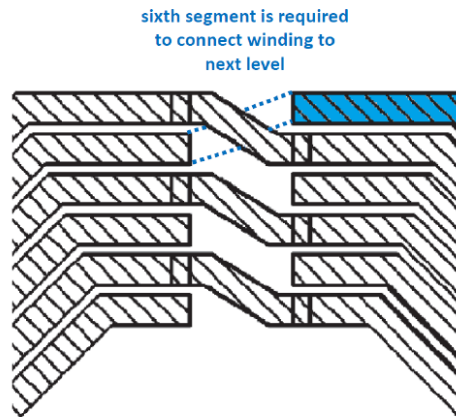
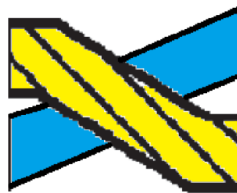


Fig. 1 original

Yang, Fig. 1 (EX-1007) (modified and annotated)



Yang, Fig. 1 (partial) (EX-1007) (annotated)



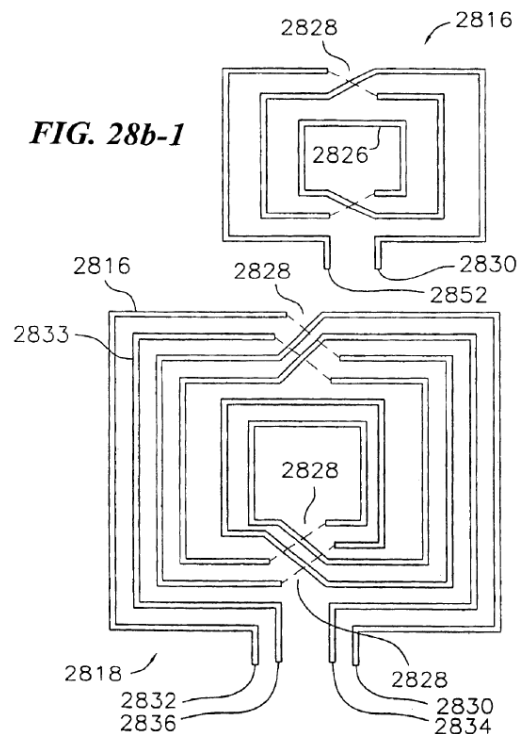
Yang, Fig. 1 (portion, modified) (EX-1007) (annotated)

126. The Petition argues that argues that a sixth segment, physically connected to the fifth segment on the second metal layer, would be required in order to maintain proper electrical conductivity among the windings. Petition, 114–115.

127. A POSITA would have understood that the purported “sixth segment” would be “directly under the top layer crossover [] except oriented in a different direction to allow connection to the next segment of the coil” as shown in the annotated and modified image above, creating a crossover region that is symmetrical. *Id.* at 116 (“symmetrical inductors have crossovers which are also symmetrical, i.e., the two windings that form the crossover are equal in size, shape, and location, just mirror opposites of each other.”).

128. Dr. Prucnal opines that *Yang* inherently discloses a sixth segment, as annotated in the above images. Ex. 1003, ¶¶ 294, 295, 320. I disagree because the claimed “sixth segment” and

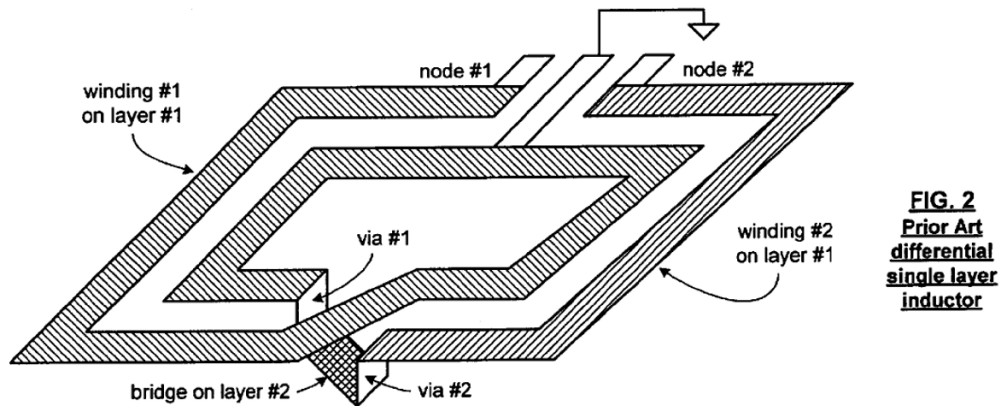
“crossover region” simply do not exist in *Yang* and are not necessary to maintain proper electrical conductivity among the windings. The sixth segment and crossover region of the Challenged Claims are not necessarily present because a POSITA would simply use what was currently taught in the prior art, the use of an underpass on a separate metal layer to close the circuit. And further, these crossings (underpasses or bridges) of the prior art could still have been implemented while substantially maintaining the inductor’s symmetry. For example, U.S. Patent No. 6,885,275 to Chang, filed on Jan. 28, 2000, teaches the use of an underpass 2828 on a separate metal layer to interconnect the ends of turns in inductor 2816, as illustrated below. Ex. 1017, 38:10–15.



Id., Fig. 28b-1; 38:13–15 (“A series of phantom lines 2828 indicate tracks on a different layer, connected to a track shown by a solid line using one or more vias.”).

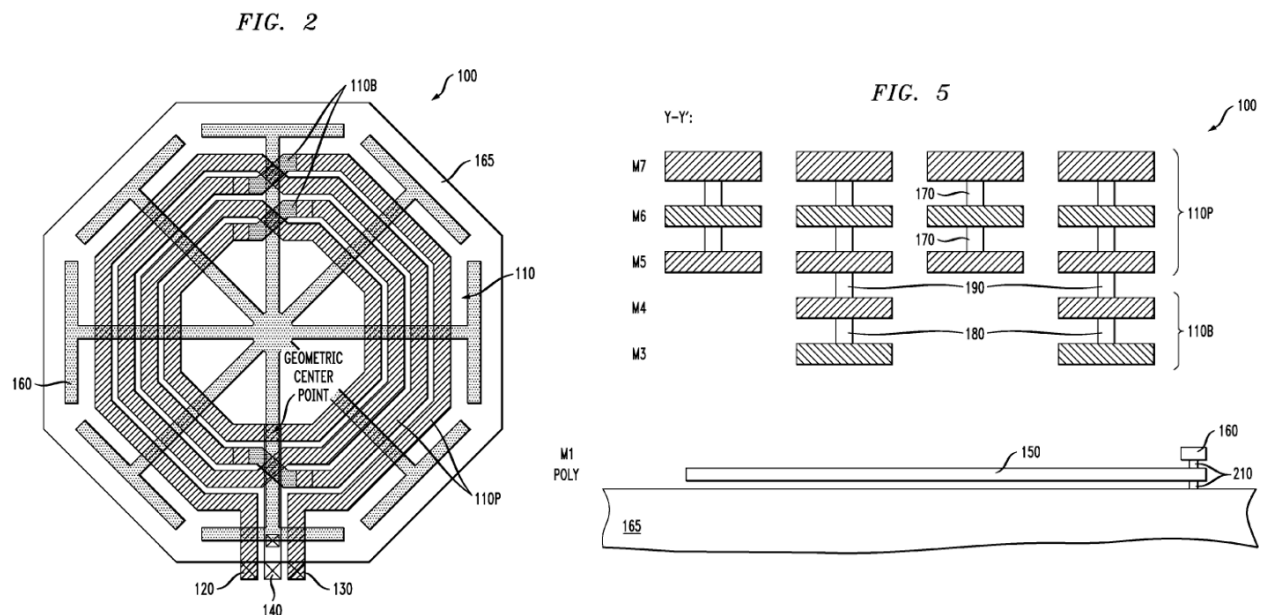
129. As another example, U.S. Patent No. 6,759,937 to Kyriazidou, filed in 2002, discloses a single-layer inductor (shown below) that uses a bridge or underpass on a separate layer

from the main winding in order to accomplish a crossover. Ex. 1013, 1:55–58.



Id. Fig. 2.

130. Additionally, U.S. Patent Pub. No. 2008/0074229 A1 to Moinian et al., filed in 2006 and cited as prior art in the '245 Patent, discloses a stacked inductor 100 (shown below) with primary winding portions 110P, located on three metal layers (M5–M7) and bridge portions 110B, located below on two separate metal layers (M3–M4). Ex. 1018, ¶¶ [0021]–[0022].



Id., Fig. 2, 5.

131. None of the prior art inductor references on which Petitioner relies teaches or

discloses utilizing the metal layers of the windings to from the crossover region as required by the Challenged Claims; rather the inductor art cited in the Petition utilized an underpass or bridge on a separate metal layer to close the circuit. Additionally, none of the prior art inductor references on which Petitioner relies teaches or discloses utilizing the metal layers of a crossover region to construct shunt windings; rather the inductor art cited in the Petition utilized an underpass or bridge on metal layers separate from the metal layers of the windings.

132. It is my opinion that *Yang* is missing material limitations of the Challenged Claims that are neither inherent nor necessary to the functionality of the structure taught and disclosed in *Yang*. Further, *Yang* provides no motivation or suggestion to add the sixth segment or crossover region of the Challenged Claims to the inductor structure of *Yang*. and the Challenged Claims are not obvious based on *Yang*.

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

Dated: February 8, 2024



Dr. Joshua Phinney