

Petitioner's Demonstratives

Intel Corporation

IPR2024-00728

U.S. Patent No. 7,151,430

July 16, 2025

'430 Patent Overview

Problem Addressed by the '430 Patent

Specification Addresses Problem of Efficiently Designing Circuits and Notes Problems with Mutual Coupling

Recent advances in wireless communication technology have allowed an entire RF transceiver to be implemented on a single semiconductor die or chip. However, integrating a complete RF transceiver on a single chip presents a number of challenges. For example, in wideband code division multiple access (WCDMA) transceivers, a single-chip solution requires two RF VCOs to be running on the chip at the same time. Such an arrangement may produce undesired interaction between the two VCOs due to various types of mutual coupling mechanisms, which may result in spurious receiver responses and unwanted frequencies in the transmit spectrum. The primary mutual coupling mechanism is usually the fundamental electromagnetic (EM) coupling between the resonators, i.e., the large inductor structures in the VCOs.

'430 Patent (INTEL-1001), 1:26-40.

As mentioned above, various embodiments of the invention provide an inductor design and method of implementing the same where mutual EM coupling is reduced. The inductor design and method serve to reduce the EM field at a certain distance from the inductor (i.e., the far field), at least in some directions, by using inductor shapes that are substantially symmetrical. As used herein, the term “symmetrical” refers to symmetry relative to at least one axis. This reduced far field may then be used to reduce the mutual coupling between two inductors. The inductor design and method may also be used to reduce the coupling between an inductor and another on-chip or external structure (e.g., an external power amplifier). This helps reduce the sensitivity of the VCO to interfering signals from other than a second on-chip VCO.

'430 Patent (INTEL-1001), 3:4-18.

Challenged Independent Claims

1. An inductor layout having reduced mutual electromagnetic coupling, comprising:

a first inductor having a reduced far field, said first inductor comprising:

a first loop having a shape that is substantially symmetrical about a first predefined axis;

a second loop connected to the first loop, said second loop having a size and shape substantially identical to the first loop, said second loop arranged such that a magnetic field emanating therefrom tends to cancel a magnetic field emanating from the first loop; and two closely spaced terminals connected to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

a second inductor positioned at a predetermined distance from the first inductor, wherein a mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

11. A method of reducing mutual electromagnetic coupling between a first inductor and a second inductor on a semiconductor die, comprising:

forming the first inductor to reduce a far field, said step of forming the first inductor comprising:

forming a first loop having a shape that is substantially symmetrical about a first predefined axis;

forming a second loop having a size and shape substantially identical to the first loop;

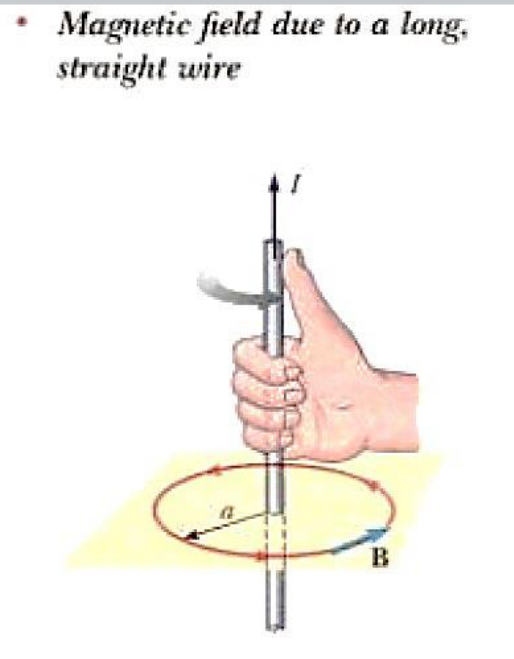
orienting the second loop in relation to the first loop such that a magnetic field emanating from the second loop tends to cancel a magnetic field emanating from the first loop; and

connecting two closely spaced terminals to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

positioning a second inductor at a predetermined distance from the first inductor, wherein the mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

Right Hand Rule for Magnetic Field Near a Conducting Structure

Magnetic Field Near a Current-Carrying Conducting Straight Wire



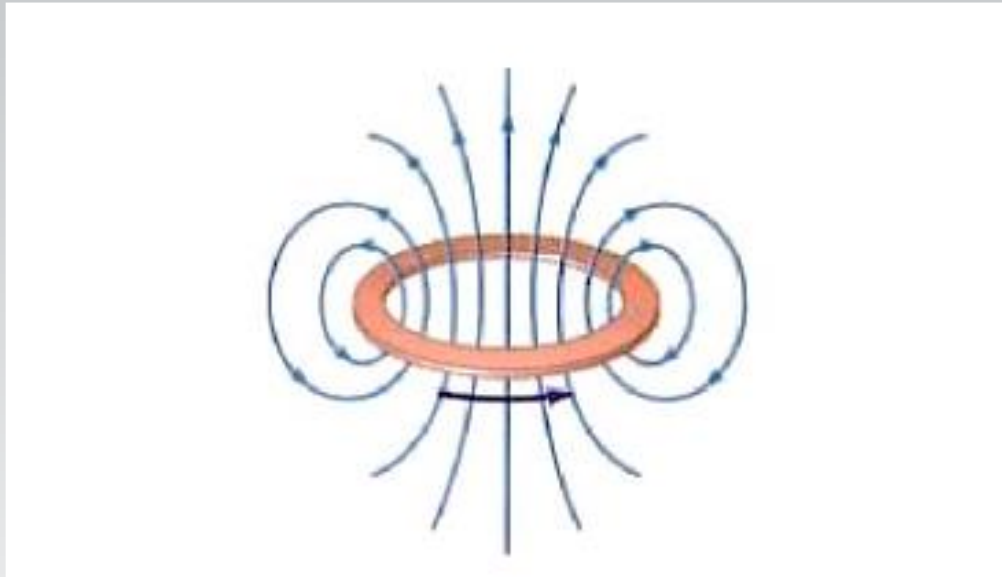
INTEL-1013 (Serway), Figure 22.14, 649.

The magnetic field near a long, straight current-carrying wire forms circles around the wire.

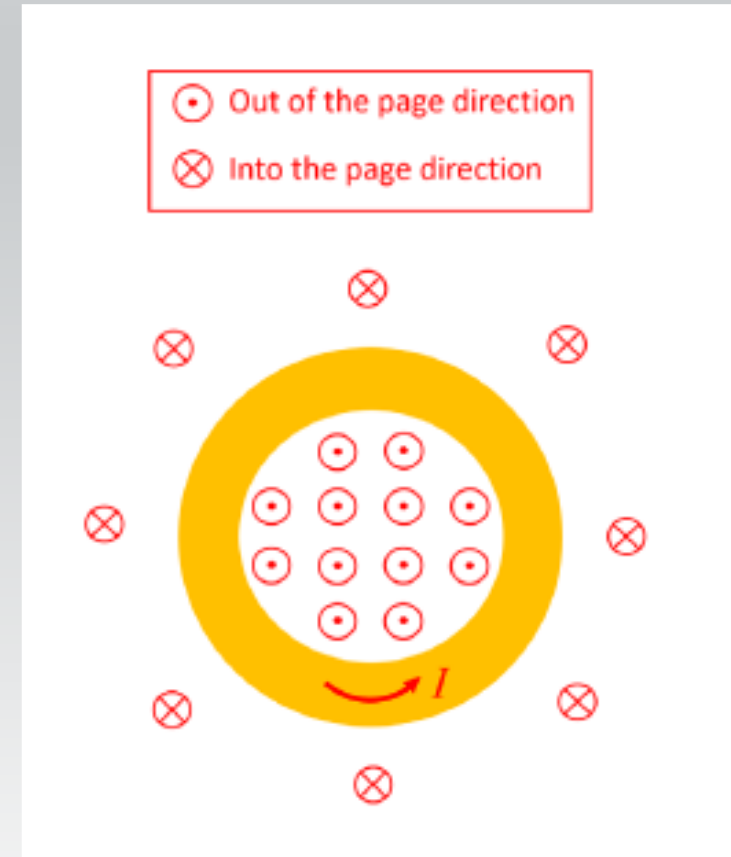
The field strength decreases with increasing distance from the wire.

Right Hand Rule for Magnetic Field Near a Conducting Structure

Magnetic Field Near a Current-Carrying Conducting Loop



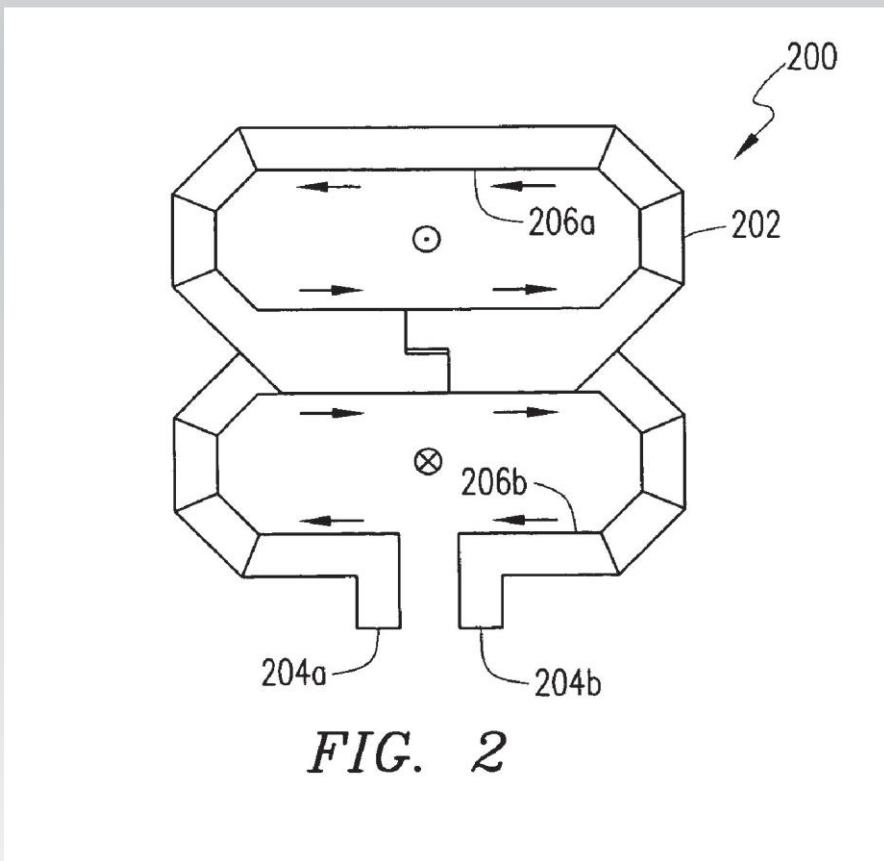
INTEL-1013 (Serway), 650.



INTEL-1003, ¶25.

'430 Patent's 8-Shaped Inductor

An 8-shaped current carrying structure has reduced far field.



'430 patent (INTEL-1001), Figure 2.

FIG. 2 shows an example of an inductor 200. The inductor 200 has an inductor coil 202 and terminals 204a and 204b, and has been designed so that it is substantially symmetrical about a horizontal axis X. In the present example, the inductor coil 202 is in the form of a single-turn 8-shaped structure with an upper loop 206a and a lower loop 206b. By virtue of the figure-8 shape, current in the upper loop 206a travels in a direction (e.g., counterclockwise, see arrows) that is opposite to current in the lower loop 206b (e.g., clockwise). As a result, the EM field components emanating at a certain distance from the two substantially symmetrical loops 206a and 206b also have opposite directions and tend to counteract each other. The directions of the EM field components are indicated by conventional notation in the middle of each loop 206a and 206b. Consequently, the inductor 200 has been found to have a significantly reduced far field at a certain distance from the inductor coil 202. Thus, by making the two loops 206a and 206b substantially symmetrical, cancellation of a significant amount of far field on either side of the horizontal symmetry axis X may be achieved. It should be noted, however, that perfect symmetry between the two loops 206a and 206b may be difficult to achieve given the presence of the terminals 204a and 204b.

'430 patent (INTEL-1001), 4:5-27.

Disclaimed Claim 20 Directed to a Single “Inductor”

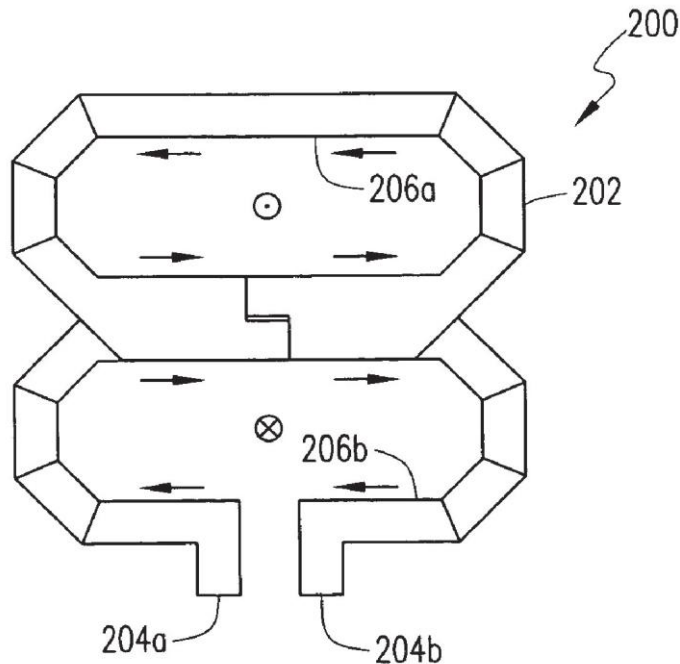


FIG. 2

'430 patent (INTEL-1001), Figure 2.

Original Claim 20 (**disclaimed**)

20. An inductor having a reduced far field, comprising:
a first loop having a shape that is substantially symmetrical about a first predefined axis;
a second loop having a size and shape substantially identical to the first loop, said second loop arranged such that a magnetic field emanating therefrom tends to cancel a magnetic field emanating from said first loop;
and
two closely spaced terminals connected to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals.

'430 patent (INTEL-1001), Claim 20.

Challenged Independent Claims Directed to First and Second Inductor

1. An inductor layout having reduced mutual electromagnetic coupling, comprising:

a first inductor having a reduced far field, said first inductor comprising:

a first loop having a shape that is substantially symmetrical about a first predefined axis;

a second loop connected to the first loop, said second loop having a size and shape substantially identical to the first loop, said second loop arranged such that a magnetic field emanating therefrom tends to cancel a magnetic field emanating from the first loop; and two closely spaced terminals connected to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

a second inductor positioned at a predetermined distance from the first inductor, wherein a mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

**Subject Matter
of Disclaimed
Claim 20**

11. A method of reducing mutual electromagnetic coupling between a first inductor and a second inductor on a semiconductor die, comprising:

forming the first inductor to reduce a far field, said step of forming the first inductor comprising:

forming a first loop having a shape that is substantially symmetrical about a first predefined axis;

forming a second loop having a size and shape substantially identical to the first loop;

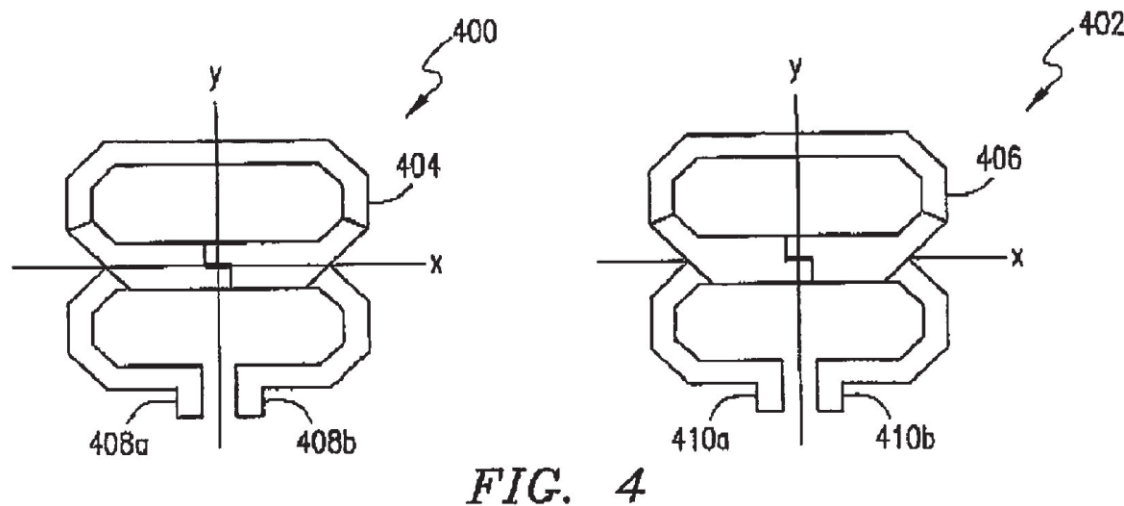
orienting the second loop in relation to the first loop such that a magnetic field emanating from the second loop tends to cancel a magnetic field emanating from the first loop; and

connecting two closely spaced terminals to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

positioning a second inductor at a predetermined distance from the first inductor, wherein the mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

'430 Patent's Inductor Layout Has Reduced EM Coupling

'430 patent leverages reduced far field of 8-shaped structure to reduce EM coupling in inductor layout.



'430 patent (INTEL-1001), Figure 4.

On the other hand, an inductor arrangement involving two 8-shaped inductors like the one in FIG. 2 may provide further reduced mutual EM coupling. This is illustrated in FIG. 4, where an inductor arrangement similar to the arrangement in FIG. 3 is shown, except the two inductors

400 and 402 have 8-shaped inductor coils 404 and 406 instead of O-shaped inductor coils. The terminals for the inductor coils 404 and 406 are labeled as 408a & 408b and 410a & 410b, respectively. Each individual inductor 400 and 402 has a reduced far field by virtue of the 8-shaped inductor coil 404 and 406, as explained above with respect to FIG. 2.

Note that it is not necessary for the two inductors 400 and 402 to have the same size. All that is needed for mutual EM coupling reduction is for them to have similar, EM reducing shapes. Further, a combination of an O-shaped inductor and an 8-shaped inductor may still result in mutual coupling reduction. However, since such an arrangement only uses the EM canceling effect of one inductor (the O-shaped inductor has little or no EM cancellation), the total isolation between the two inductors is less.

'430 patent (INTEL-1001), 4:63-5:6, 5:14-22.

'430 Patent's Inductor Layout Has Reduced EM Coupling

'430 patent
contemplates second
inductor in layout
may be O-shaped or
rotated.

Note that it is not necessary for the two inductors **400** and **402** to have the same size. All that is needed for mutual EM coupling reduction is for them to have similar, EM reducing shapes. Further, a combination of an O-shaped inductor and an 8-shaped inductor may still result in mutual coupling reduction. However, since such an arrangement only uses the EM canceling effect of one inductor (the O-shaped inductor has little or no EM cancellation), the total isolation between the two inductors is less.

In some embodiments, it has been found that even greater isolation may be achieved by rotating one of the inductor coils, as shown in FIG. 5. Here, two inductors **500** and **502** having nearly identical 8-shaped inductor coils **504** and **506** have again been placed side-by-side. Their terminals are again labeled as **508a** & **508b** and **510a** & **510b**, respectively. However, one of the inductor coils, say, the inductor coil **504** on the left, has been rotated by 90 degrees to further reduce mutual EM coupling.

'430 patent (INTEL-1001), 5:14-32.

Instituted Grounds

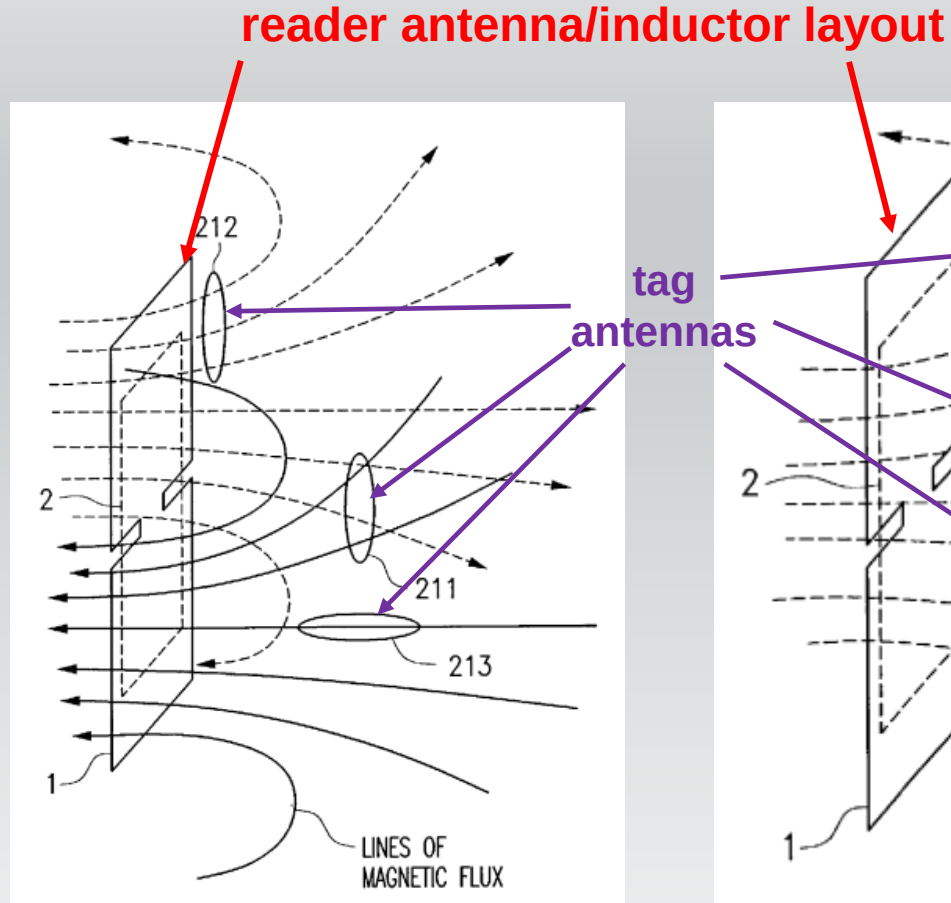
Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1, 3–5, 7, 10, 11, 13–15, 17, 19	103 ²	Taniguchi ³
2, 8, 11, 12–15, 17–19	103	Taniguchi, Rostoker ⁴
1, 3–6, 9, 11–16	103	Midya, ⁵ Raghavan ⁶
2, 11–16	103	Midya, Raghavan, Gardner ⁷
1, 3–5, 7, 10, 11, 13–15, 17, 19	103	Taniguchi, Brooks ⁸
2, 8, 11, 12–15, 17–19	103	Taniguchi, Rostoker, Brooks
1, 3–6, 9, 11–16	103	Midya, Raghavan, Brooks
2, 11–16	103	Midya, Raghavan, Gardner, Brooks

Prior Art Overview

Taniguchi's Inductive Coupling System

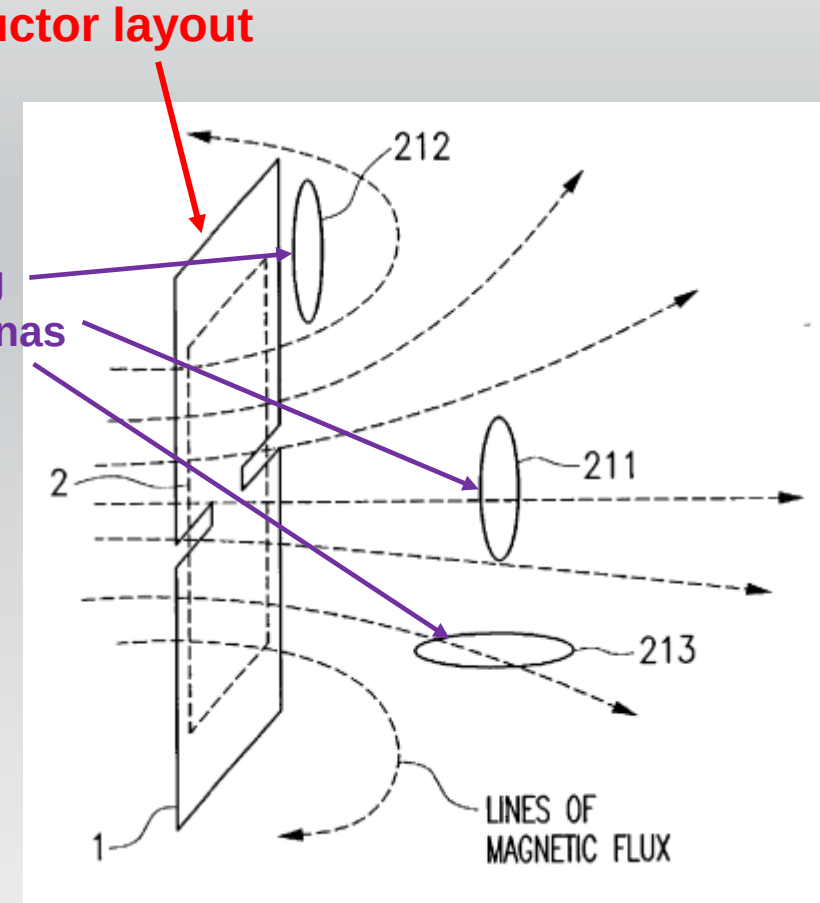
A radio guidance antenna in which the sum of mutual inductances of antennas is minimized. The radio guidance antenna includes a first antenna which is divided into upper and lower half regions by antenna conductors, and a second antenna which is composed of an antenna conductor and formed on the same plane as or a plane parallel to a plane of the first antenna. The second antenna is not connected to the first antenna at any points where it intersects the first antenna, but rather is inductively coupled to the upper and lower halves of the first antenna through mutual inductance regions. The first antenna is supplied with electric power from a first feeding point, and the second antenna is supplied with electric power from a second feeding point. The invention also includes a data communication method and a non-contact data communication apparatus which make use of the radio guidance antenna.

INTEL-1005 (Taniguchi), Abstract.



INTEL-1005 (Taniguchi), Figure 4.

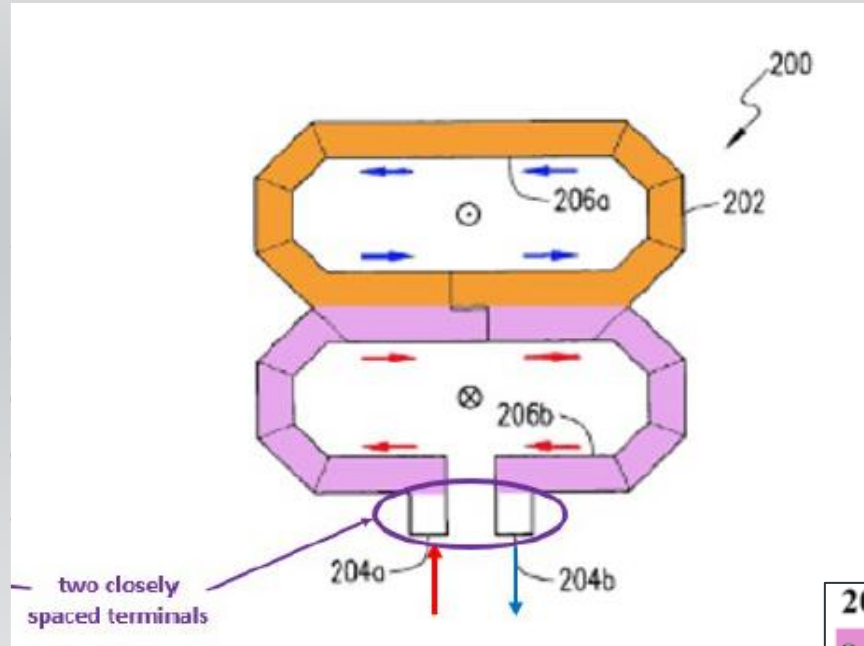
**8-Shaped Antenna/Inductor 1
Magnetic Field Lines**



INTEL-1005 (Taniguchi), Figure 5.

**O-Shaped Antenna/Inductor 2
Magnetic Field Lines**

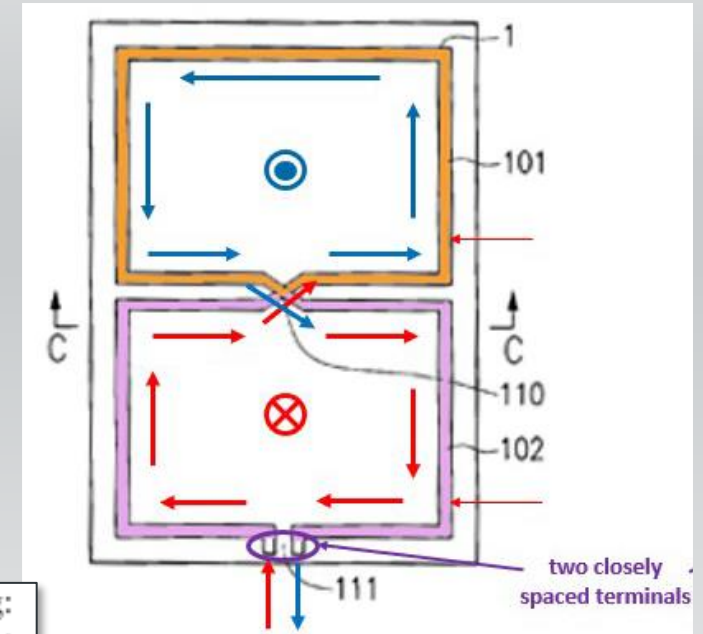
Taniguchi's 8-Shaped Antenna/Inductor



'430 8-Shaped Inductor

Claim 20 (disclaimed)

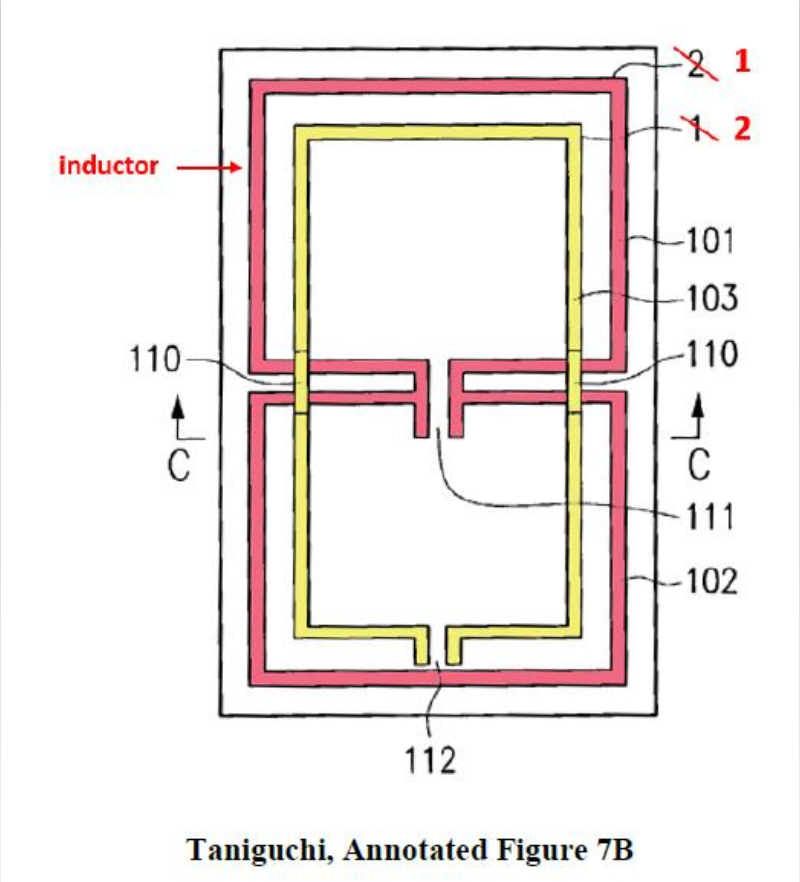
20. An inductor having a reduced far field, comprising:
a first loop having a shape that is substantially symmetrical about a first predefined axis;
a second loop having a size and shape substantially identical to the first loop, said second loop arranged such that a magnetic field emanating therefrom tends to cancel a magnetic field emanating from said first loop; and
two closely spaced terminals connected to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals.



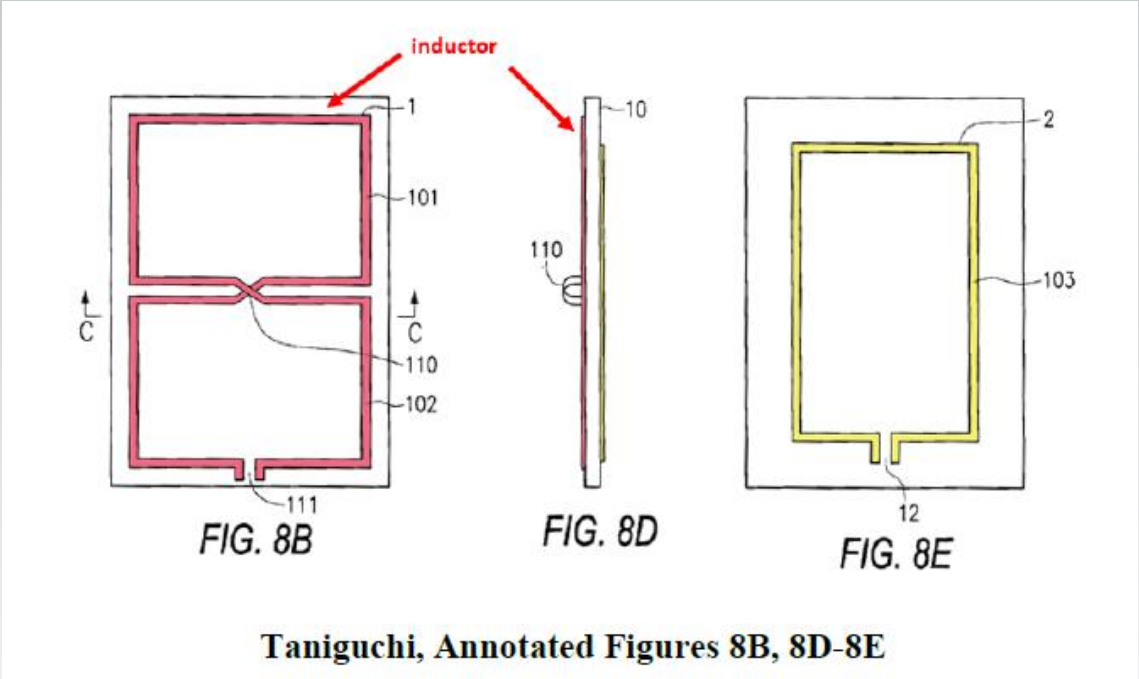
Taniguchi 8-Shaped Inductor/Antenna

Taniguchi Leverages the Reduced Far Field of Its 8-shaped First Antenna/Inductor to Develop Layouts With an O-Shaped, 8-Shaped, or Rotated 8-Shaped Second Antenna/Inductor

8-Shaped Antenna/Inductor 1 + O-Shaped Antenna/Inductor 2



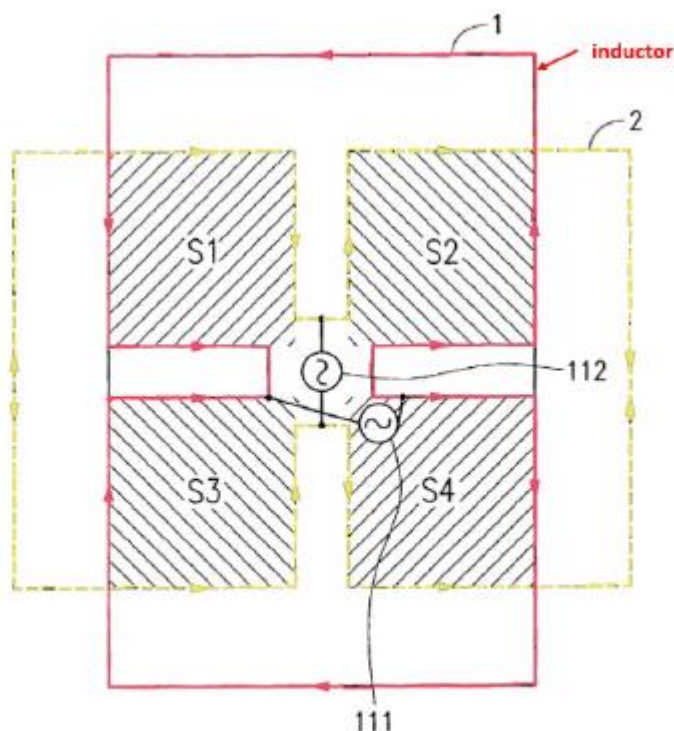
INTEL-1005 (Taniguchi), Figure 7B (Annotated).



INTEL-1005 (Taniguchi), Figures 8B, 8D, 8E (Annotated).

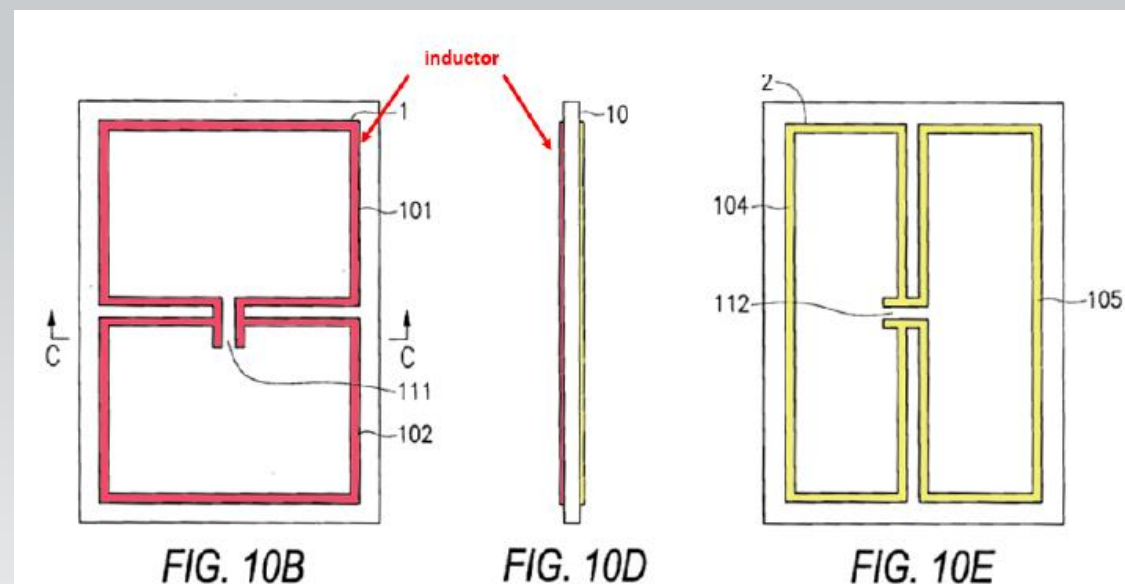
Taniguchi Leverages the Reduced Far Field of Its 8-shaped First Antenna/Inductor to Develop Layouts With an O-Shaped, 8-Shaped, or Rotated 8-Shaped Second Antennas/Inductors

8-Shaped Antenna/Inductor 1 + Rotated 8-Shaped Antenna/Inductor 2



Taniguchi, Annotated Figure 9

INTEL-1005 (Taniguchi), Figure 9 (Annotated).

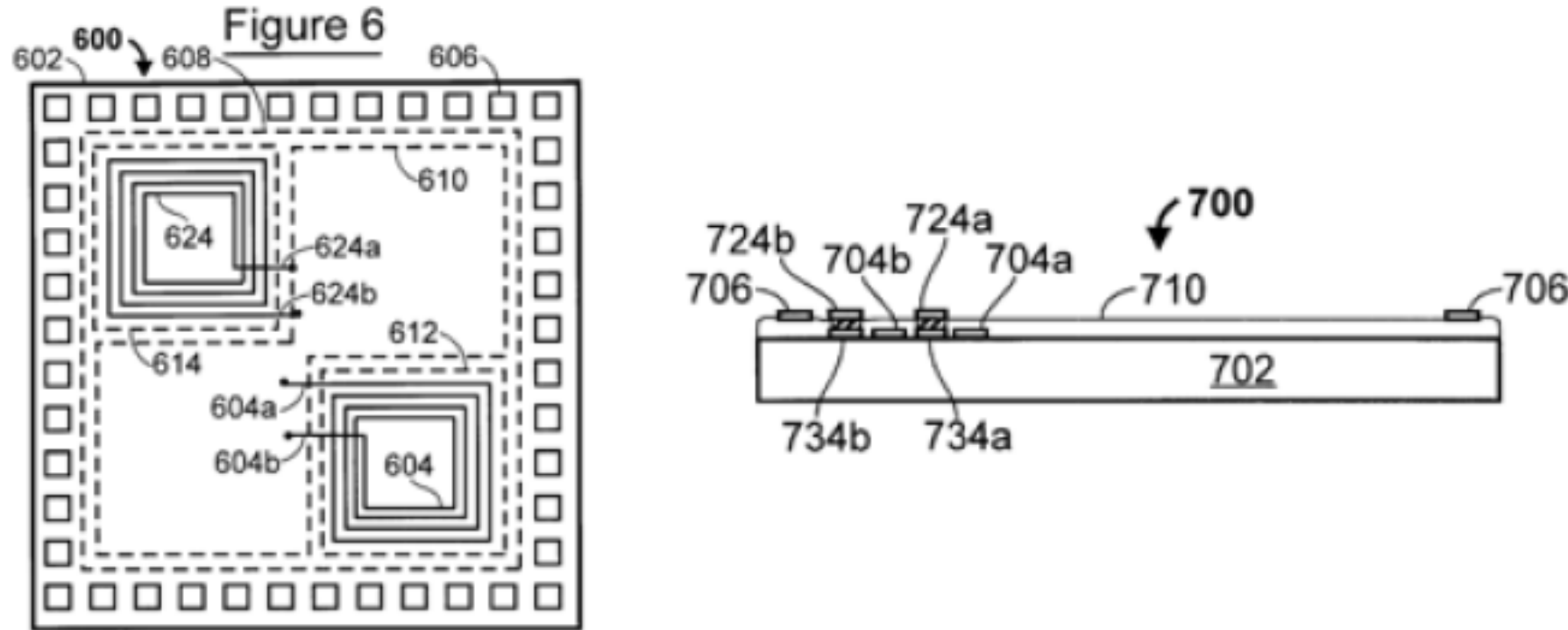


Taniguchi, Annotated Figure 10B, 10D-10E

INTEL-1005 (Taniguchi), Figures 10B, 10D, 10E (Annotated).

Rostoker Discloses Multiple Antennas Formed on a Single Integrated Circuit Chip

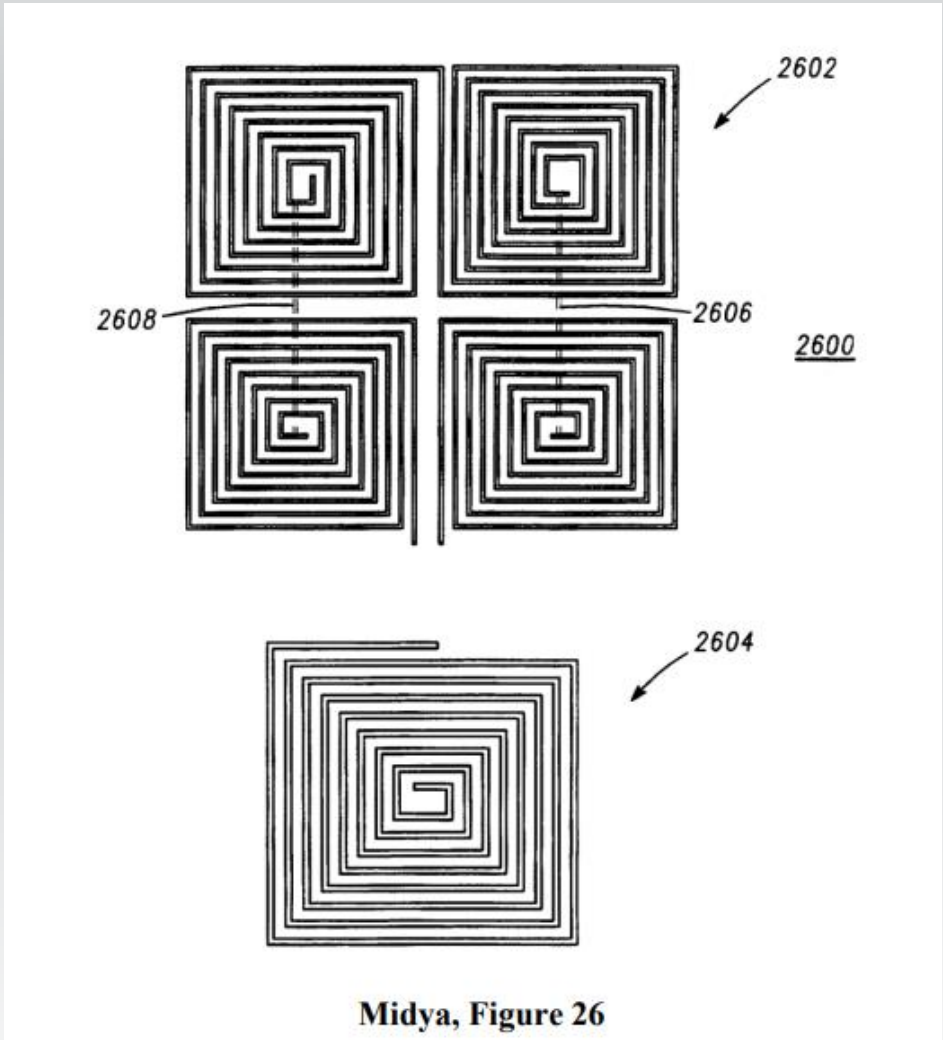
Rostoker's embodiments include two antennas on the chip surface (Figure 6) or in two different vertical planes (Figure 7B).



Rostoker, Figure 6 (left), Figure 7B (right)

INTEL-1006 (Rostoker), Figures 6, 7B.

Midya's Inductor Layouts Include Multiloop Inductor



The present invention relates generally to induction and more particularly, to substantially planar inductors.

INTEL-1007 (Midya), 1:5-6

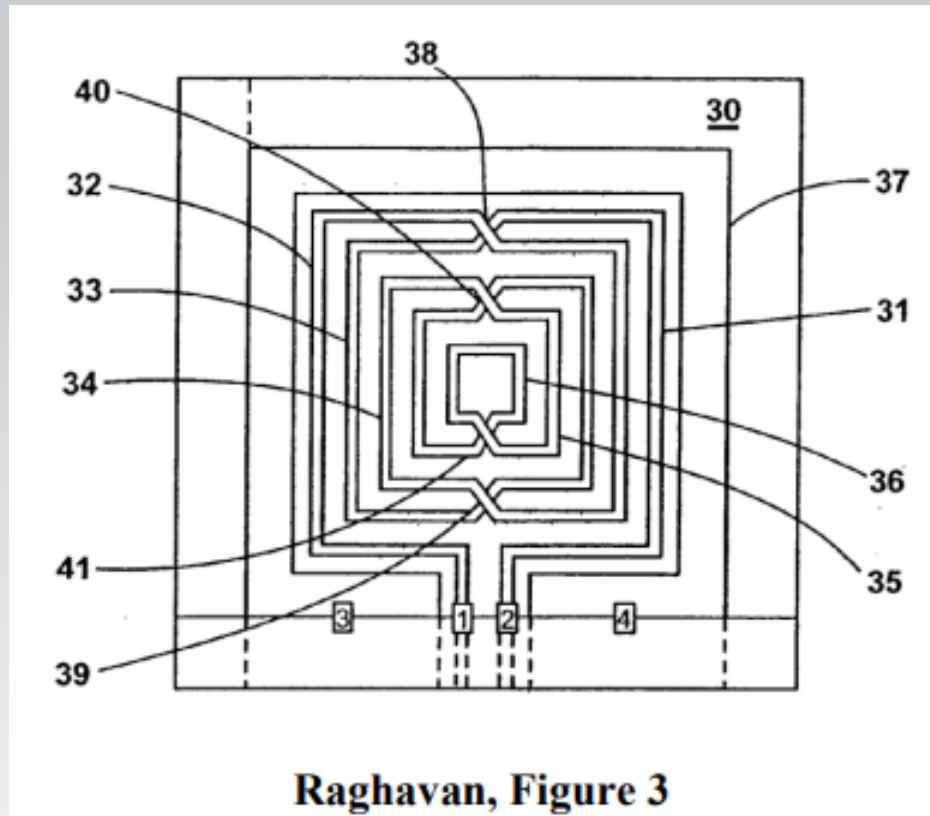
current produced by a signal source. The even number of planar adjacent loops/spiral conductor coils are arranged to provide total cancellation of a magnetic field on N axes and to maximize overall cancellation of the magnetic field. The

INTEL-1007 (Midya), 10:22-25.

FIG. 26 is a diagrammatic representation of a spiral inductor that is placed concentrically above a non-interacting multiloop inductor structure such that the coupled magnetic field is substantially zero in accordance with the present invention.

INTEL-1007 (Midya), 5:21-25.

Raghavan's Symmetric Inductor

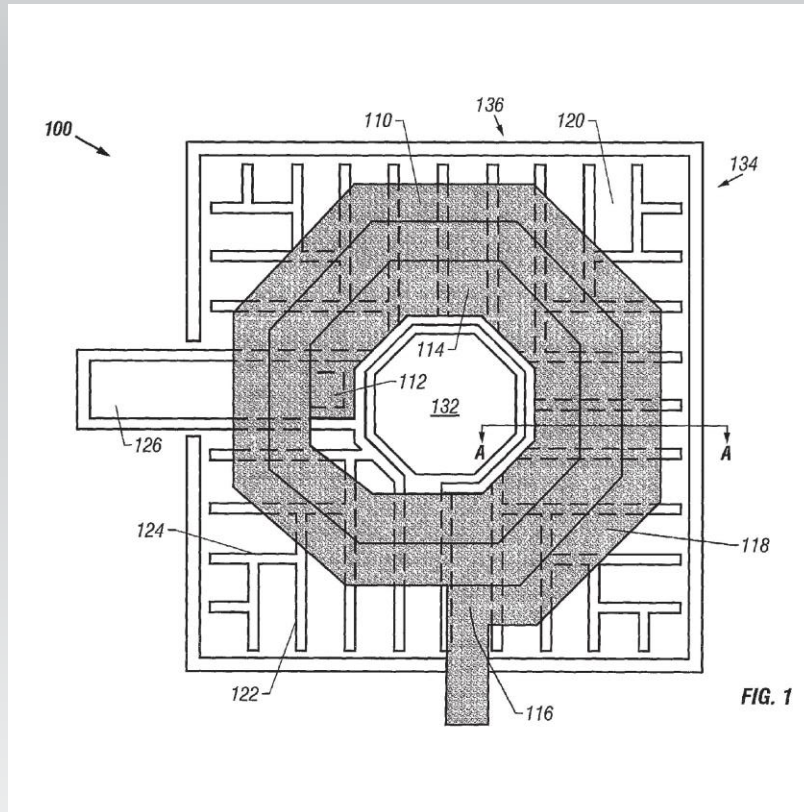


[0002] This invention relates to the field of inductors which are used in integrated circuits. In particular, this invention relates to symmetric inductors particularly

INTEL-1008 (Raghavan), ¶[0002].

INTEL-1008 (Raghavan), Figure 3.

Gardner's Inductor for Integrated Circuits



INTEL-1009 (Gardner), Figure 1.

[0002] 1. Field of the Invention

[0003] The present invention relates generally to the field of electrical inductors. More particularly, the present invention relates to the field of electrical inductors for integrated circuits (ICs) and IC packages.

INTEL-1009 (Gardner), ¶¶[0002]-[0003].

Disputed Issues

Disputed Issues

1. Taniguchi, Rostoker, Midya, Raghavan, and Gardner are analogous art to the '430 patent.
2. A POSITA would be motivated to combine PCB art (Taniguchi, Midya, Brooks) with IC art (Rostoker, Raghavan, Gardner).
3. Claim 11 preamble is not limiting as to “semiconductor die.”
4. Taniguchi discloses the “reducing mutual electromagnetic coupling”/“reduced electromagnetic field”/“reduced far field” and “predetermined distance” limitations.
5. Taniguchi, the Midya-Raghavan combination and the Brooks reference disclose the “closely spaced terminals” limitation.
6. The Midya-Raghavan combination retains Raghavan’s symmetry and Midya’s reduced EM field.
7. Gardner does not teach away from the alleged invention.

Analogous Art

Analogous Art Tests

Prior art is deemed to be analogous if one of two tests is satisfied:

- (1) Same Field of Endeavor Test:** if the art is from the same field of endeavor, regardless of the problem addressed or
- (2) Same Problem Test:** when the reference is not within the field of the inventor's endeavor, if it is reasonably pertinent to the particular problem with which the inventor is involved

Petitioner's Applied References Are Analogous Art

Field of Endeavor of the '430 Patent

Field of Endeavor

Petitioner: “Inductor Design”

The ID correctly determined that the field of endeavor is “inductor design.”

(ID, 17.) PO’s proposed additional limitation of “inductor design *for semiconductor*” is not supported. (POR, 13 (emphasis added).) To the contrary, PO’s cited passages describe specific, non-limiting embodiments and simulations. (See POR, 13, citing ’430 patent, 2:13-17 (referring to semiconductor die “in another aspect” of invention); 2:19-20 (same); 3:14-15 (method “may also be used ... on-chip”); 5:45-48 (describing exemplary simulations).) The full scope of the invention is not

Reply (Paper 19), 4.

the wireless communications industry.” See Prelim. Resp. 15–16. Thus, on the present record, we preliminarily agree with Petitioner that the ’430 patent’s field of endeavor is inductor design. See Prelim. Reply 1–2.

Institution Decision (Paper 10), 17

PO: “Inductor Design For Integrated Circuits”

ITC337-TA-1300. EX1051, ¶¶ 2, 37. It is erroneous to define the field of endeavor as efficient circuit design when the ’430 Patent’s specification focuses on inductor designs for integrated circuits. EX2002, ¶ 17-28; EX2009, ¶¶ 20, 22, 39.

PO Sur-reply (Paper 25), 7-8.

Specification Confirms Field of Endeavor is Inductor Design

As mentioned above, various embodiments of the invention provide an inductor design and method of implementing the same where mutual EM coupling is reduced. The inductor design and method serve to reduce the EM field at a certain distance from the inductor (i.e., the far field), at least in some directions, by using inductor shapes that are substantially symmetrical. As used herein, the term “symmetrical” refers to symmetry relative to at least one axis. This reduced far field may then be used to reduce the mutual coupling between two inductors. The inductor design and method may also be used to reduce the coupling between an inductor and another on-chip or external structure (e.g., an external power amplifier). This helps reduces the sensitivity of the VCO to interfering signals from other than a second on-chip VCO.

'430 Patent (INTEL-1001), 3:4-18

Further, although various embodiments of the invention are described herein mainly with respect to VCO-related isolation issues, RF amplifiers and mixers with tuned LC loads or inductive degeneration may also couple to each other or to a VCO and create interference problems. Thus, a person having ordinary skill in the art will appreciate that the inductor design and method may be used to reduce coupling between two functional blocks of any type so long as each contains one or more inductors.

'430 Patent (INTEL-1001), 3:32-40

The '430 patent teaches its designs and methods are broadly applicable

Field of endeavor is “not limited to the specific point of novelty, the narrowest possible conception of the field, or the particular focus within a given field.”

- *Unwired Planet LLC v. Google, Inc.*, 841 F.3d 995, 1001 (Fed. Cir. 2016).

Claims Confirm Field of Endeavor is Inductor Design

Independent Claim 1 and Disclaimed Claim 20 Not Limited to Inductor(s) for Integrated Circuits

1. An inductor layout having reduced mutual electromagnetic coupling, comprising:

- a first inductor having a reduced far field, said first inductor comprising:
 - a first loop having a shape that is substantially symmetrical about a first predefined axis;
 - a second loop connected to the first loop, said second loop having a size and shape substantially identical to the first loop, said second loop arranged such that a magnetic field emanating therefrom tends to cancel a magnetic field emanating from the first loop; and
- two closely spaced terminals connected to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and
- a second inductor positioned at a predetermined distance from the first inductor, wherein a mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

20. An inductor having a reduced far field, comprising:

- a first loop having a shape that is substantially symmetrical about a first predefined axis;
- a second loop having a size and shape substantially identical to the first loop, said second loop arranged such that a magnetic field emanating therefrom tends to cancel a magnetic field emanating from said first loop; and
- two closely spaced terminals connected to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals.

Claims Confirm Field of Endeavor is Inductor Design

Semiconductor Die Only Recited in Non-Limiting Way in Preamble of Claim 11

11. A method of reducing mutual electromagnetic coupling between a first inductor and a second inductor on a semiconductor die, comprising:

- forming the first inductor to reduce a far field, said step of forming the first inductor comprising:
 - forming a first loop having a shape that is substantially symmetrical about a first predefined axis;
 - forming a second loop having a size and shape substantially identical to the first loop;
 - orienting the second loop in relation to the first loop such that a magnetic field emanating from the second loop tends to cancel a magnetic field emanating from the first loop; and
 - connecting two closely spaced terminals to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and
- positioning a second inductor at a predetermined distance from the first inductor, wherein the mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

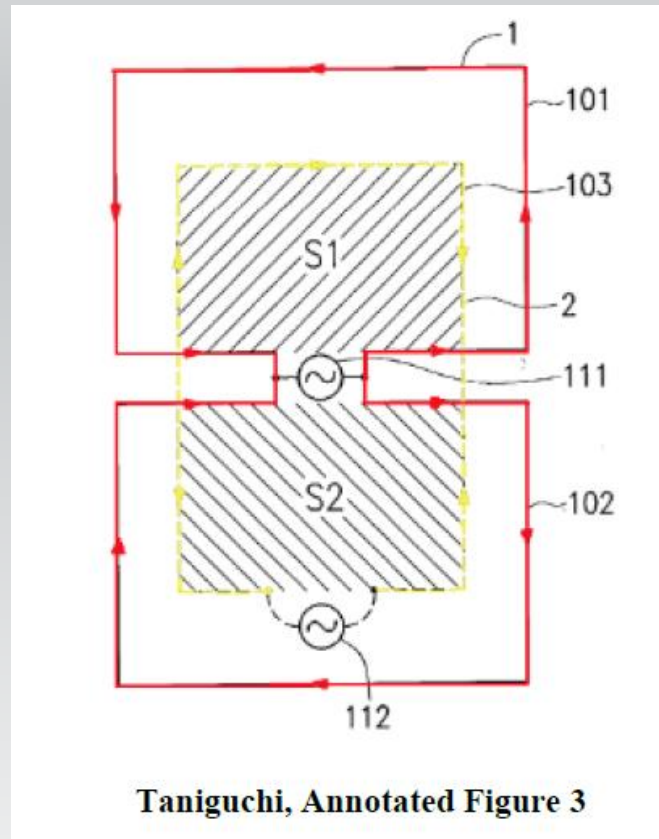
Claims Confirm Field of Endeavor is Inductor Design

Only One Dependent Claim Recites “Semiconductor Die” in Claim Body

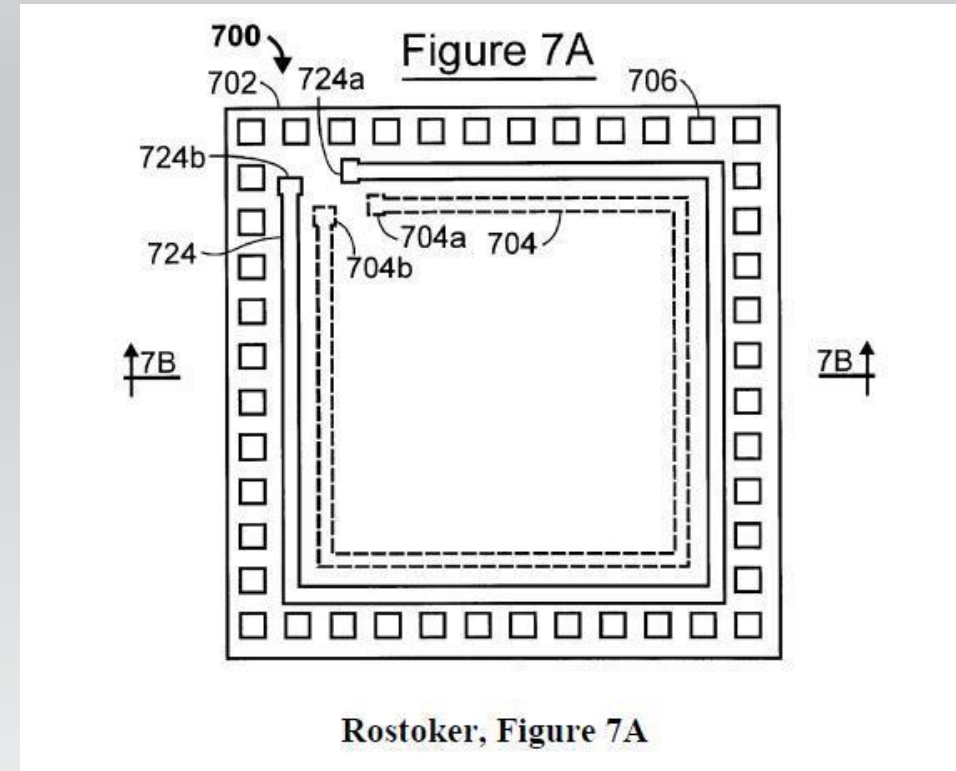
2. The inductor layout according to claim 1, wherein said first inductor and said second inductor are formed on a single semiconductor die.

Taniguchi and Rostoker Are In Same Field of Endeavor Because Loop Antennas Are Inductors

Taniguchi and Rostoker Describe Loop Antennas



INTEL-1005 (Taniguchi), Figure 3
(annotated).



INTEL-1006 (Rostoker), Figure 7A.

Taniguchi's Loop Antennas Are Inductors

[0015] The invention provides a radio guidance antenna comprising at least first and second antennas, which are different in electric supply method, and wherein the first antenna has at least two regions for generating lines of magnetic flux in reciprocal directions, and the second antenna has first and second mutual inductances for generating induced electromotive forces in opposite directions due to an action of electromagnetic induction from the first antenna, the second antenna being arranged so that the sum of mutual inductances between it and the first antenna is decreased.

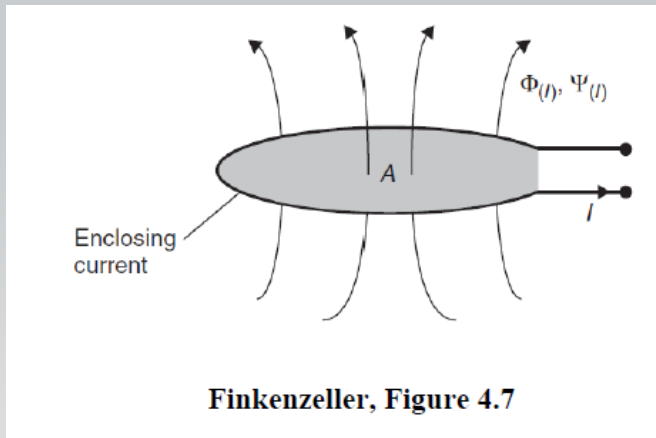
[0016] The coupling of the antennas is composed of inductive coupling with a slight mutual induction and electrostatic coupling, so that even when the antennas are arranged on parallel planes and a state of feeding electricity to a certain antenna is changed with time, it is possible to decrease influences on another antenna. That is, since electric power as supplied can be efficiently converted to electromagnetic field with a simple construction and a remote electromagnetic-field intensity can also be suppressed to be small, it is possible to realize a radio guidance antenna which is small, lightweight and excellent in quality of communication.

Taniguchi's antennas communicate with tags via inductive coupling

INTEL-1005 (Taniguchi), ¶¶15-16.

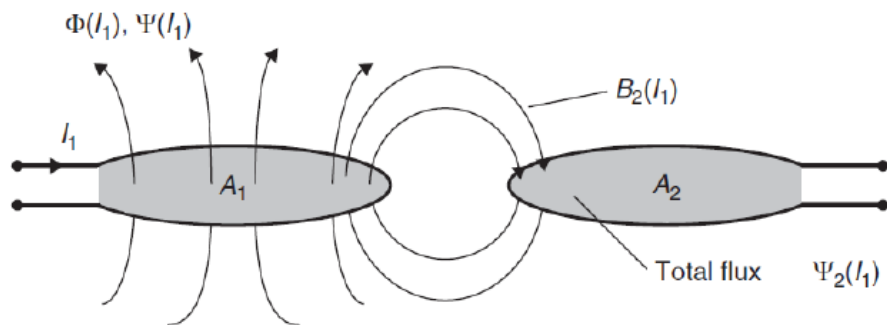
Finkenzeller Confirms Taniguchi's and Rostoker's Loop Antennas are Inductors

Finkenzeller's Antennas Use Magnetic Field of a Loop for Inductive Coupling



“A magnetic field, and thus a magnetic flux Φ , will be generated around a conductor of any shape. This will be particularly intense if the conductor is in the form of a loop (coil).”

-Finkenzeller, RFID Handbook (INTEL-1012), 67



“Mutual inductance describes the coupling of two circuits via the medium of a magnetic field.”

-Finkenzeller, RFID Handbook (INTEL-1012), 68

U.S. Patent 5,345,231 to Koo Refers to Antennas Used for Inductive Coupling as Inductors

fixed frequency. In other words, the **inductive antenna**, for frequency independence of signals received thereby, is formed exclusively by at least one coil (10a and 10b).

9. The contactless inductive data-transmission system defined in claim 1 wherein said means for generating of said sending-and-receiving station includes an oscillator for generating said given high frequency signal and said **inductor is an antenna** connected to said oscillator, said modulating means of said sending-and-receiving station including a modulator connected to a data processor for pulse width modulation of the signal produced by said oscillator.

INTEL-1022 (Koo); 7:7-9, claim 9.

Taniguchi and Rostoker's Loop Antennas Are Inductors

EM Field Created by Structure Is Not Dependent On Structure Being Labeled an Antenna or Inductor

The -- the antenna in Taniguchi is about 1,000 times larger than the inductors in -- in the '430. So, they both have the same physics in that there is a field produced. But the scale is such that what happens after that with the fields combining would be at much different distances.

**PO's Expert Agrees Inductors and Antennas
"Have the Same Physics"**

INTEL-1044 (Prucnal Dep. Tr.), 110:13-18.

Balanis Recognizes a Loop Antenna “is Primarily Inductive”

Balanis, “Antenna Theory: Analysis and Design” “small loop is primarily inductive”

5.1 INTRODUCTION

Another simple, inexpensive, and very versatile antenna type is the loop antenna. Loop antennas take many different forms such as a rectangle, square, triangle, ellipse, circle, and many other configurations. Because of the simplicity in analysis and construction, the circular loop is the most popular and has received the widest attention. It will be shown that a small loop (circular or square) is equivalent to an infinitesimal magnetic dipole whose axis is perpendicular to the plane of the loop. That is, the fields radiated by an electrically small circular or square loop are of the same mathematical form as those radiated by an infinitesimal magnetic dipole.

A small loop is primarily inductive, and it can be represented by a lumped element equivalent circuit similar to those of Figure 2.22.

INTEL-1045 (Balanis); 203, 214.

U.S. Patent 6,533,178 to Gaul Describes an Antenna Modeled as an Inductor

receiving device 5 and a transmitting device 4. Both the transmitting device 4 and the receiving device 5 are interconnected with the aid of an antenna 6. In the simplest case, the antenna 6 is an arbitrarily shaped conductor loop. Both

tors R, inductors L and capacitors C. The antenna 6 is modeled as an inductor L_F and a loss resistor R_{LF} . The

INTEL-1021 (Gaul), 6:55-58, 7:39-40.

USPTO Classification Recognized Loop Antennas as Inductors

336, Inductor Devices, appropriate subclasses, for inductor structure, per se, including coils and coil structure which may be used as loop antennas or in the coupling systems of antennas. See (12) Note, above.

27. Note. As between loop antennas and the inductor devices of Class 336, Inductor Devices, the claiming of an antenna by name only or structure peculiar to antennas together with inductor structure would classify the patent in this class (343), subclasses 700+, and particularly subclasses 866+. If the disclosure is a loop antenna, but the claims recite merely an inductor device, classification is in Class 336.

INTEL-1042; 13, 14.

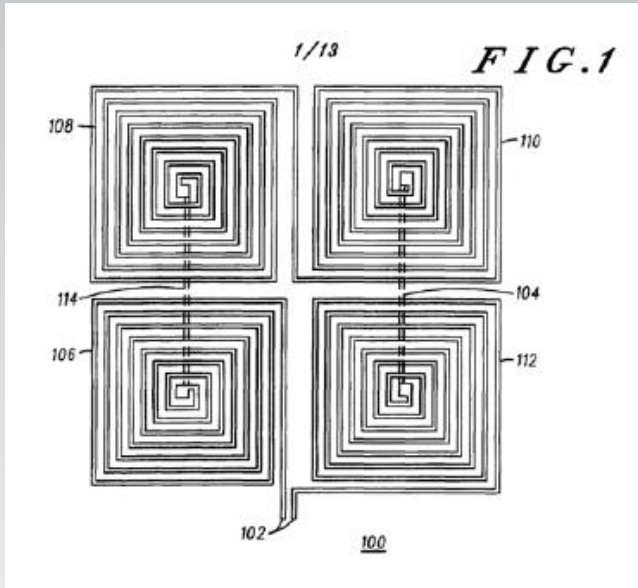
POR Adds Nothing to Indicate Error in Preliminary Determination

Similarly, although parts of Taniguchi describe an RFID system, on the current record, we are persuaded by Petitioner's arguments that a person of ordinary skill would understand Taniguchi's teachings to be applicable to the design of inductors generally. *See* Prelim. Reply 4–5. Among other things, on the present record, Petitioner sufficiently shows that the electromagnetic field created by a structure is not dependent upon it being labeled an antenna or an inductor. Prelim. Reply 2–3 (citing Ex. 1003

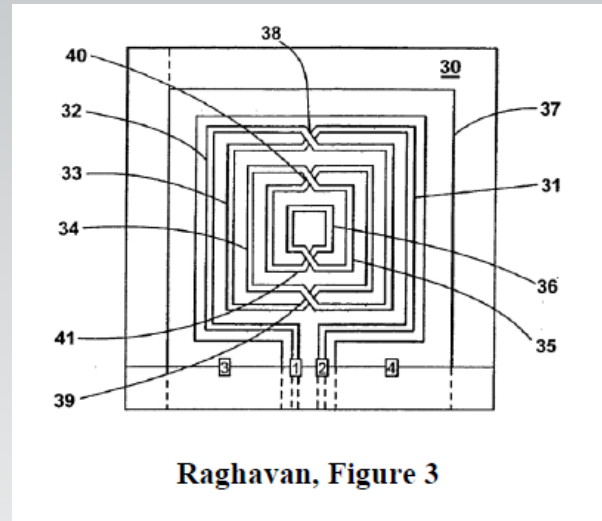
Midya, Raghavan, and Gardner Are Directed to Inductors

Midya, Raghavan, and Gardner's Inductors

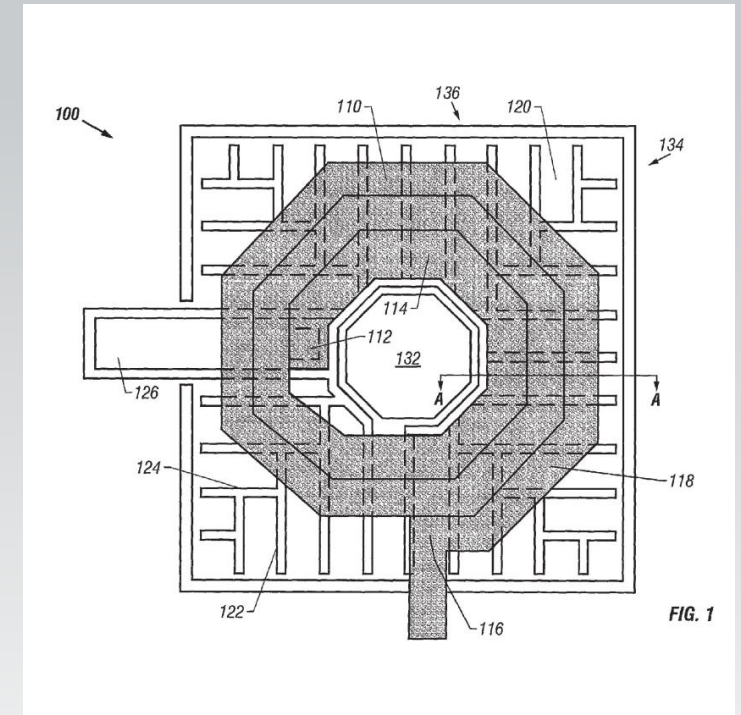
Midya discloses inductors on PCBs whereas Raghavan and Gardner (like the '430 patent) disclose inductors on ICs.



INTEL-1007 (Midya), Figure 1.



INTEL-1008 (Raghavan), Figure 3.



INTEL-1009 (Gardner), Figure 1.

'430 Patent Problem to Be Solved

Problem Addressed by the '430 Patent

Specification Addresses Problem of Efficiently Designing Circuits

Recent advances in wireless communication technology have allowed an entire RF transceiver to be implemented on a single semiconductor die or chip. However, integrating a complete RF transceiver on a single chip presents a number of challenges. For example, in wideband code division multiple access (WCDMA) transceivers, a single-chip solution requires two RF VCOs to be running on the chip at the same time. Such an arrangement may produce undesired interaction between the two VCOs due to various types of mutual coupling mechanisms, which may result in spurious receiver responses and unwanted frequencies in the transmit spectrum. The primary mutual coupling mechanism is usually the fundamental electromagnetic (EM) coupling between the resonators, i.e., the large inductor structures in the VCOs.

'430 Patent (INTEL-1001), 1:26-40.

As mentioned above, various embodiments of the invention provide an inductor design and method of implementing the same where mutual EM coupling is reduced. The inductor design and method serve to reduce the EM field at a certain distance from the inductor (i.e., the far field), at least in some directions, by using inductor shapes that are substantially symmetrical. As used herein, the term “symmetrical” refers to symmetry relative to at least one axis. This reduced far field may then be used to reduce the mutual coupling between two inductors. The inductor design and method may also be used to reduce the coupling between an inductor and another on-chip or external structure (e.g., an external power amplifier). This helps reduce the sensitivity of the VCO to interfering signals from other than a second on-chip VCO.

'430 Patent (INTEL-1001), 3:4-18.

Taniguchi is Reasonably Pertinent to Efficient Circuit Design

[0012] In this manner, it is very difficult to arrange a plurality of antennas in an overlapping manner and control them independently. Because of this, in the case of using a plurality of antennas, the antennas are conventionally arranged with particular distances therebetween so that mutual inductance between the antennas becomes small, but it becomes difficult to assure the stability of read and write regions.

[0014] Therefore, a primary object of the invention is to provide a radio guidance antenna in which the sum of mutual inductances of antennas is small and which is inexpensive and excellent in quality of communication, a data communication method, and a non-contact data communication apparatus which makes use of the antenna.

INTEL-1005 (Taniguchi), ¶¶[0012], [0014].

Taniguchi is Reasonably Pertinent to Efficient Circuit Design

[0022] According to these inventions, electric power as supplied can be efficiently converted to electromagnetic field with a radio guidance antenna for transmission and reception, and data communication is enabled in a communication area in non-contact manner even when a tag is oriented in any direction. Also, in these inventions, the radio guidance antenna is arranged on a substrate and the transmission means or receiver means is arranged on the substrate. **Thereby, it is possible to make a data communication apparatus which is small-sized, lightweight and high in performance.**

INTEL-1005 (Taniguchi), ¶[0022].

PO Mischaracterizes Petition

different field of endeavor than the '430 Patent. EX2002, ¶ 27. Taniguchi is not reasonably pertinent to the problem solved with the '430 Patent. *Id.*, ¶ 28.

Taniguchi focuses on solving the problem of too little mutual magnetic coupling between antennas for large, radio guidance antennas and tags for retail antitheft systems. *Id.*, ¶ 27-8. Taniguchi is not analogous to the '430 Patent, and it does not

POR (Paper 16), 28.

- **Petition relies on layout of Taniguchi's two reader antennas/inductors**
- **Taniguchi's reader antennas/inductors are designed for reduced EM coupling to permit close placement**

Claim Construction:
Claim 11's Preamble is Not Limiting as to
“on a Semiconductor Die”

Claim 11 Preamble is Not Limiting as to “Semiconductor Die”

11. A method of reducing mutual electromagnetic coupling between a first inductor and a second inductor on a **semiconductor die**, comprising:

forming the first inductor to reduce a far field, said step of forming the first inductor comprising:

forming a first loop having a shape that is substantially symmetrical about a first predefined axis;

forming a second loop having a size and shape substantially identical to the first loop;

orienting the second loop in relation to the first loop such that a magnetic field emanating from the second loop tends to cancel a magnetic field emanating from the first loop; and

connecting two closely spaced terminals to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

positioning a second inductor at a predetermined distance from the first inductor, wherein the mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

- **Does not provide an antecedent basis for any claim limitation.**
- **“Semiconductor die” is easily parsed from the preamble without impacting understandability or grammatical completeness.**
- **The claim body recites complete structure without “semiconductor die.”**
- **Does not recite essential structure or steps.**
- **“Semiconductor die” describes a purpose or intended use.**

“Semiconductor Die” Does Not Provide Antecedent Basis

11. A method of reducing mutual electromagnetic coupling between a first inductor and a second inductor on a semiconductor die, comprising:

forming the first inductor to reduce a far field, said step of forming the first inductor comprising:

forming a first loop having a shape that is substantially symmetrical about a first predefined axis;

forming a second loop having a size and shape substantially identical to the first loop;

orienting the second loop in relation to the first loop such that a magnetic field emanating from the second loop tends to cancel a magnetic field emanating from the first loop; and

connecting two closely spaced terminals to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

positioning a second inductor at a predetermined distance from the first inductor, wherein the mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

The preamble provides an antecedent basis for the “first inductor” but not “semiconductor die.” This is consistent with the ITC’s finding in the 1376 Investigation.

For the 273 patent, the preambles of claims 1, 7, and 12 provide antecedent basis for the term “transformer filter arrangement,” and for the 430 patent, the preamble of claim 11 provides antecedent basis for the term “first inductor.” It is not clear, however, that the preambles of these claims are otherwise limiting; for instance, it is not clear that the recitation of “on a semiconductor die” in claim 11 of the 430 patent is properly understood as a limitation, or that claims 1, 7, and 12 of the 273 patent are properly limited to “radio communication” devices. And it is entirely unclear why the preamble of claim 1 of the 430 patent is limiting.

INTEL-1019, 2.

“Semiconductor Die” Is Readily Parsed

11. A method of reducing mutual electromagnetic coupling between a first inductor and a second inductor **on a semiconductor die**, comprising:

forming the first inductor to reduce a far field, said step of forming the first inductor comprising:

forming a first loop having a shape that is substantially symmetrical about a first predefined axis;

forming a second loop having a size and shape substantially identical to the first loop;

orienting the second loop in relation to the first loop such that a magnetic field emanating from the second loop tends to cancel a magnetic field emanating from the first loop; and

connecting two closely spaced terminals to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

positioning a second inductor at a predetermined distance from the first inductor, wherein the mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

“Semiconductor die” can be parsed from the preamble without impacting the understandability or completeness of the claim.

Claim 1 Confirms “Semiconductor Die” is Easily Parsed

Claim 11

11. A method of reducing mutual electromagnetic coupling between a first inductor and a second inductor on a semiconductor die, comprising:

- forming the first inductor to reduce a far field, said step of forming the first inductor comprising:
 - forming a first loop having a shape that is substantially symmetrical about a first predefined axis;
 - forming a second loop having a size and shape substantially identical to the first loop;
- orienting the second loop in relation to the first loop such that a magnetic field emanating from the second loop tends to cancel a magnetic field emanating from the first loop; and
- connecting two closely spaced terminals to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

positioning a second inductor at a predetermined distance from the first inductor, wherein the mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

Claim 1

1. An inductor layout having reduced mutual electromagnetic coupling, comprising:

- a first inductor having a reduced far field, said first inductor comprising:
 - a first loop having a shape that is substantially symmetrical about a first predefined axis;
 - a second loop connected to the first loop, said second loop having a size and shape substantially identical to the first loop, said second loop arranged such that a magnetic field emanating therefrom tends to cancel a magnetic field emanating from the first loop; and
 - two closely spaced terminals connected to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and
- a second inductor positioned at a predetermined distance from the first inductor, wherein a mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

“Semiconductor Die” Does Not Recite Essential Structure or Steps

Essential
Structure

Not limiting

11. A method of reducing mutual electromagnetic coupling between a first inductor and a second inductor on a semiconductor die, comprising:

forming the first inductor to reduce a far field, said step of forming the first inductor comprising:

forming a first loop having a shape that is substantially symmetrical about a first predefined axis;

forming a second loop having a size and shape substantially identical to the first loop;

orienting the second loop in relation to the first loop such that a magnetic field emanating from the second loop tends to cancel a magnetic field emanating from the first loop; and

connecting two closely spaced terminals to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

positioning a second inductor at a predetermined distance from the first inductor, wherein the mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

1. A method for generating and updating data for use in a destination tracking system of at least one mobile unit comprising:

generating and storing traveled distance data in at least one storage device provided in said mobile unit at least at predetermined time intervals, wherein the traveled distance data represent traveled sections by at least a series of nodes P_i and to each node P_i geographical coordinates x_i and y_i are assigned;

generating and storing section data in the storage device provided in the mobile unit, said section data being generated by selecting, from the traveled distance data, nodes P_j and P_k , which define contiguous sections P_jP_k , to which at least their geographical starting point and end point are assigned; and

generating a section data file from the section data and storing the section data file in the storage device provided in the mobile unit, said section data file being continuously supplemented and/or updated with section data newly generated by the mobile unit.

Antecedent
basis

TomTom, Inc. v. Adolph, 790 F.3d 1315, 1317, 1322-23 (Fed. Cir. 2015).

'430 Patent's Methods Not Limited to Inductors on Semiconductor Dies, Which is Merely an Intended Use

As mentioned above, various embodiments of the invention provide an inductor design and method of implementing the same where mutual EM coupling is reduced. The inductor design and method serve to reduce the EM field at a certain distance from the inductor (i.e., the far field), at least in some directions, by using inductor shapes that are substantially symmetrical. As used herein, the term “symmetrical” refers to symmetry relative to at least one axis. This reduced far field may then be used to reduce the mutual coupling between two inductors. The inductor design and method may also be used to reduce the coupling between an inductor and another on-chip or external structure (e.g., an external power amplifier). This helps reduce the sensitivity of the VCO to interfering signals from other than a second on-chip VCO.

'430 Patent (INTEL-1001), 3:4-18

Further, although various embodiments of the invention are described herein mainly with respect to VCO-related isolation issues, RF amplifiers and mixers with tuned LC loads or inductive degeneration may also couple to each other or to a VCO and create interference problems. Thus, a person having ordinary skill in the art will appreciate that the inductor design and method may be used to reduce coupling between two functional blocks of any type so long as each contains one or more inductors.

'430 Patent (INTEL-1001), 3:32-40

The '430 patent teaches its methods are broadly applicable.

PO Broadened Claim 11 During Prosecution

11. A method of reducing mutual electromagnetic coupling between two inductors on a semiconductor die, comprising:

forming a first inductor on said semiconductor die having a shape that is substantially symmetrical about a first predefined axis, said shape causing said first inductor to have a reduced far field, at least in some directions; and

forming a second inductor on said semiconductor die at a predetermined distance from said first inductor, wherein a mutual electromagnetic coupling between said first inductor and said second inductor is reduced as a result of said first inductor having a reduced far field.

INTEL-1002, 23.

26. (New) A method of reducing mutual electromagnetic coupling between a first inductor and a second inductor on a semiconductor die, comprising:

forming the first inductor to reduce a far field, said step of forming the first inductor comprising:

forming a first loop having a shape that is substantially symmetrical about a first predefined axis;

forming a second loop having a size and shape substantially identical to the first loop;

orienting the second loop in relation to the first loop such that a magnetic field emanating from the second loop tends to cancel a magnetic field emanating from the first loop; and

connecting two closely spaced terminals to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

positioning a second inductor at a predetermined distance from the first inductor, wherein the mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

INTEL-1002, 72.

PO's Case Law is Distinguishable

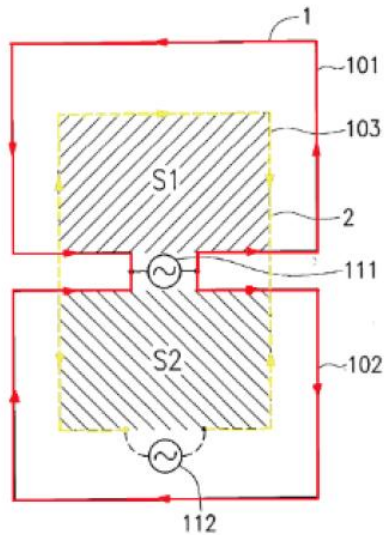
Case	Federal Circuit Guideposts	
<i>In re Fought</i> , 941 F.3d 1175, 1178-79 (Fed. Cir. 2019)	“[A] preamble [is] limiting when it serves as <u>antecedent basis</u> for a term appearing in the body of a claim.” “[A] ‘travel trailer’ is a <u>specific type of recreational vehicle</u> and [] this term is a <u>structural limitation</u> of the claims.”	No antecedent basis Not a structural limitation
<i>Deere & Co. v. Bush Hog, LLC</i> , 703 F.3d 1349, 1357-58 (Fed. Cir. 2012)	“[I]f the body of the claim describes a <u>structurally complete invention</u>, a preamble is not limiting where it <u>merely gives a name to the invention, extols its features or benefits, or describes a use for the invention.</u>”	Structurally complete Merely describes a use
<i>Invitrogen Corp. v. Biocrest Mfg., L.P.</i> , 327 F.3d 1364, 1366 (Fed. Cir. 2003)	“[C]lear reliance on the preamble during prosecution to <u>distinguish the claimed invention from the prior art</u> transforms the preamble into a claim limitation because such reliance indicates use of the preamble to define, in part, the claimed invention.”	Applicant did not distinguish over prior art

Petitioner's Grounds

**Taniguchi Renders Claims 1, 3-5, 7, and 10
Obvious**

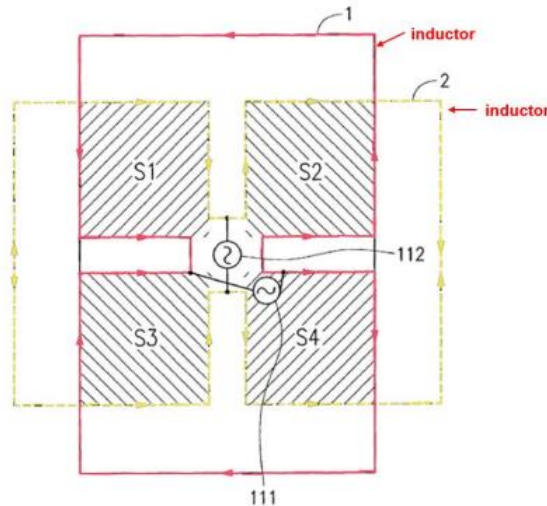
**Taniguchi Renders Claims 11, 13-15, 17 and 19
Obvious if Claim 11's Preamble Not Limiting**

Taniguchi's Antenna/Inductor Layout



Taniguchi, Annotated Figure 3

Lower Feeding Point/Same Plane O-Shaped Antenna 2 Embodiments

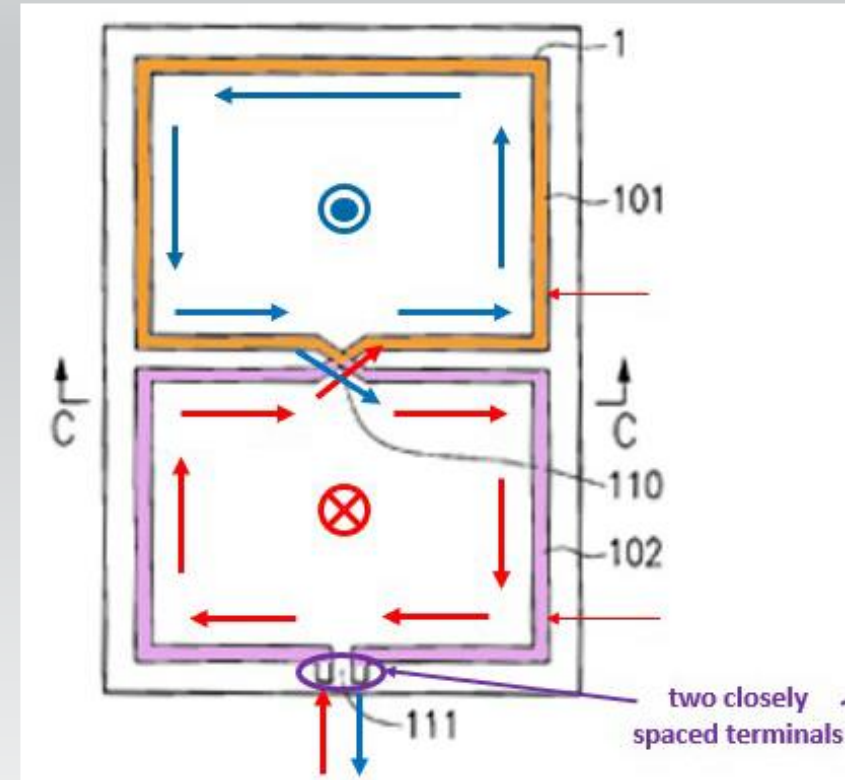


Taniguchi, Annotated Figure 9

Rotated Eight-Shaped Antenna 2

1. An inductor layout having reduced mutual electromagnetic coupling, comprising:
 - a first inductor having a reduced far field, said first inductor comprising:
 - a first loop having a shape that is substantially symmetrical about a first predefined axis;
 - a second loop connected to the first loop, said second loop having a size and shape substantially identical to the first loop, said second loop arranged such that a magnetic field emanating therefrom tends to cancel a magnetic field emanating from the first loop; and
 - two closely spaced terminals connected to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and
 - a second inductor positioned at a predetermined distance from the first inductor, wherein a mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

Eight-Shaped Antenna 1



INTEL-1005 (Taniguchi), Figure 8B (annotated).

PO's Arguments Against Taniguchi Lack Merit

- Taniguchi discloses “reduce[d] far field” and “reduced electromagnetic field” limitations of claims 1 and 11
- Taniguchi discloses “reducing mutual electromagnetic coupling” [11P]
- Taniguchi discloses its first antenna/inductor is positioned at a predetermined distance from the second antenna/inductor
- Taniguchi discloses “closely spaced terminals”

“Reduced Far Field”/“Reduced Electromagnetic Field”/ “Reduced Electromagnetic Coupling” Limitations

1. An inductor layout having reduced mutual electromagnetic coupling, comprising:

a first inductor having a reduced far field, said first inductor comprising:

a first loop having a shape that is substantially symmetrical about a first predefined axis;

a second loop connected to the first loop, said second loop having a size and shape substantially identical to the first loop, said second loop arranged such that a magnetic field emanating therefrom tends to cancel a magnetic field emanating from the first loop; and two closely spaced terminals connected to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

a second inductor positioned at a predetermined distance from the first inductor, wherein a mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

**Subject Matter
of Disclaimed
Claim 20**

11. A method of reducing mutual electromagnetic coupling between a first inductor and a second inductor on a semiconductor die, comprising:

forming the first inductor to reduce a far field, said step of

forming the first inductor comprising:

forming a first loop having a shape that is substantially symmetrical about a first predefined axis;

forming a second loop having a size and shape substantially identical to the first loop;

orienting the second loop in relation to the first loop such that a magnetic field emanating from the second loop tends to cancel a magnetic field emanating from the first loop; and

connecting two closely spaced terminals to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

positioning a second inductor at a predetermined distance from the first inductor, wherein the mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

'430 Specification Disclosures Regarding “Reduced Far Field”/“Reduced Electromagnetic Field”/ “Reduced Electromagnetic Coupling”

structure with an upper loop **206a** and a lower loop **206b**. By virtue of the figure-8 shape, current in the upper loop **206a** travels in a direction (e.g., counterclockwise, see arrows) that is opposite to current in the lower loop **206b** (e.g., clockwise). As a result, the EM field components emanating at a certain distance from the two substantially symmetrical loops **206a** and **206b** also have opposite directions and tend to counteract each other. The directions of the EM field components are indicated by conventional notation in the middle of each loop **206a** and **206b**. Consequently, the inductor **200** has been found to have a significantly reduced far field at a certain distance from the inductor coil **202**.

'430 Patent (INTEL-1001), 4:10-21.

Choosing a substantially symmetrical shape (e.g., a figure-8 or a four-leaf clover shape) for the first inductor helps reduce the EM field at far distances. This will, in turn, reduce mutual EM coupling to the second inductor, regardless of its shape. If the second inductor also has a similar or substantially identical shape, the tendency of the second inductor to pick up the EM field from the first inductor is also reduced via the same mechanisms. Thus, the overall isolation between the two inductors is further improved. Note, however, that the two inductors need not have the same size or the same shape as long as they have a substantially symmetrical shape. To the extent identical inductor layouts are shown in the figures, it is for illustrative purposes only.

'430 Patent (INTEL-1001), 3:19-31.

410a & **410b**, respectively. Each individual inductor **400** and **402** has a reduced far field by virtue of the 8-shaped inductor coil **404** and **406**, as explained above with respect to FIG. 2. In addition, there is also a reduction in the mutual coupling between the two inductors **400** and **402**. This is because the same mechanism that causes the radiated EM field from the first inductor to be reduced also causes the “EM field receive sensitivity” of the second inductor to be reduced. Thus, the combined effect of the two inductors upon each other provides the desired coupling reduction.

'430 Patent (INTEL-1001), 5:4-13.

Applicant Foreign Prosecution History Statements Regarding “Reduced Far Field”/“Reduced Electromagnetic Field”/ “Reduced Electromagnetic Coupling”

Item B

The applicant respectfully disagrees with the Examiner’s assessment under item B. The reduction of electromagnetic coupling between the first and the second inductor (compared with two O-shaped inductors) is a technical effect of the shape of the first inductor. Although the distance between the inductors has an influence on the total amount of coupling (see e.g. Fig. 6), it is still significantly reduced compared with two O-shaped inductors at the same distance. Hence, no particular distance between the two inductors is mandated in the description. Furthermore, it is clear from the description that the two inductors may be rotated and/or offset relative to one another, see e.g. page 2, lines 16-17, and tables 1-3. Hence, it is submitted that the root parent application as filed does not mandate any particular distance or relative orientation of the two inductors. (The same goes for the two divisional applications).

INTEL-1016 (EP Prosecution), 59.

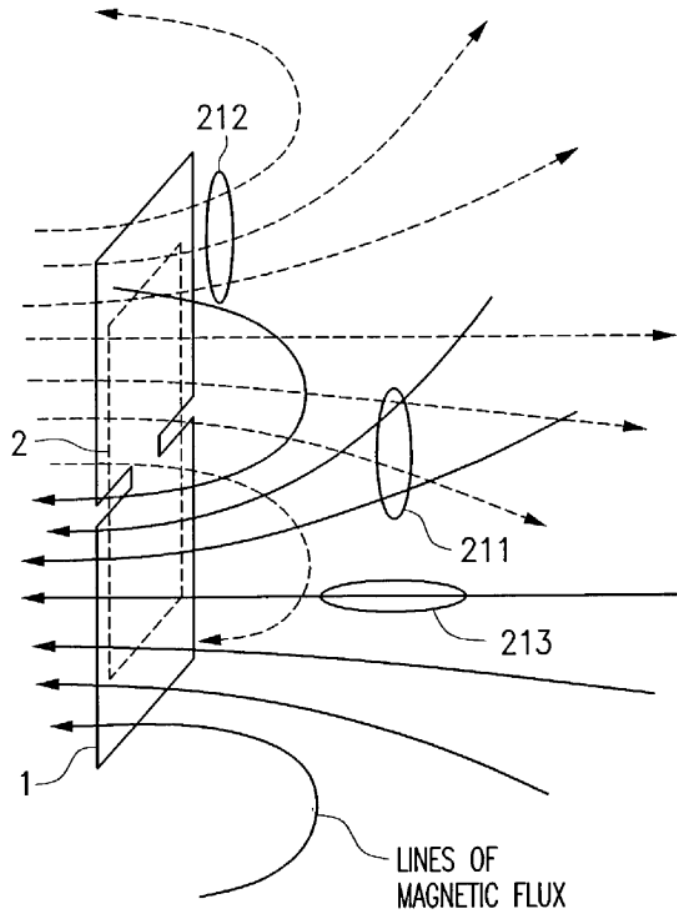
ITC-337-TA-1300 Constructions for “Reduced Far Field” and “Reduced Electromagnetic Coupling”

Claim Term

Adopted Construction

“a first inductor having a reduced far field” (claim 1)	“(reduced/reduce) the electromagnetic field at a certain distance from the first inductor (where the second inductor is positioned)”
“forming the first inductor to reduce a far field” (claim 11)	
“reduced electromagnetic field” (claims 1 and 11)	Plain and ordinary meaning applies, which is “the electromagnetic field emanating from the first inductor is reduced (at a certain distance from the first inductor where the second inductor is positioned)”

Taniguchi Discloses “Reduced Far Field”/ “Reduced Electromagnetic Field” To Extent Described in '430 Patent and Under ITC Construction



INTEL-1005 (Taniguchi), Figure 4.

[0064] In FIG. 4, lines of magnetic flux indicated by solid lines are ones generated from a lower loop among two upper and lower loops of the antenna 1, and lines of magnetic flux indicated by broken lines are ones generated from the upper loop. The lines of magnetic flux indicated by solid lines and the lines of magnetic flux indicated by broken lines, which are substantially the same in number, make interlinkage with a tag 211, and the lines of magnetic flux indicated by solid lines and the lines of magnetic flux indicated by broken lines, which make such interlinkage, are equal in magnitude to each other and directed opposite to each other all the time.

Therefore, the induced electromotive force generated on the tag **211** becomes substantially zero and so the tag **211** has difficulty remaining in continual communication with the antenna **1**. Also, a second tag **213** is positioned to be perpendicular to the lower loop, and so no lines of magnetic flux indicated by solid lines make interlinkage with this tag. Only lines of magnetic flux indicated by broken lines and having an exceedingly small intensity (not shown) make interlinkage with the tag **213** difficult, which in turn impedes communication. A third tag **212** makes interlinkage with many lines of magnetic flux indicated by broken lines and is shown as being in a state in which it can favorably make communication with the antenna **1**.

INTEL-1005 (Taniguchi), ¶[0064].

By virtue of its figure-8-shape, the EM field components emanating from the substantially symmetrical loops Taniguchi's antenna/inductor 1 are equal and opposite and counteract each other

Taniguchi Discloses “Reduced Far Field”/ “Reduced Electromagnetic Field” To Extent Described in ’430 Patent and Under ITC Construction

[0055] FIG. 3 is a view showing a preferred embodiment of the antennas 1 and 2 shown in FIG. 1. In FIG. 3, the first antenna 1 is provided by forming antenna conductors 101, 102 in a substantially figure eight shape, which reduces a remote electromagnetic-field effect. The first antenna 1 is divided into upper and lower halves by the antenna conductors 101, 102. Meanwhile, the second antenna 2 is composed of an antenna conductor 103 formed on the same plane as or a plane parallel to the plane on which the first antenna 1 is formed, but is not connected to the first antenna 1 at any point. The second antenna 2 is coupled in electromagnetic induction to the upper and lower halves of the first antenna 1 via regions S1, S2.

[0059] More specifically, even when one of the antennas is varied in impedance and a power feeding state, the other antenna is influenced thereby not to be varied in impedance and antenna current. In this way, electric power supplied to the antennas can be converted to an electromagnetic field with high efficiency and a plurality of antennas can be installed, while the remote electromagnetic-field intensity is also controlled at an exceedingly low level.

INTEL-1005 (Taniguchi), ¶¶[0055], [0057].

By virtue of its figure-8-shape, Taniguchi’s antenna/inductor 1 has reduced electromagnetic field

[0094] As described above, an intense magnetic field can be generated with the same supply of electric power. Also, since all the electric power is supplied to the substantially figure eight-shaped antenna, the current flowing to the two loops defining the 8-shape is well balanced. That is, the remote electromagnetic-field intensity is much suppressed by the figure eight-shaped antenna, thus enabling an ideal radio guidance antenna capable of lessening an effect of interfering electromagnetic waves on other equipment.

[0095] As described above, according to the invention, the first antenna has at least two regions for generating lines of magnetic flux in reciprocal directions, and the second antenna has first and second mutual inductances for generating induced electromotive forces in opposite directions due to an action of electromagnetic induction from the first antenna, the second antenna being arranged to decrease the sum of mutual inductances between it and the first antenna. Doing so enables electric power to be efficiently converted to electromagnetic field with a simple construction and a remote electromagnetic-field intensity can also be suppressed to be small, so that it is possible to realize a radio guidance antenna, which is small-sized, lightweight and excellent in quality of communication.

INTEL-1005 (Taniguchi), ¶¶[0094], [0095].

No Dispute Between Experts that 8-Shaped Structure Has Reduced Electromagnetic Field Away From Structure

PO's Expert, Dr. Prucnal:

A Yeah. Well, again, the bottom line here, the significance of this inductor shape, is that with the figure 8, the figure 8 has a -- has two loops with counter-propagating currents, one clockwise and the other counterclockwise. And I have discussed, that creates magnetic fields in opposite directions, ultimately which can cancel.

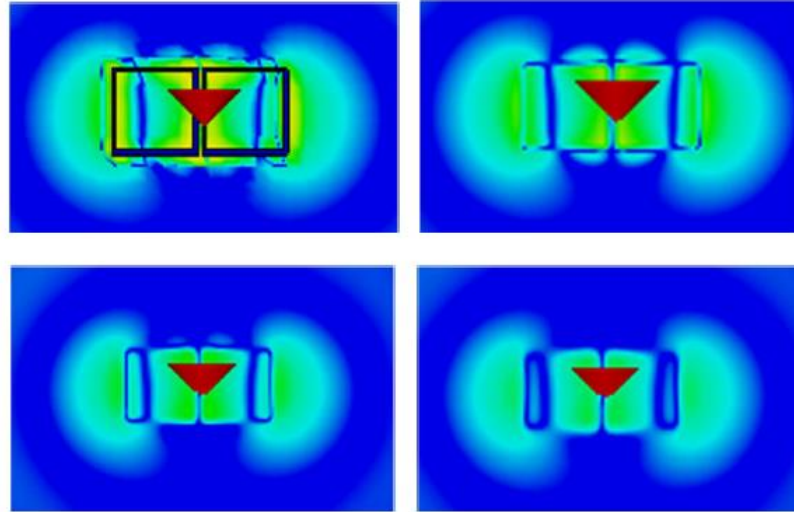
INTEL-1044, 53:19-54:3.

Petitioner's Expert, Dr. Tentzeris:

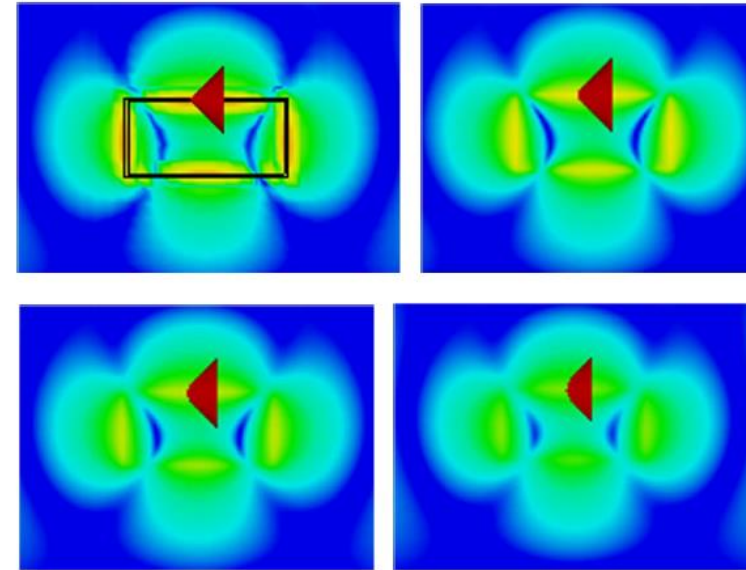
53, 4:3-11, 4:22-28, 6:19-27.) That is, conductor 101 ("*second loop*") is oriented or arranged relative to conductor 102 ("*first loop*") to form a figure-eight shape so that the current in conductor 101 flows in an opposite direction than the current in conductor 102 which results in the magnetic field from the second loop "tend[ing] to cancel" the magnetic field emanating from the first loop. (INTEL-1005, ¶¶55-57, 63-64, Figure 3 (showing current flow through conductors 101, 102).)

INTEL-1003, ¶116.

Simulations Counter PO's Argument and Confirm that 8-Shaped Structure Has Reduced Electromagnetic Field Away From Structure



Magnetic Field Measured in Plane of 8-Shaped Loop (top left) and Above Loop: 1X (top right), 2X (bottom left) and 3X (bottom right) Substrate Thickness



Magnetic Field Measured in the Plane of the Rectangular Conducting Loop (left) and Above the Conducting Loop: 1X (top right), 2X (bottom left) and 3X (bottom right) Substrate Thickness

Simulations confirm the magnetic field of an eight-shaped antenna/inductor is vertically and laterally constrained as compared with a rectangular antenna/inductor.

Taniguchi discloses “Reduced Far Field” Under the ITC’s Construction

- In the Figure 8 and rotated 9/10 embodiments, antenna/inductor 2 is on the opposite side of the insulation from antenna/inductor 1—a certain distance away.
- In the Figure 7 embodiment, antenna/inductor 2 is within and concentric with antenna/inductor 1 such that each side of antenna 2 is a certain distance from each side of antenna/inductor 1.
- The 8-shaped antenna/inductor has a reduced field in locations away from the antenna/inductor in all directions.

“Predetermined Distance”/ “Reduced EM Coupling” Limitations

1. An inductor layout having reduced mutual electromagnetic coupling, comprising:

- a first inductor having a reduced far field, said first inductor comprising:

- a first loop having a shape that is substantially symmetrical about a first predefined axis;

- a second loop connected to the first loop, said second loop having a size and shape substantially identical to the first loop, said second loop arranged such that a magnetic field emanating therefrom tends to cancel a magnetic field emanating from the first loop; and
- two closely spaced terminals connected to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

- a second inductor positioned at a predetermined distance from the first inductor, wherein a mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

11. A method of reducing mutual electromagnetic coupling between a first inductor and a second inductor on a semiconductor die, comprising:

- forming the first inductor to reduce a far field, said step of forming the first inductor comprising:

- forming a first loop having a shape that is substantially symmetrical about a first predefined axis;

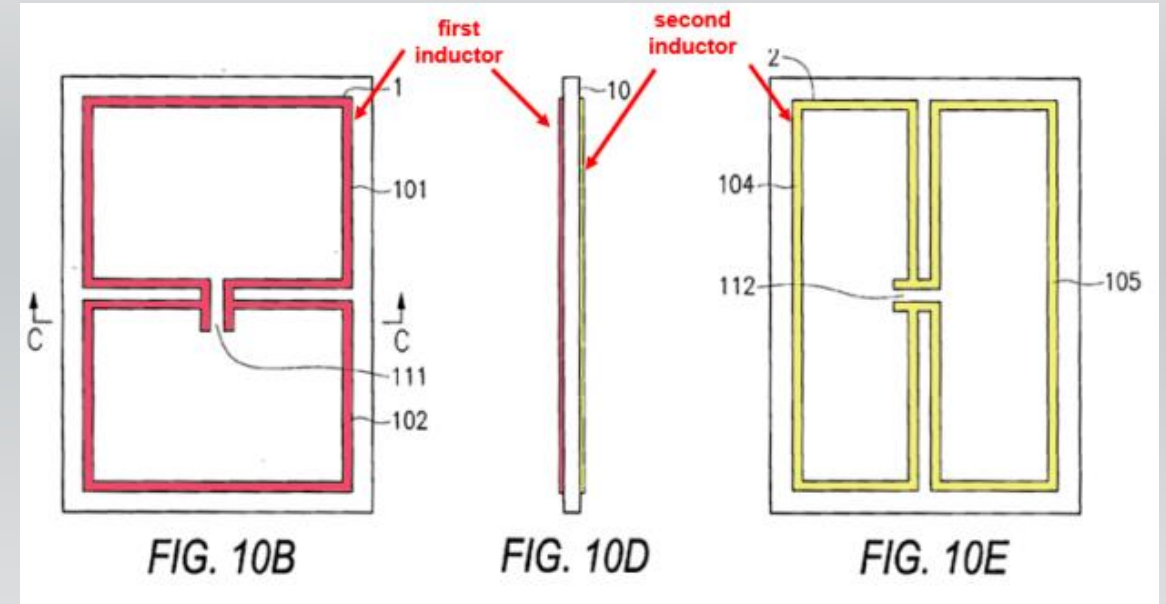
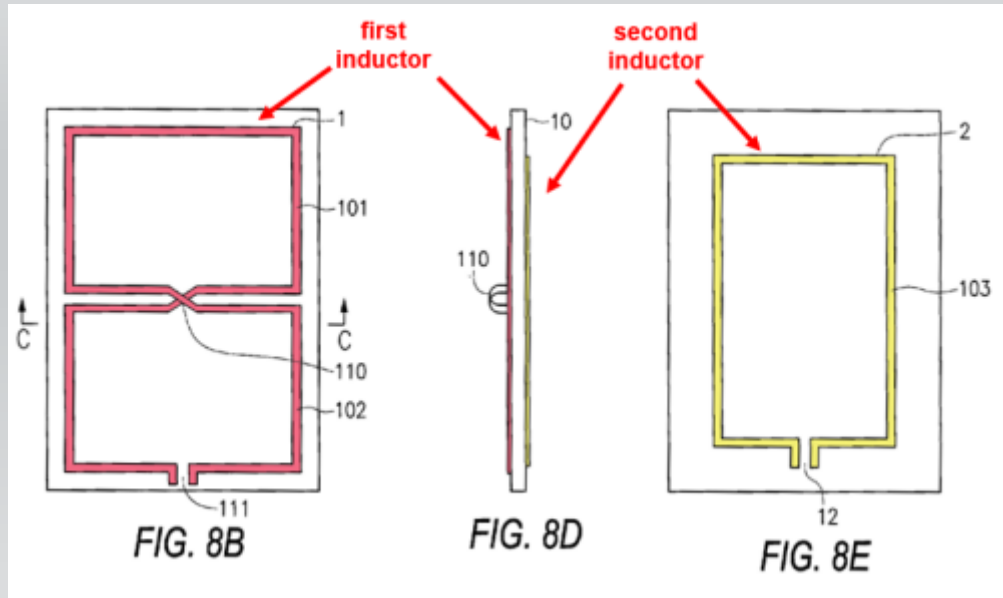
- forming a second loop having a size and shape substantially identical to the first loop;

- orienting the second loop in relation to the first loop such that a magnetic field emanating from the second loop tends to cancel a magnetic field emanating from the first loop; and

- connecting two closely spaced terminals to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

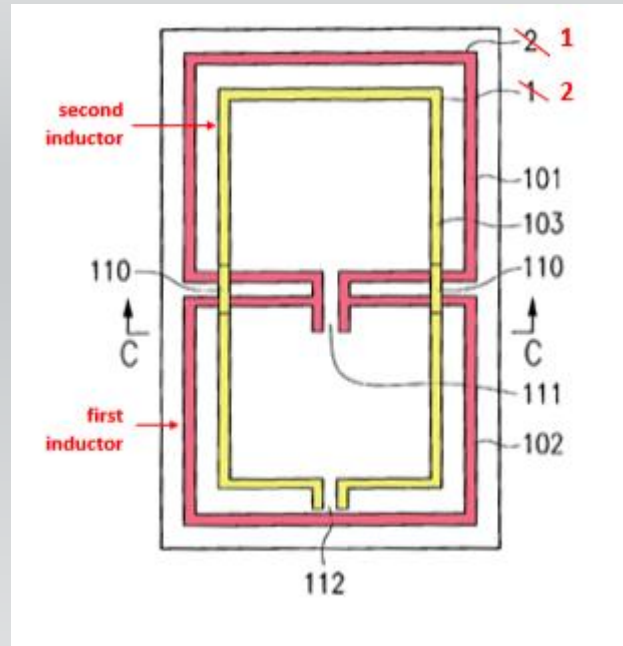
- positioning a second inductor at a predetermined distance from the first inductor, wherein the mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

Taniguchi's Antennas/Inductors are Positioned At Predetermined Distance From Each Other



- Antenna/Inductor 2 in Figure 8/10 embodiment is positioned at a distance equal to the thickness of insulation 10
- Consistent with PO's statement during EP prosecution: "it is submitted that the root parent application as filed does not mandate any particular distance or relative orientation of the two inductors" (INTEL-1016, 59)

Taniguchi's Antennas/Inductors are Positioned At Predetermined Distance From Each Other



- Each side of antenna/inductor 2 in Figure 7 embodiment is positioned at same fixed distance from corresponding side of antenna/inductor 1
- Consistent with PO's statement during EP prosecution: "it is submitted that the root parent application as filed does not mandate any particular distance or relative orientation of the two inductors" (INTEL-1016, 59)

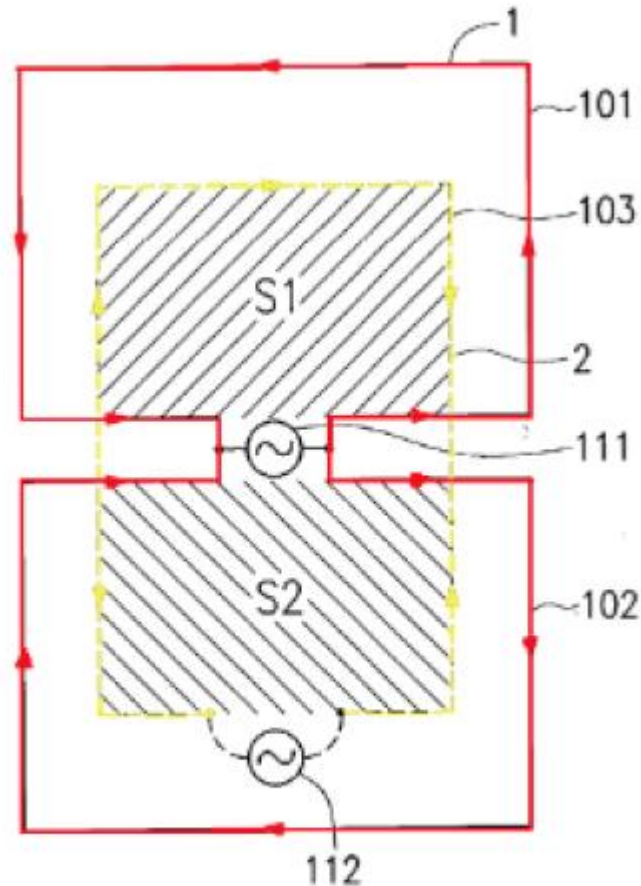
Patent Owner Misconstrues “Predetermined Distance”

Figs. 4-5, 6, 8, and 12 of the '430 Patent show the first and second inductors on a semiconductor die are “positioned at a predetermined distance from” each other, *i.e.*, the “center distance” between the two inductors is far enough away to reduce the electromagnetic coupling between them. EX1001, FIG. 6, FIG. 8, FIG. 12, 6:60-61, 7:20-21, 9:3-5 & EX2002, ¶ 50-51. The two inductors need not have the same size or shape as long as they are substantially symmetrical. EX1001, 3:27-31. The horizontal and vertical axes X and Y in Fig. 4 (below) and the electromagnetic data shown in Figures 6, 8, and 12 show a major factor in reducing the EM interference between the two inductors is the lateral distance between the X, Y center points of the two inductors (the “center distance” in Figs. 6, 8, & 12).

PO incorrectly argues predetermined distance is a “lateral distance between X, Y center points of the two inductors”

- **claims are not so limiting**
- **no support in specification**
- **PO's cites are to simulations of exemplary layouts which are not limiting**
- **Inconsistent with statements made during EP prosecution regarding specification**

Taniguchi's Antenna/Inductor Layout Has Reduced EM Coupling



Taniguchi, Annotated Figure 3

[0057] As shown in FIG. 3, the directions of induced electromotive forces generated on the antenna 2 are such that induced current is caused to flow in the regions S1, S2 in opposite directions. That is, induced electromotive forces generated in the regions S1, S2, respectively, are generated in the direction in which the forces cancel each other. Here, in particular, in the case of $S1/S2=1$ ($S1=S2$), the induced electromotive force generated on the antenna 2 as a whole becomes zero. That is, residual mutual inductances of the antenna 1 and the antenna 2 are put in a state of zero.

INTEL-1005, [0057], Fig. 3.

By virtue of its figure-8-shape, Taniguchi's antenna/inductor 1 has reduced far field which necessarily results in magnetic coupling of the field with second antenna/inductor to be reduced

PO Admits Taniguchi Teaches Reduced Mutual EM Coupling

Taniguchi teaches a reduced inductance coupling between first antenna 1 and second antenna 2 only when first and second antennas are positioned concentrically. EX1005, FIG. 3, FIGS. 8A – 8E, & [0057]-[0058], EX1003, ¶ 107, 163.

6-10, 12, [0057], [0058], [0061] & claims 1 and 8-10. Taniguchi teaches this complete overlap is the only way for antennas 1 and 2 to be in close proximity without EM coupling with each other. *Id.* ¶¶ 52, 69. Taniguchi's Fig. 4 (below)

“closely spaced terminals” limitations

1. An inductor layout having reduced mutual electromagnetic coupling, comprising:

a first inductor having a reduced far field, said first inductor comprising:
a first loop having a shape that is substantially symmetrical about a first predefined axis;
a second loop connected to the first loop, said second loop having a size and shape substantially identical to the first loop, said second loop arranged such that a magnetic field emanating therefrom tends to cancel a magnetic field emanating from the first loop; and
two closely spaced terminals connected to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

a second inductor positioned at a predetermined distance from the first inductor, wherein a mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

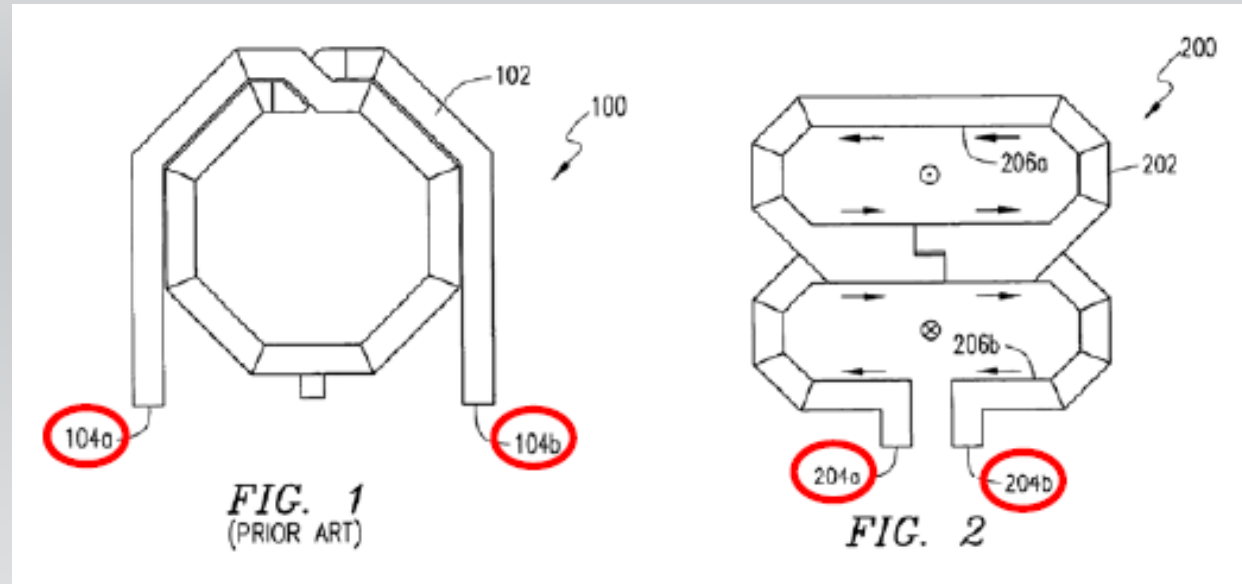
**Subject Matter
of Disclaimed
Claim 20**

11. A method of reducing mutual electromagnetic coupling between a first inductor and a second inductor on a semiconductor die, comprising:

forming the first inductor to reduce a far field, said step of forming the first inductor comprising:
forming a first loop having a shape that is substantially symmetrical about a first predefined axis;
forming a second loop having a size and shape substantially identical to the first loop;
orienting the second loop in relation to the first loop such that a magnetic field emanating from the second loop tends to cancel a magnetic field emanating from the first loop; and
connecting two closely spaced terminals to the first loop for supplying electrical current to the first and second loops while minimizing magnetic field contributions from the terminals; and

positioning a second inductor at a predetermined distance from the first inductor, wherein the mutual electromagnetic coupling between the first inductor and the second inductor is reduced as a result of the first inductor having a reduced electromagnetic field.

'430 Specification Disclosures Regarding “Closely Spaced Terminals”



'430 Patent (INTEL-1001), Figs. 1 & 2 (annotated).

In addition, the positioning of the terminals 204a and 204b may help minimize the far field. For example, positioning the two terminals 204a and 204b as close to each other as possible helps make the field contributions from the two parts of the inductor 200 identical. It is also desirable to

'430 Patent (INTEL-1001), 4:28-32.

PO's Statement During JP Prosecution Regarding “Closely Spaced Terminals”

Furthermore, cited document 2 discloses a configuration wherein each winding has an "8" shape, flows a current in the same direction, and has three intersecting conductors that are provided between two loops, as a resolution method for reducing magnetic field components generated on an outside of a winding loop, but contains no suggestion whatsoever regarding suppressing a far field by the positioning of two terminals. Rather, in cited document 2, the two terminals are placed at an interval that is greater than the width of the winding loop, and the configuration is the exact opposite of the invention stated in claim 1 of the present application.

INTEL-1015, 19 (JP2007526642, Written Argument).

PO's Expert's ITC Position Regarding “Closely Spaced Terminals”

Dr. Prucnal ITC Declaration:

64. These features of conductors and electromagnetism inform a person of ordinary skill that the “closely spaced” limitations in the claims are related to the functional limitations. Magnetic field contributions from these two terminals are minimized and mutual electromagnetic coupling between the two inductors is reduced as long as the spacing between the terminals is close enough that magnetic field contributions from each of the two terminals tend to cancel each other out in the vicinity of the second inductor.

INTEL-1051, ¶64.

The ITC's Construction of "Closely Spaced Terminals"

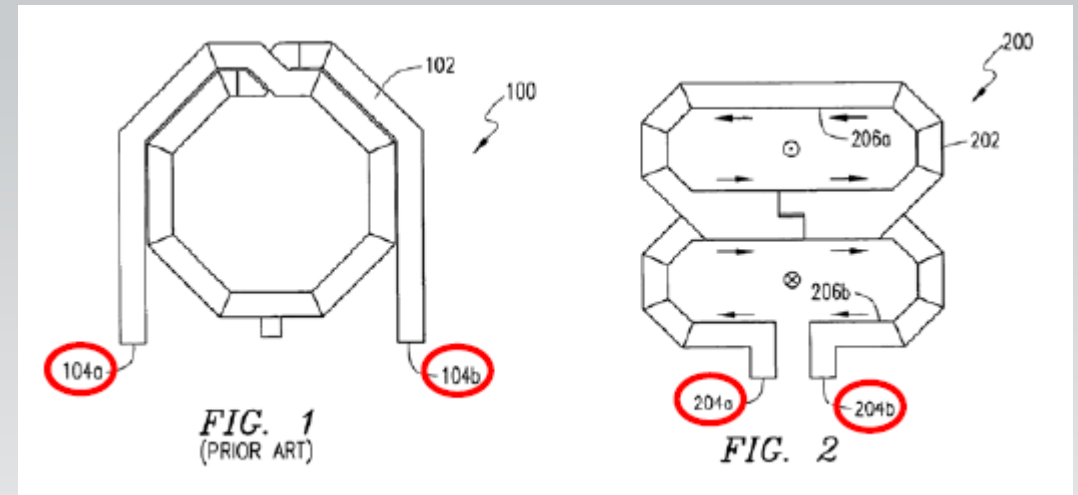
a. "two closely spaced terminals" (claims 1 and 11)

Ericsson's Proposed Construction	Apple's Proposed Construction	Adopted Construction
This term does not need to be construed. Plain and ordinary meaning applies, which is "two terminals in proximity to each other (such that the electromagnetic field at a certain distance from the first inductor (where the second inductor is positioned) is reduced)"	"two terminals spaced as close to each other as possible" Alternatively: Indefinite	Plain and ordinary meaning applies, which is "two terminals in proximity to each other (such that the electromagnetic field at a certain distance from the first inductor (where the second inductor is positioned) is reduced)"

INTEL-1020, 12.

The ITC's Construction of “Closely Spaced Terminals”

Ericsson's construction is supported by the figures of the '430 patent, which provide examples and show that the spacing is relative to the proportions and locations of other claim elements. See *Guangdong Alison Hi-Tech Co. v. Int'l Trade Comm'n*, 936 F.3d 1353, 1363 (Fed. Cir. 2019); *Exmark Mfg. Co. Inc. v. Briggs & Stratton Power Prod. Grp., LLC*, 879 F.3d 1332, 1345-46 (Fed. Cir. 2018). Figure 1 of the '430 patent depicts a prior art inductor 100 with terminals 104a and 104b that are clearly not spaced close to one another. By contrast, Figure 2 depicts an 8-shaped inductor 200 with terminals 204a and 204b that are closely spaced. Figures 1 and 2 are replicated below.



INTEL-1020, 13.

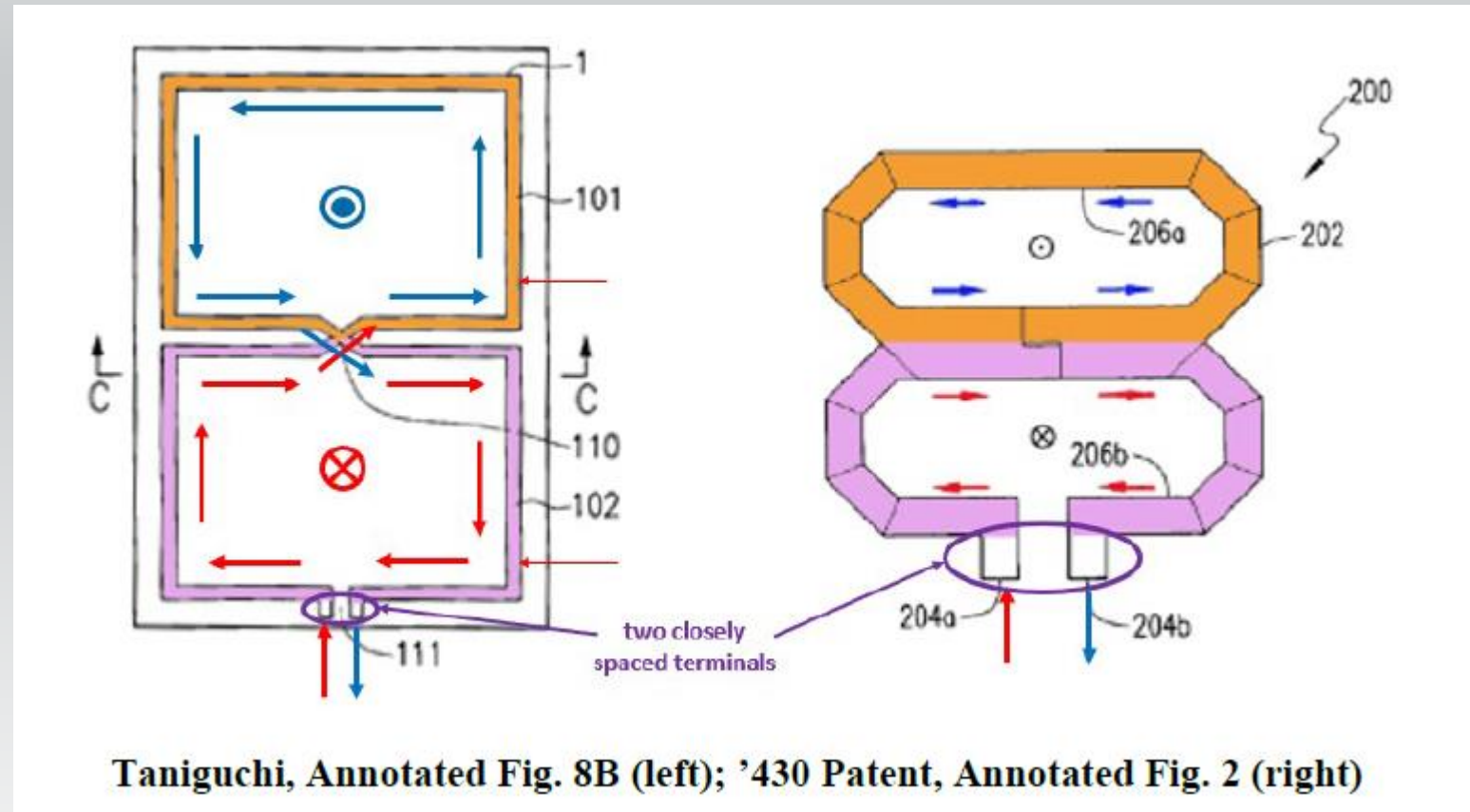
INTEL-1020, 14.

Taniguchi's Terminals meet “Closely Spaced” Limitations Under Plain Meaning and ITC Construction

Taniguchi's “terminals” 111 are “closely spaced” “relative to the proportions and locations of other claim elements” (i.e., the width of conductor loops 101 and 102)

Because terminals 111 are placed closely together, electromagnetic fields cancel or are not measurable

Field of 8-shaped antenna/inductor 1 is therefore not altered by terminal



“Closely Spaced Terminals” Minimize Magnetic Field Contributions

127. The two closely spaced terminals of Taniguchi’s feeding point 111 “*minimiz[e] magnetic field contributions from the terminals*” due to the opposing currents flowing through the wires of the terminals, that is the current entering the left terminal wire and the current exiting the right terminal wire as shown in annotated Figure 8B above. Prior to the earliest priority date claimed on the face of the ’430 patent, a POSITA would have understood that a consequence of having terminals spaced closely together (and more closely than the width of the inductor loop) is a minimization of magnetic field contributions from the terminals relative to the field contributions when the terminals are placed farther apart. The book, “Signal Integrity Issues and Printed Circuit Board Design” by Douglas Brooks (“Brooks”; INTEL-1010), published in 2003, summarizes this basic concept.

A POSITA would have understood that closely spaced terminals minimize the magnetic field contributions from the terminals relative to when the terminals are placed farther apart.

PO's Arguments Against "Closely Spaced Terminals" Disclosure Lack Merit

- **PO now argues "closely spaced" is tied to size of a semiconductor die**
 - **No support in specification for this position**
 - **Contrary to PO's prosecution history and ITC positions**
- **PO argues that Intel has not demonstrated terminals are positioned closely enough to minimize electromagnetic field contributions**
 - **Extrinsic evidence confirms Intel's position**
 - **Both experts agree that closely spaced terminals minimize electromagnetic field contributions**
 - **Simulations performed rebut PO's position and confirm Intel's position**

“Closely Spaced Terminals” Minimize Magnetic Field Contributions

Extrinsic Evidence Confirms “Closely Spaced Terminals” That Carry Equal and Opposite Current Minimize EM Field Contribution

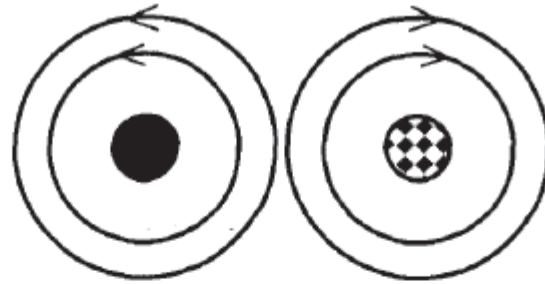


Figure 9-2 A signal and its return have magnetic fields that approximately cancel.

But if we move the two wires closer together, then you, as an observer off to the right, would begin to see radiations from each wire that are more equal. And since they are opposite in phase, or polarity, they tend to cancel. In the limit, if the wires were very close together, their EMI radiations would completely cancel and would not be measurable. Herein is one of our most basic principles: *If you want to minimize EMI radiation, keep the signals and their returns close together.* That, of course, may be easier to say than to do.

INTEL-1010 (Brooks), 157.

Experts Agree the Magnetic Field Contributions Are Minimized

Petitioner's Expert, Dr. Tentzeris:

337. A POSITA would have been motivated to make Taniguchi's terminals (Grounds 5-6) and Midya-Raghavan's terminals (Grounds 7-8) "*closely spaced*" so as to "*minimiz[e] magnetic field contributions from the terminals*" because Brooks provides an express teaching, characterized as a "most basic principle[]," to keep two wires carrying current in opposite directions close together to "*minimize EMI radiation.*" (INTEL-1010, 157, 155 (electromagnetic field includes magnetic field).) Indeed, Brooks is clear that EMI is a problem for circuit designs. (INTEL-1010, 50, 152, 156.) A POSITA would have also been motivated to combine

INTEL-1003, ¶337.

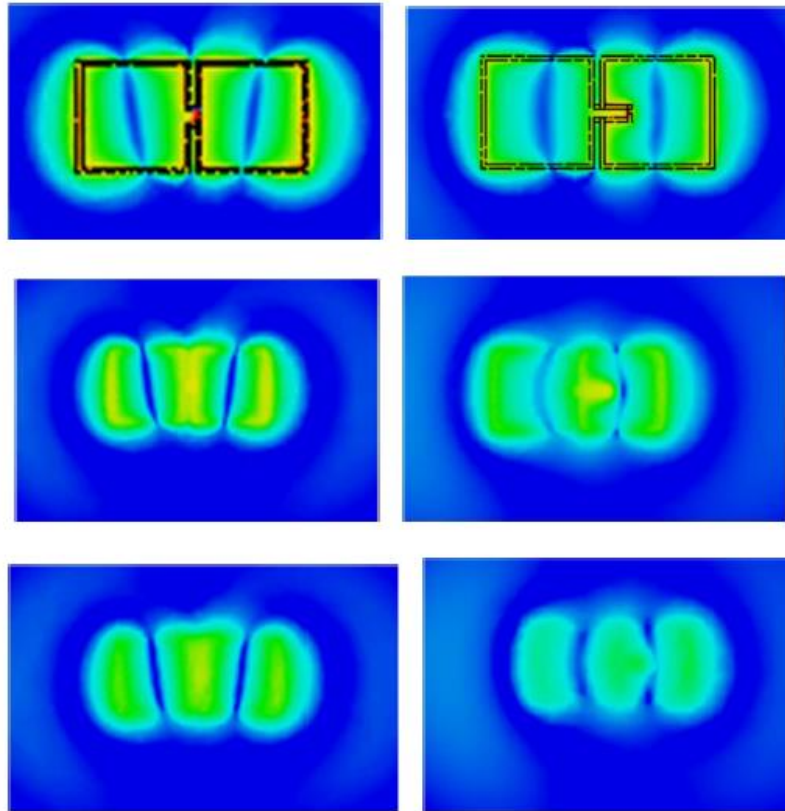
PO's Expert, Dr. Prucnal:

And I believe what Brooks is talking about here is that those fields would tend to cancel. And from an outside perspective away from these two conductors, the closer the two conductors are relative to the distance away that you're observing, the greater the -- the cancellation.

here. By physically putting the two terminals close to one another, then the function will be that the fields -- the currents go in and out, the fields are counter to one another, and that the function will be at some distance away that those fields aren't -- those fields are canceled.

INTEL-1044 (Prucnal Dep. Tr.), 132: 7-12, 137:14-19.

Simulations Confirm Closely Spaced Terminals Minimize Magnetic Field Contributions



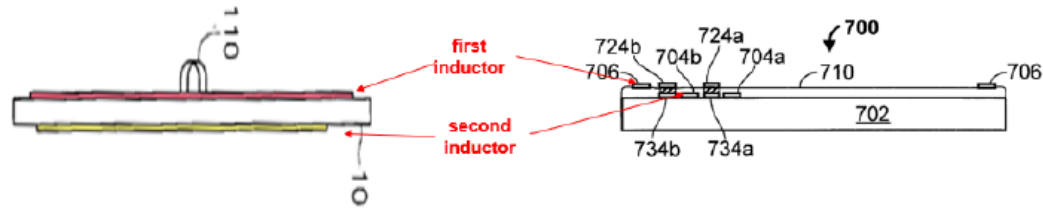
Magnetic Field Measured in Plane of 8-Shaped Loop (top left) and Above Loop: 1X (middle left), and 3X (bottom left) Substrate Thickness (PCB)

Simulations show no meaningful contribution to the net magnetic field at locations away from the terminals.

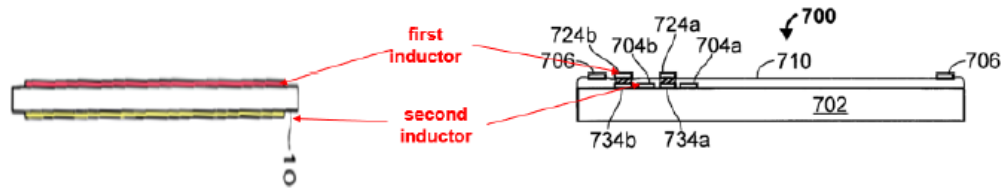
**Combination of Taniguchi and Rostoker
Renders Claims 2 and 8 Obvious**

**Combination of Taniguchi and Rostoker
Renders Claims 11, 13-15, and 17-19 Obvious if
Claim 11's Preamble is Found to be Limiting**

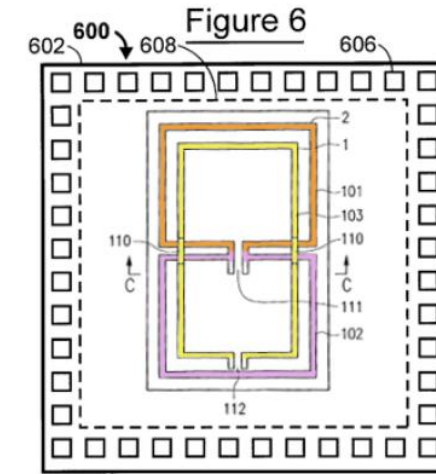
Petitioner's Taniguchi and Rostoker Combination



Taniguchi, Figure 8D (annotated/rotated); Rostoker, Figure 7B



Taniguchi, Figure 10D (annotated/rotated); Rostoker, Figure 7B



Excerpts of Annotated Taniguchi, Figure 7B superimposed on Rostoker, Figure 6

Taniguchi's Different Plane Embodiments

Taniguchi's Same Plane Embodiments

Petition Established Motivations to Combine

(1) Taniguchi Suggests the Combination by Teaching Small Form Factor Devices

[0022] According to these inventions, electric power as supplied can be efficiently converted to electromagnetic field with a radio guidance antenna for transmission and reception, and data communication is enabled in a communication area in non-contact manner even when a tag is oriented in any direction. Also, in these inventions, the radio guidance antenna is arranged on a substrate and the transmission means or receiver means is arranged on the substrate. Thereby, it is possible to make a data communication apparatus which is small-sized, lightweight and high in performance.

INTEL-1005 (Taniguchi), ¶[0022].

[0001] The invention relates to a radio guidance antenna, a data communication method, and a non-contact data communication apparatus, which make use of such antenna, and more particularly, to a radio guidance antenna for use in non-contact identification apparatus such as physical distribution systems, electronic coupon ticket systems, and the like, a data communication method, and a non-contact data communication apparatus, which make use of such antenna.

[0002] Conventionally, a system for identification and management of articles is needed in article identification apparatus such as assembly and conveyance lines and physical distribution systems, and electronic coupon ticket systems.

INTEL-1005 (Taniguchi), ¶¶[0001], [0002].

Petition Established Motivations to Combine

Extrinsic evidence confirms a POSITA would have understood it was beneficial for such applications to integrate components, including antennas, on single die to achieve small form factor device

Koo:

load modulation. The coil or coils are preferably integrated in the transponder or the sending-and-receiving station circuitry which may be in the form of a single chip integrated circuit in which the active semiconductor topography is provided with the coil in one or more planes preferably applied by a photolithographic process. In this manner, the flat spatial requirement for the chip is not enlarged and the coil or coils can be integrated in or on the chip.

INTEL-1022 (Koo), 3:50-58.

O:

Integration of entire radio functions into a single chip provides improved reliability, ease of use and reduced cost compared to the hybrid alternative comprising a multi-chip assembly bonded to an antenna, crystal, passive components, and power source. The cost will be lower than the cost of the several chips which are required in the hybrid approach. The cost of the external antenna, and external passive components is avoided, and unit assembly cost is greatly reduced. Because the component count and mechanical connections are reduced to a minimum, ruggedness and reliability significantly exceed that of the hybrid multi-chip assembly.

INTEL-1025 (O), 8:11-22.

Petition Established Motivations to Combine

Extrinsic evidence confirms a POSITA would have understood it was beneficial for such applications to integrate components, including antennas, on single die to achieve small form factor device

Heinrich:

[0018] Referring now to FIG. 2, an embodiment of an RFID scanner 40 is illustrated. The RFID scanner 40 comprises a housing 42 that is affixed to an operator's wrist with strap 44 or other like attachment device. The housing 42 may include both the RFID reader and antenna (as described above with respect to Fig.1). An optional cable 46 may be used to couple the RFID reader to an external systems, such as a portable data terminal located elsewhere on the operator or disposed remotely. Alternatively, the housing 42 may include only the antenna, and the cable 46 would extend from the back of the housing to an RFID reader that is separately disposed, such as mounted to another part of the operators body or physically located remotely from the operator. The RFID reader/antenna housing 42 may include an internal power source (e.g., battery) and could communicate externally via any of the well known wireless communication techniques such as wireless local area network (LAN), infrared, personal area networks or wide area networks.

INTEL-1026 (Heinrich), [0018].

Kovach:

The RFID tag 10 facilitates increased security measures within the airport with little or no additional burden or restriction of passenger movement. For example, security personnel may carry hand-held scanners to perform random passenger checks at step 125 by simply coming into proximity to the RFID tags carried by passengers. The hand-held scanner may be used to identify passengers and look up associated passenger records, minimizing the need to stop passengers to ask them security-related questions, which can disrupt the flow of passenger traffic. Similarly, at step 125

INTEL-1027 (Kovach), 6:52-61.

Petition Established Motivations to Combine

(2) Rostoker Suggests the Combination

With increasing dependents on local and wide area wireless networks, particularly those with low power (range) requirements, there is perceived to be a need to have an antenna structure integrated onto single semiconductor devices. One important lack has been an on-chip antenna structure.

INTEL-1006 (Rostoker), 1:10-15.

Petition Established Motivations to Combine

(3) Taniguchi Contemplates Other Implementations

[0086] The substrate used in the present invention is not limited to the printed board 21 but can be formed of an insulating film and an insulating material, on which a metallic paste is applied to provide an equivalent function to that of the board. As seen from FIGS. 16A and 16B, a radio guidance antenna is used to constitute a communication system, thereby enabling a small-sized, lightweight communication system of high performance.

INTEL-1005 (Taniguchi), ¶[0086].

PO's Arguments Against Taniguchi-Rostoker Grounds Lack Merit

- Taniguchi does not expressly state its teachings apply to ICs and Rostoker does not expressly state its teachings apply to PCBs
 - **Petitioner established a POSITA would view PCB art as relevant to IC design and vice versa**
- Taniguchi and Rostoker are directed to antennas, not inductors
 - **Petitioner established that loop antennas are inductors**
- Rostoker distinguishes “antennas” from “inductors”
 - **Petitioner established Rostoker does not distinguish “antennas” from “inductors”; loop antennas are inductors**
- Rostoker (individually) teaches away for reasons related to Rostoker's antenna
 - **Petitioner's combination does not use Rostoker's antenna; the combination uses Taniguchi's antenna on Rostoker's chip**

Sole Disputed Motivation to Combine Issue

Would a POSITA view PCB art (Taniguchi) as relevant to IC design (Rostoker) and vice versa?

PO's Argument

A POSITA would not have been motivated to combine Taniguchi and Rostoker to obtain the claimed invention. EX2002, ¶ 76. Taniguchi teaches antennas on a PCB but does not state that its teachings apply to semiconductor chips. EX2009, ¶ 38. Taniguchi's antennas must be positioned concentrically. *Id.*, ¶ 36. Rostoker teaches antennas on IC chips but does not state that its teachings apply to PCBs. EX2009, ¶ 24. A POSITA would not have found a reason to combine Taniguchi's PCB teachings with Rostoker's IC teachings from their respective disclosures. EX2009, ¶¶ 25, 53. The Petition fails to establish a

YES:

- PCB design rules are applicable to ICs
- Inductors on PCBs and ICs Produce the Same Magnetic Fields
- Applicant of the '430 Patent cited PCB art in Information Disclosure Statements

PCB Design Rules are Applicable to ICs and Vice Versa

Extrinsic Evidence Establishes a POSITA Would Recognize the Applicability of PCB Teachings to ICs and IC Teachings to PCBs

needed. This anticipated IC design environment is similar to the PCB design environment, where selection of IP cores is analogous to selection of packaged IC's and where chip design becomes analogous to PCB design. For example, an ASIC design will increasingly focus on interconnection, personalized "glue" circuits, and some specialized high-value-added circuits with appreciable reuse of a prior-verified basic building blocks. A key component in such a software tool set is the VDE as developed for PCB design [23], [24].

INTEL-1047; 670.

layout and routing. The trends toward increasing reuse of previously designed and verified IP cores or macrocells in new ASICs and SOC implementations establishes a parallel between leading-edge PCB design and IC design in this new environment. Lower cost and rapid time-to-market products will result from more design reuse and long-distance IC interconnect routing that is not performance limiting.

INTEL-1048; 164.

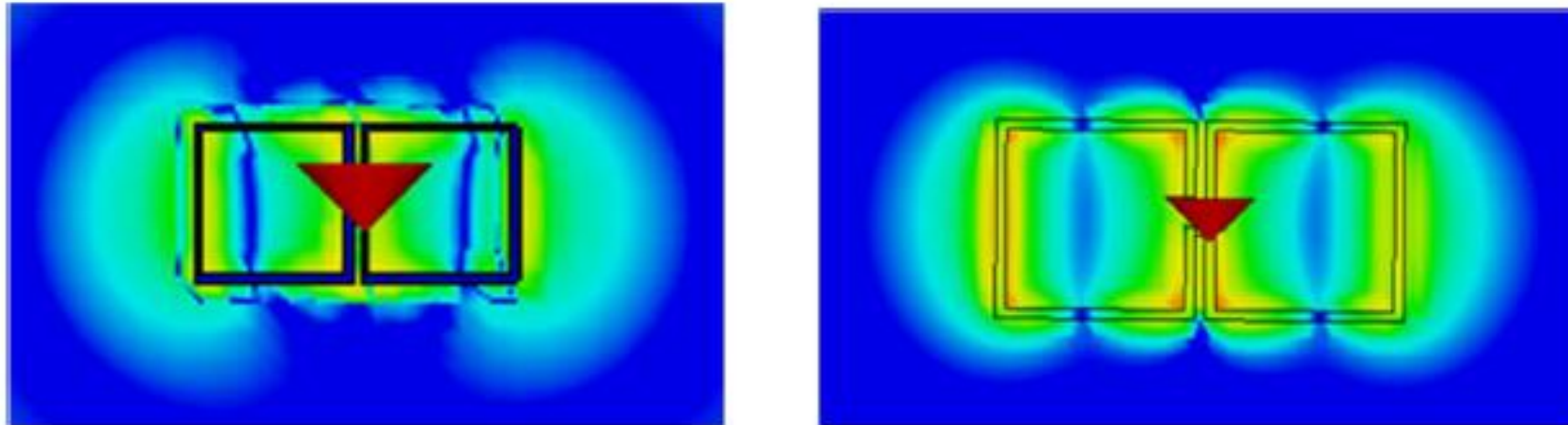
PCB Design Rules are Applicable to ICs and Vice Versa

Extrinsic Evidence Establishes a POSITA Would Recognize the Applicability of PCB Teachings to ICs and IC Teachings to PCBs

Interfacing with on-chip buses. Designers can use standard on-chip buses to eliminate the suboptimal glue logic required to integrate one or more cores with customer logic or with each other. Successfully used in the world of printed circuit board design for several years, this method is extendable to SOC designs. Standard buses ease integration of peripherals and independent design of user modules by providing a standard interface and communication protocol. Core logic and customer logic designed to a consistent protocol can quickly interconnect without requiring additional glue logic gates.

INTEL-1049; 28.

Inductors on PCBs and ICs Produce the Same Magnetic Fields



**Magnetic Field Produced by Eight-Shaped Conducting Loop
on PCB (left) and Silicon (right)**

Applicant Deemed PCB References Relevant

(10) Patent No.:	US 7,151,430 B2
(45) Date of Patent:	Dec. 19, 2006

6,891,444	B1 *	5/2005	Jacobsson et al.	331/117	R
6,894,598	B1 *	5/2005	Heima	336/200	
6,974,740	B1 *	12/2005	Lowther et al.	438/214	
2003/0155630	A1	8/2003	Woo		
2003/0186674	A1	10/2003	Keeney et al.		
2003/0202331	A1 *	10/2003	Jessie et al.	361/764	

FOREIGN PATENT DOCUMENTS

WO	WO 98/05048	A	2/1998
WO	WO-03/084295		10/2003
WO	WO 2004/012213	A	2/2004

Keeney: One or more high Q value planar spiral inductors implemented on a PCB

Midya: Multiple spiral inductors implemented on a PCB

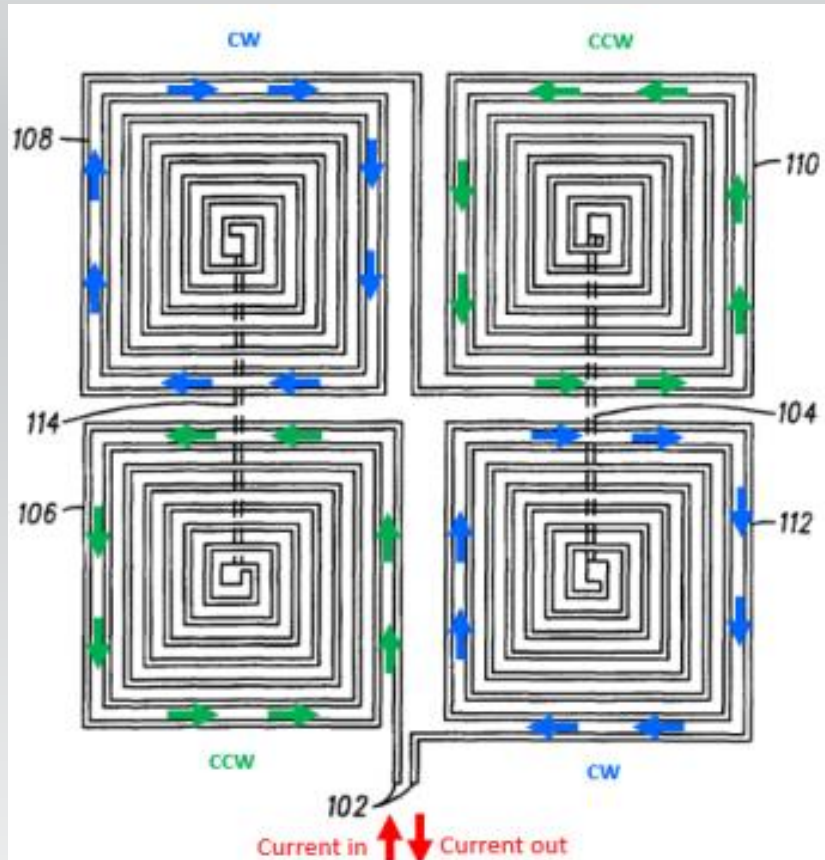
Bhailis: Spiral inductors implemented on a PCB

'430 Patent (INTEL-1001), cover page.

**Midya-Raghavan Combination Renders Claims
1, 3-6, and 9 Obvious**

**Midya-Raghavan Combination Renders Claims
11-16 Obvious if Claim 11's Preamble is Not
Limiting**

Midya Discloses a Four-Loop Inductor With “Reduced Far Field” / “Reduced Electromagnetic Field”



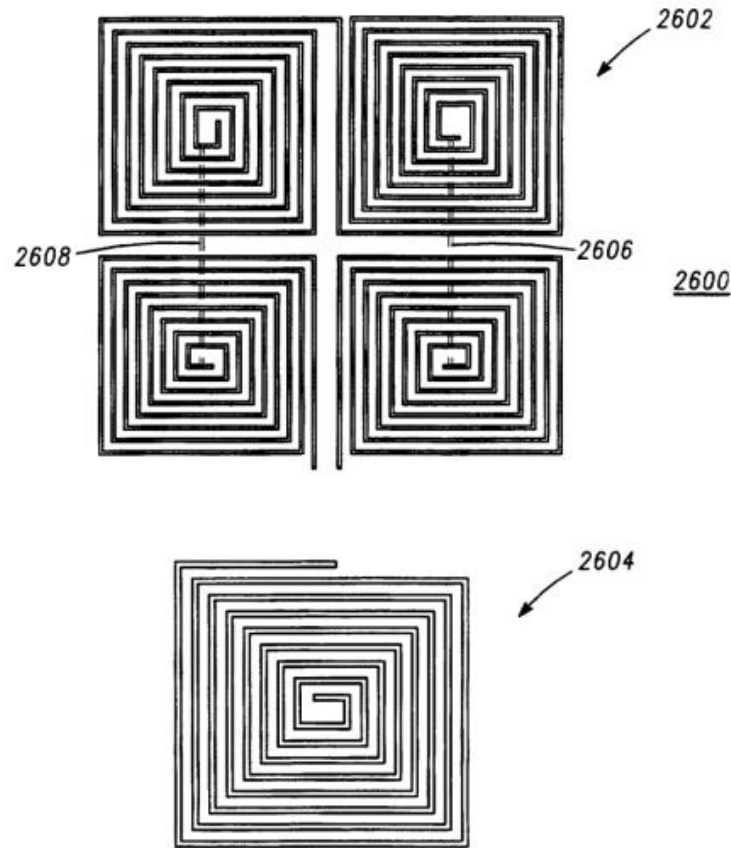
Midya, Annotated Figure 1

current produced by a signal source. The even number of planar adjacent loops/spiral conductor coils are arranged to provide total cancellation of a magnetic field on N axes and to maximize overall cancellation of the magnetic field. The planar magnetic field inductor/transformer may be further

INTEL-1007 (Midya), 10:22-25.

INTEL-1007 (Midya), Figure 1 (annotated).

Midya's Inductor Layout Reduces Electromagnetic Coupling



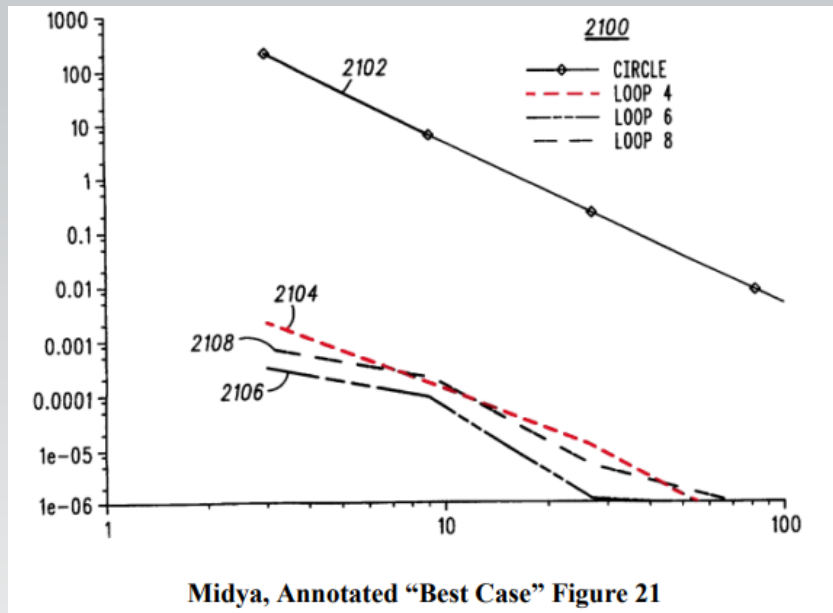
Midya, Figure 26

FIG. 26 is a diagrammatic representation of a spiral inductor that is placed concentrically above a non-interacting multiloop inductor structure such that the coupled magnetic field is substantially zero in accordance with the present invention.

INTEL-1007 (Midya), 5:21-25.

INTEL-1007 (Midya), Figure 26.

Midya's Inductor Layout Reduces Electromagnetic Coupling



INTEL-1007 (Midya), Figure 21 (annotated).

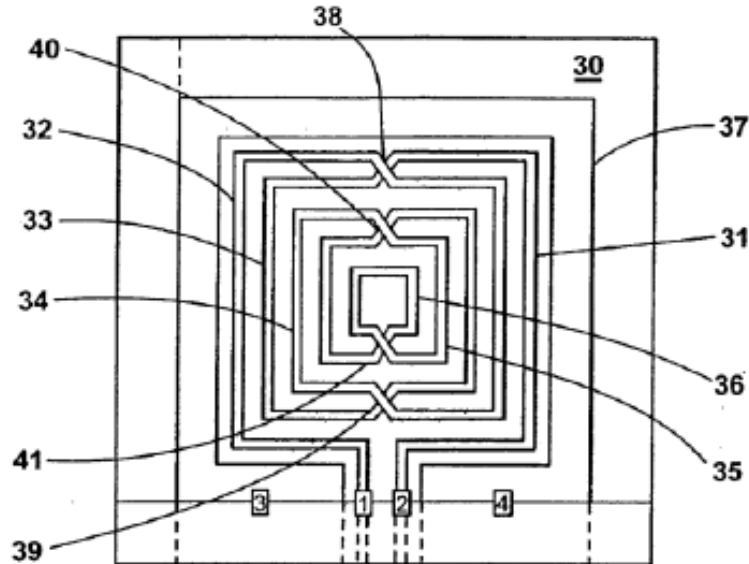
The coupled magnetic field in the plane of the multiloop structure has been computed (FIGs. 21-22) for a 4-loop, 6-loop and 8-loop implementation (see FIGs. 3, 4, 5). The horizontal axis represents distance from the center of the multiloop structure relative to the lateral dimension of the structure.

The vertical axis represents a measure of the mutual inductance with a test loop. The coupled magnetic field of the multiloop structure is plotted as a function of distance from the center and compared to the magnetic field for a simple circular loop which has the same inductance. The coupling depends on the direction. A best (FIG. 21-perpendicular to a side of a polygon) and a worst (FIG. 22-along a diagonal of a polygon) case coupling are shown.

In the best case (2100), the coupling is reduced by at least 80dB for the 4-loop (2104), 6-loop (2106) and 8-loop (2108) structures at 2 inductor lengths away and beyond compared to coupling for a simple circular loop (2102).

INTEL-1007 (Midya), 18:4-16; 19:6-9.

Raghavan Discloses a Symmetric Inductor



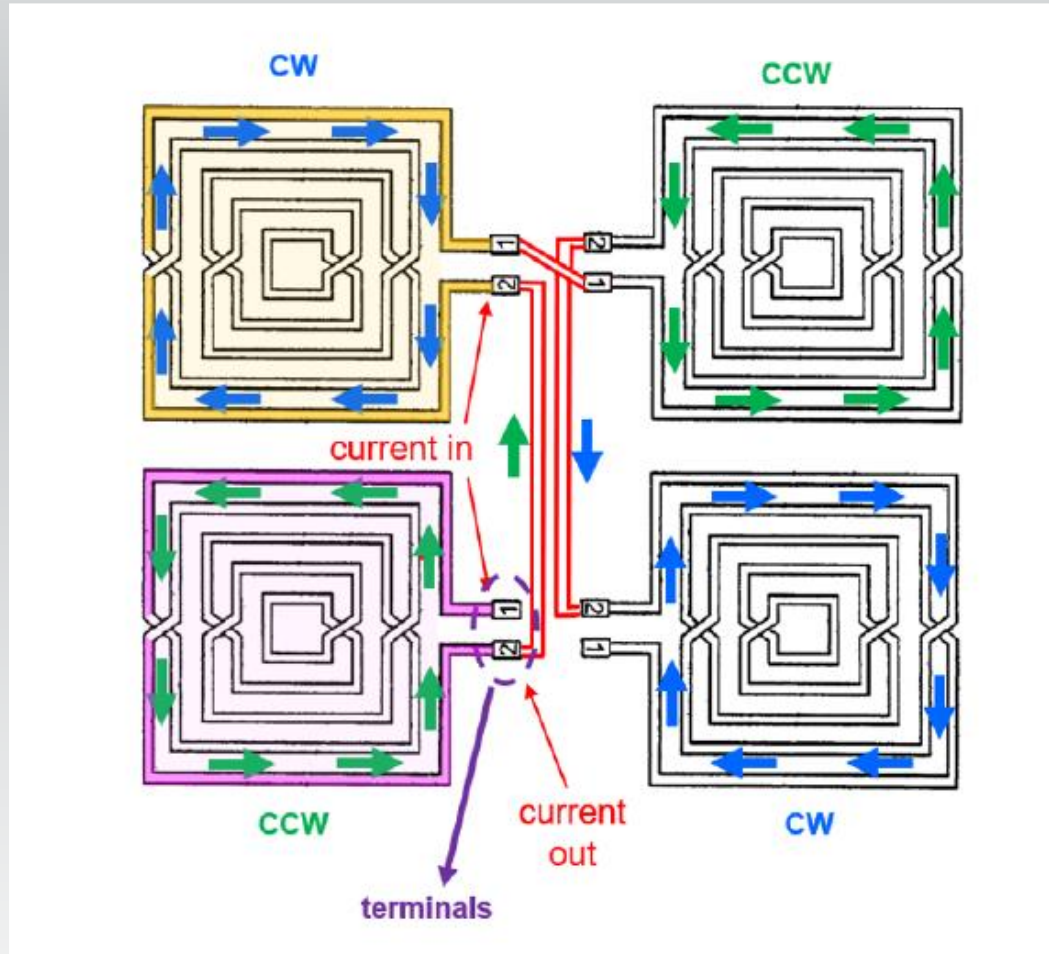
Raghavan, Figure 3

INTEL-1008 (Raghavan), Figure 3.

[0002] This invention relates to the field of inductors which are used in integrated circuits. In particular, this invention relates to symmetric inductors particularly adequate for use in circuits using differential signals. The inductors winding preferably have either a spiral or a spiral-like planar configuration.

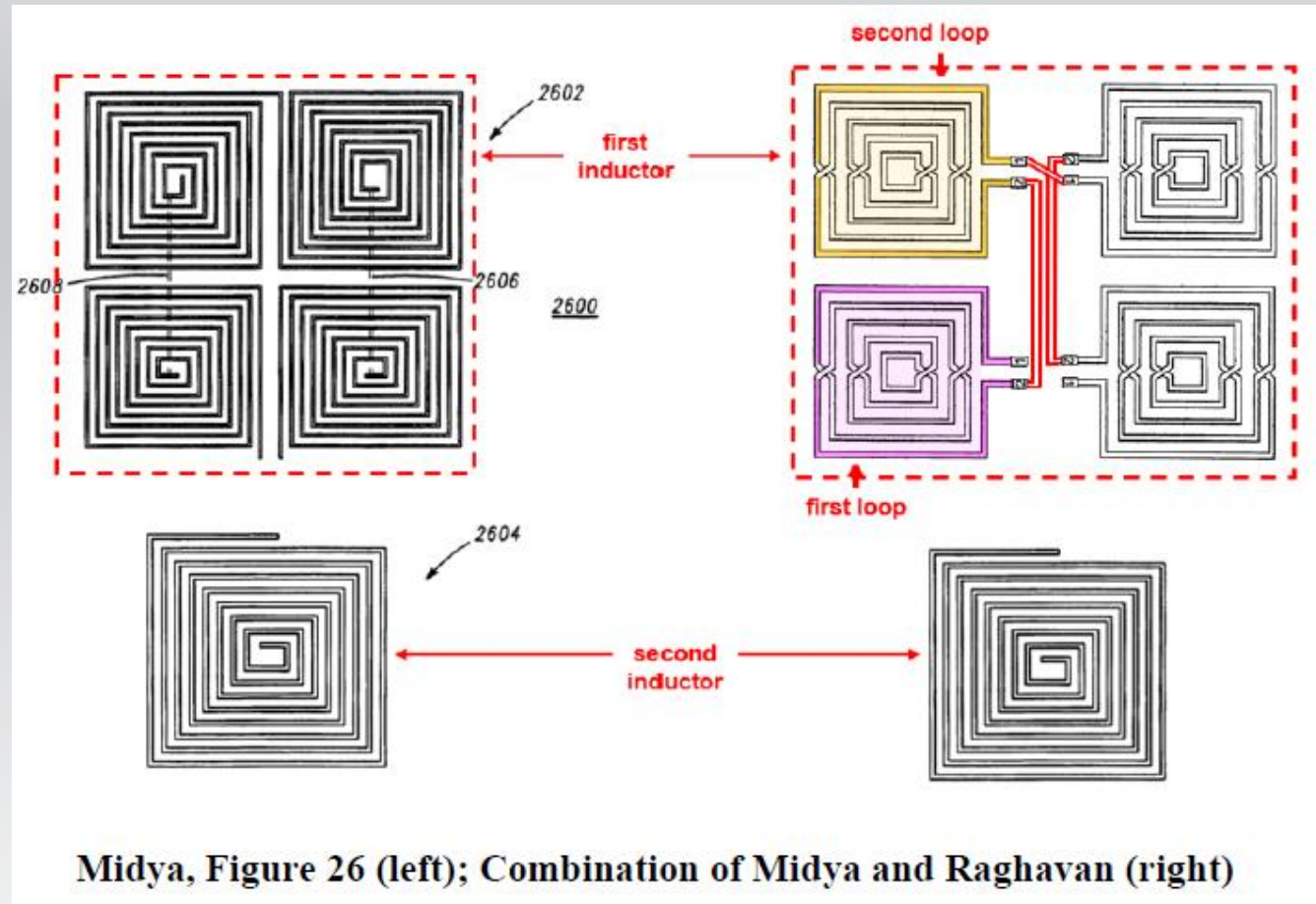
INTEL-1008 (Raghavan), [0002].

Midya-Raghavan Combination



- Use of Raghavan's symmetric inductor winding reduces problematic crossovers and minimizes capacitive effects.
- The combination is the simple substitution of one known element (Raghavan's inductor winding) for another (Midya's loop in a non-interacting inductor).
- The combination is the use of a known technique (Raghavan's inductor winding) to improve similar devices (Midya's non-interacting inductor) in the same way (minimizing undesired capacitive coupling and improving quality factor of the inductor).

Midya-Raghavan Grounds



Patent Owner's Motivation to Combine Arguments Lack Merit

- PO Argues POSITA would not have been motivated to combine because Midya “states its teachings are typically located on a PCB”

Midya is not limited to a PCB

The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

INTEL-1007, 22:12-20.

1. A planar magnetic field inductor/transformer comprising a plurality of at least three planar adjacent loops/spiral conductor coils coupled serially and arranged one after another in a simple/compound loop fashion, carrying a current produced by a signal source, wherein the plurality of planar adjacent loops/spiral conductor coils are arranged to maximize cancellation of a moment of the plurality of loops/spiral conductor coils over a predetermined range.

INTEL-1007, 23, claim 1.

Patent Owner's Arguments Against Midya-Raghavan Grounds Lack Merit

- PO Argues Midya-Raghavan combination is not symmetric due to the interconnections between inductors.
 - The '430 patent only requires “substantial” (not perfect) symmetry. Any alleged asymmetry does not materially impact the reduced far field achieved by the combination.
- PO Argues Midya's “concentric” inductor “is outside the scope of claim 11.”
 - The '430 patent does not require the first and second inductor to be laterally spaced from one another.
 - Midya discloses inductor layouts in which the first and second inductor are laterally spaced from one another
- PO Argues Midya was considered by the examiner.
 - Midya was cited on an IDS by the applicant and not substantively examined.

Patent Owner's Missing Limitation Arguments Attack Midya and Raghavan in Isolation

- PO Argues Midya does not disclose closely spaced terminals connected to the first loop.
 - The Midya-Raghavan combination discloses closely spaced terminals connected to the first loop.
- PO Argues that Raghavan's inductors are spiral and have a single loop.
 - The combination discloses two loops.
- PO Argues Raghavan does not disclose an inductor layout.
 - The combination provides an inductor layout having reduced electromagnetic coupling and reduced crossovers.

Midya-Raghavan-Gardner Combination Renders Claims 2, 11-16 Obvious if Claim 11's Preamble is Limiting

Patent Owner Attacks Gardner in Isolation

PO's Arguments:

- Gardner's inductor is spiral-shaped.
- Gardner's terminals are not "closely spaced."

Petitioner's combination does not use Gardner's inductor

- Midya-Raghavan teaches an inductor layout having reduced electromagnetic coupling
- Gardner teaches integrating inductors on a semiconductor die
- The combination provides reduced electromagnetic coupling between a first inductor and a second inductor on a semiconductor die.

**Brooks: Grounds 5-8
Explicit Back-Up Combination for “Closely Spaced”
/ “Minimizing Magnetic Field Contributions from the
Terminals” Limitations (Claims 1, 11)**

PO Mischaracterizes Brooks

supra. Id. Brooks does not show “closely spaced terminals” or “minimizing magnetic field contributions from the terminals,” and, therefore, does not provide these teachings missing from Midya, Raghavan, and Gardner. *Id.* Consequently,

**PO is incorrect – Brooks teaches
this concept was well-known**

Brooks Teaches Cancellation of Magnetic Field by Closely Spaced Terminals

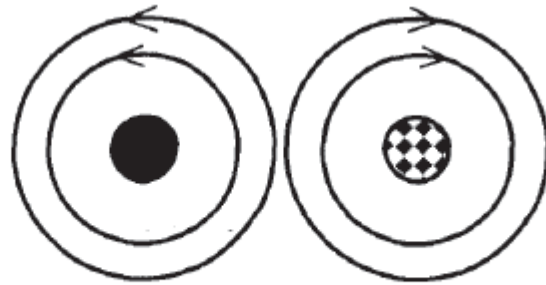


Figure 9-2 A signal and its return have magnetic fields that approximately cancel.

But if we move the two wires closer together, then you, as an observer off to the right, would begin to see radiations from each wire that are more equal. And since they are opposite in phase, or polarity, they tend to cancel. In the limit, if the wires were very close together, their EMI radiations would completely cancel and would not be measurable. Herein is one of our most basic principles: *If you want to minimize EMI radiation, keep the signals and their returns close together.* That, of course, may be easier to say than to do.

INTEL-1010, 157 (Brooks).

Brooks makes clear that EMI is a problem in circuit design. Brooks furthers Taniguchi's and Midya's goals of reducing interference by teaching closely spaced terminals that minimize EMI radiation.

Dr. Prucnal Admits the Physics is the Same

But -- but, again, Brooks is talking -- as I recall, this whole book was on -- was on printed circuit -- on PCBs, printed circuit boards. So, it -- although this principle is the same, it does not relate to integrated circuits or inductors on integrated circuits in any way.

Q You just said the principle is the same?

A Well, the physics, the electromagnetics of having -- having opposite fields coming from currents in different directions is the same -- is the same principle.

The same physics principles govern the magnetic field produced by closely spaced terminals whether formed on PCBs or ICs.

INTEL-1044, 132:13-133:1.

No Capacitive Crosstalk Between Connected Terminals

PO's Argument:

82; EX1010, p. 157. For an inductor layout used in RF transceivers on a single semiconductor die at relatively high frequencies, there are problems with noise, capacitance, and complexity of the conductive traces, such as capacitive crosstalk between the interconnect lines. EX2002, ¶ 82; EX1010, p. 222. A POSITA would have been motivated to increase the distance, not reduce the distance, between two signal lines to reduce coupling. EX2002, ¶ 82; EX1010, p. 222. A POSITA would have chosen CMOS IC design rules over Brooks' PCB teachings. EX2009, ¶ 60.

PO and its expert fail to explain the alleged problem of capacitive crosstalk.

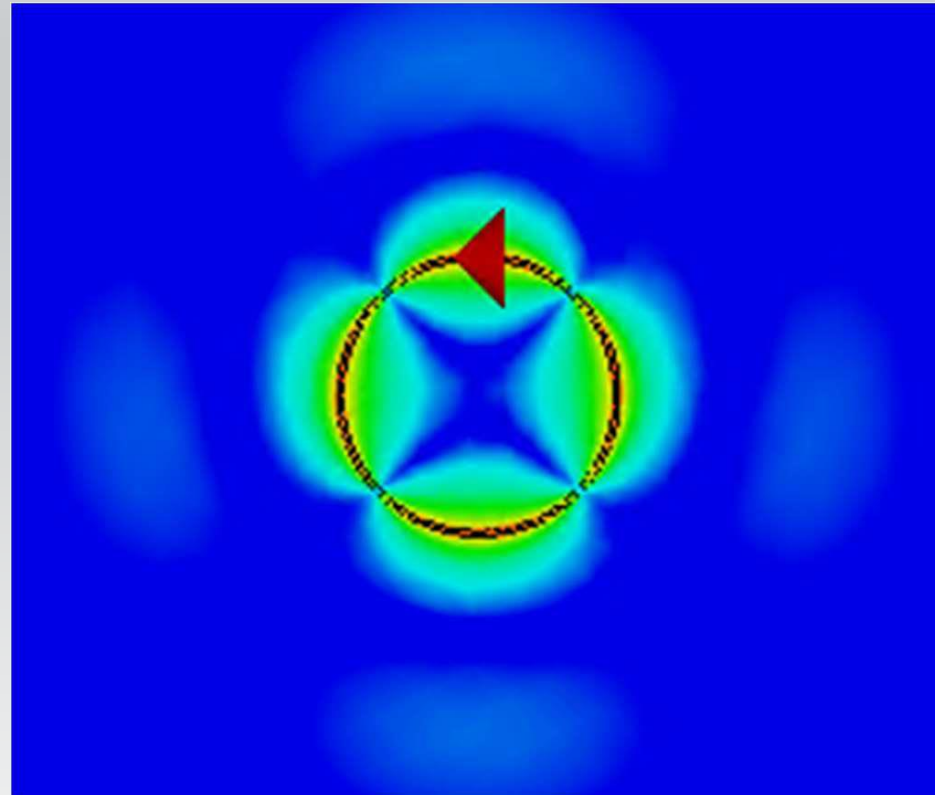
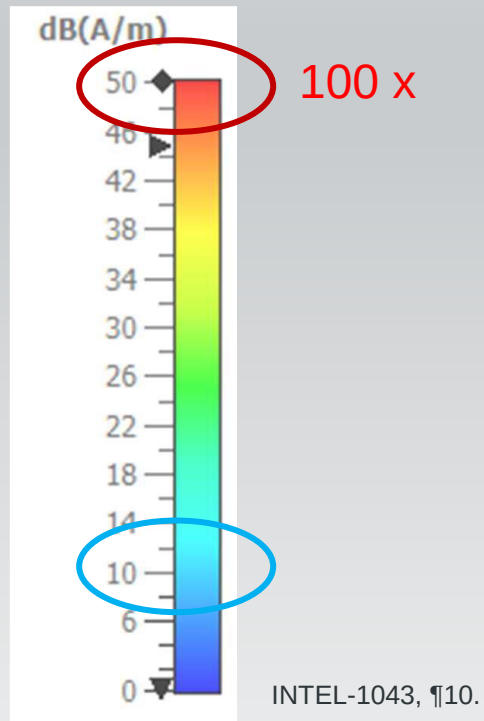
There is no crosstalk where terminals are part of the same conductive trace and carry the same signal in opposite directions.

Backup

Definition of a POSITA

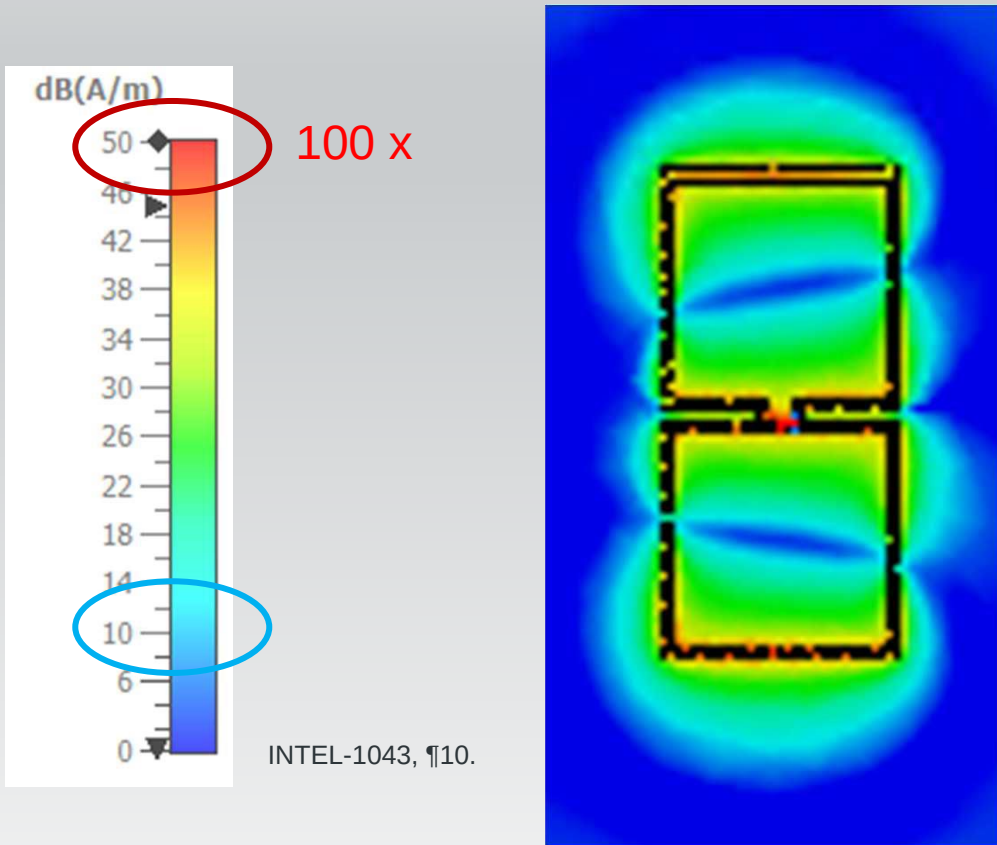
- Petitioner:
 - A person of ordinary skill in the art (“POSITA”) would have had at least a master’s degree in electrical engineering, physics, or similar discipline and at least two years’ experience in designing integrated circuits or inductors or a bachelor’s degree in electrical engineering, physics, or a similar discipline and at least four years’ experience in designing integrated circuits or inductors. Additional education might compensate for less experience and vice versa.
- Patent Owner:
 - POPR: A POSITA would have a bachelor’s degree in electrical engineering, physics, or a similar discipline, and either a master’s degree in one of these fields of study or a minimum of two years of experience working in the wireless communications industry.
 - POR: For the ’430 Patent, a POSITA would have a bachelor’s degree in electrical engineering, physics, or a similar discipline, and either a master’s degree in one of these fields of study or a minimum of two years of experience designing integrated radiofrequency circuits and inductors for semiconductors.

Magnetic Field Near a Current-Carrying Conducting Loop



The magnetic field strength in the plane of a current-carrying loop decreases with increasing distance from the loop.

Magnetic Field Near an 8-Shaped Current-Carrying Loop



The total magnetic field is the sum of the fields produced by the upper and lower loops. The total magnetic field is zero (dark blue) where the magnetic field produced by the upper loop is opposite in direction and equal in magnitude of the magnetic field produced by the lower loop.

CERTIFICATE OF SERVICE

The undersigned hereby certifies that on July 9, 2025, a copy of the foregoing Petitioner's Demonstratives were served via email on the following attorneys for the Patent Owner:

Alastair J. Warr
Bryan A. Santarelli
alastair.warr@fisherbroyles.com
bryan.santarelli@fisherbroyles.com

Date: July 9, 2025

/Lori A. Gordon/

Lori A. Gordon
Reg. No. 50,633
Attorney for Petitioner

Goodwin Procter LLP
1900 N. Street NW
Washington, D.C. 20036
Phone: (202) 346-4000
Fax: (202) 346-4444