

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VIVINT, INC.,
Petitioner,

v.

FRACTUS, S.A.,
Patent Owner,

Patent No. 8,994,604 to Puente Baliarda et al.

Issue Date: March 31, 2015

Title: Coupled Multiband Antennas

Inter Partes Review No.: IPR2024-00089

DECLARATION OF DR. MANOS M. TENTZERIS

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Exhibit No.	Exhibit Name
1001	U.S. Patent No. 8,994,604
1002	Declaration of Dr. Manos M. Tentzeris
1003	<i>Curriculum Vitae</i> of Manos M. Tentzeris
1004	Joint Claim Construction Statement from <i>Fractus, S.A. v. ADT, LLC</i> , 2:22-cv-00412 (E.D. Tex) (Oct. 5, 2023)
1005	U.S. Patent No. 6,239,765 (“Johnson”)
1006	U.S. Patent No. 6,509,882 (“McKivergan”)
1007	Excerpt from Prosecution History of the ’604 Patent
1008	Docket Control Order from <i>Fractus, S.A. v. ADT, LLC</i> , 2:22-cv-00412 (E.D. Tex) (Feb. 3, 2023)
1009	Expert Declaration of Stuart A. Long from <i>Fractus, S.A. v. ADT, LLC</i> , 2:22-cv-00412 (E.D. Tex) (Oct. 5, 2023)

I, Dr. Manos Tentzeris, declare as follows:

I. INTRODUCTION

1. I have been retained by Petitioner Vivint, Inc. (“Petitioner” or “Vivint”) to serve as an independent expert consultant in the *Inter Partes* review proceedings regarding U.S. Patent No. 8,994,604 (“the ’604 patent”) (EX1001). I have been asked to consider the validity of claims 1, 3, 4, 9, and 13 of the ’604 patent (the “Challenged Claims”). My opinions are set forth below.

2. I am being compensated at my normal rate of \$850/hour for all services rendered. My compensation is not dependent, in any way, on the nature of my findings, the content of my testimony, or the outcome of this proceeding or any other proceeding.

3. I have no other interest in this proceeding.

4. My analysis of the materials produced in this proceeding is ongoing and I will continue to review any new material that is provided. This declaration is indicative of only those opinions that I have formed to date. I reserve the right to amend, revise, and/or supplement my opinions stated herein based on any new information that may become available to me or my continuing analysis of the materials already provided.

II. QUALIFICATIONS

5. My qualifications for forming the opinions in this report are

summarized here and explained in more detail in my Curriculum Vitae (“CV”), which is submitted as Exhibit EX1003.

6. I am currently Ken Byers Professor in the School of Electrical and Computer Engineering at the Georgia Institute of Technology. I received my Bachelor of Science degree in Electrical Engineering from the National Technical University of Athens in Greece in 1992. I received my Master’s degree and Ph.D. from the University of Michigan at Ann Arbor in 1994 and 1998, respectively. A complete list of my academic positions, activities, and publications is set out in my CV, attached.

7. Between 1991 and 1992, I was a research assistant in the Microwave Lab at the National Technical University of Athens, Greece. From 1992 to 1998, I was a research assistant in the Radiation Laboratory at the University of Michigan, Ann Arbor. I became an assistant professor at the School of Electrical and Computer Engineering at Georgia Technical Institute in 1998, lasting until I became an Associate Professor in the same School in 2004. I then served as Associate Professor until my promotion to Professor in 2016, a title I have held since then. Also in 2016, I was appointed as the Ken Byers Professor in Flexible Electronics.

8. As described in my CV, I have more than 30 years of industry and academic experience. I have experience with antennas, fractal RF structures and

circuit design for these systems. As a professor of Electrical and Computer Engineering, I have taught courses relating to antenna and electromagnetic technologies. A complete list of my teaching positions, honors, and classes taught is set out in my CV. As a professor, I collaborated with over 130 Undergraduate, Masters and Doctoral students, as well as visiting students, post-doctoral fellows, and other researchers.

9. Throughout my career, I have received a variety of awards. I am a Fellow of IEEE, a member of the MTT-15 Committee, an Associate Member of European Microwave Association (EuMA), a Fellow of the Electromagnetics Academy, and a member of Commission D, URSI and of the Technical Chamber of Greece. In recognition of my world-leading achievements in the area of antennas and miniaturized/fractal RF structures, I served as an IEEE C-RFID (Committee on RFID technologies) Distinguished Lecturer from 2016-2022 and I served as an IEEE MTT Distinguished Microwave Lecturer (DML) from 2010-2012. I have won awards for my contributions in developing various technologies, including numerous multiband antenna topologies operating at different frequencies and integrated RF modules up to sub-THz frequencies. My achievements include the following:

- IEEE fellow — a distinction reserved for select IEEE members whose extraordinary accomplishments in any of the IEEE fields of interest

are deemed fitting of this prestigious grade elevation. IEEE, About the IEEE Fellow Program, <http://www.ieee.org/membership/fellows/>.

- 2021 IEEE Antennas and Propagation Symposium (APS) Best Student Paper Award (co-authored)
- 2019 Humboldt Research Prize 2019 IEEE Antennas and Propagation (APS) Conference Co-Chair
- 2018 Intel IEEE ECTC 2018 Best Student Paper Award
- 2015-present IEEE CRFID Distinguished Lecturer
- 2010-2012 IEEE MTT-S Distinguished Microwave Lecturer
- 2017 Georgia Tech Outstanding Achievement in Research Program Development Award
- 2017 Archimedes IP Salon Gold Medal
- 2016 Bell Labs Prize Third Award
- 2015 IET Microwaves, Antennas and Propagation Premium Award
- 2014 Georgia Tech ECE Distinguished Faculty Achievement Award
- 2014 IEEE RFID-TA Best Student Paper Award
- 2013 IET Microwaves, Antennas and Propagation Premium Award
- 2012 Finland Distinguished Professor (Fi.Di.Pro.) Award
- 2012 Architecture Award of Excellence, Architecture World Summit
- 2010 IEEE Antennas and Propagation Society Piergiorgio L. E.

Uslenghi Letters Prize Paper Award

- 2010 Georgia Tech Senior Faculty Outstanding Undergraduate Research Mentor Award
- 2009 IEEE Transactions on Components and Packaging Technologies Best Paper Award
- 2009 IEEE Antennas and Propagation Symposium (APS) Second Best Student Paper Award
- 2009 E.T.S. Walton Award from Science Foundation Ireland
- 2007 IEEE Antennas and Propagation Symposium (APS) Best Student Paper Award
- 2007 IEEE International Microwave Symposium (IMS) Third Best Student Paper Award
- 2007 IEEE International Symposium on Antennas and Propagation (ISAP) Poster Presentation Award
- 2006 Asian-Pacific Microwave Conference (APMC) Award
- 2006 IEEE-MTT Outstanding Young Engineer Award
- 2004 IEEE Transactions on Advanced Packaging Commendable Paper Award
- 2003 NASA Godfrey “Art” Anzic Collaborative Distinguished Publication Award

- 2003 IBC International Educator of the Year Award
- 2003 IEEE-CPMT Outstanding Young Engineer Award
- 2002 International Conference on Microwave and Millimeter-Wave Technology Best Paper Award (Beijing, China)
- 2002 Georgia Tech-ECE Outstanding Junior Faculty Award
- 2001 ACES Conference Best Student Paper Award
- 2000 NSF CAREER Award
- 1999 Technical Program Co-Chair of the 54th ARFTG Conference, Atlanta, GA
- 1997 Best Paper Award, International Hybrid Microelectronics and Packaging Society
- 1989 Papastavridios Greek Mathematics Excellence Fellowship
- 1988-1992 Greek Government Academic Excellence Fellowships

10. In Google scholar, there are over 27,810 citations to my work and my work has an h-index of 83. An h-index represents the number of papers with the same number of citations, meaning I have over 83 papers with 83 citations.

11. I have authored or contributed to over 30 books and 850 refereed journal and conference papers; spoke in over 140 presentations, many of which relate to antennas, antenna arrays, RFID systems, and other modes of wireless communication and electronics design. A complete list of my publications and

conference presentations is included in my curriculum vitae.

12. I am a named inventor on 20 patents in the US and in Europe. In particular, I am a named inventor on patents relating to antenna design, RF systems, and means of reducing signal interference in RF applications. A complete list of my patents and published applications is included in my curriculum vitae.

13. In addition to gaining expertise via my academic training, professional experiences, and research accomplishments described above, I have kept abreast of various sub-disciplines within the antennas space, by reading technical literature, attending and presenting at conferences, and attending and presenting at symposia. I have served as an editor for various journals and participated in the peer review process for various technical journals and conferences, and have reviewed manuscripts submitted by other scholars relating to antenna topologies. I have contributed further to the profession by chairing conference committees and planning conferences and panels. Furthermore, I have collaborated with or have communicated with many of the scholars and engineers in the field of antennas systems.

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

III. SUMMARY OF OPINIONS AND MATERIALS CONSIDERED

15. All of the opinions contained in this declaration are based on the documents I have reviewed and my professional judgment, as well as my education, experience, and professional knowledge. I am not an attorney and I am not offering any legal opinions in this declaration.

16. In forming my opinions expressed in this declaration, I relied on the '604 patent (EX1001), the prosecution history of the '604 patent (EX1007), the prior art references cited herein (EX1005, EX1006), and other exhibits I have cited in this declaration. Each of these documents is a type of document that an expert in my field would have reasonably relied upon when forming their opinion.

17. My opinions are additionally guided by my appreciation and understanding of how a POSITA would have understood the claims of the '604 patent at the time of the alleged invention.

18. Based on my experience and expertise, it is my opinion that:

- Ground 1: Claims 1, 3, 4, 9, and 13 of the '604 patent should be found unpatentable based on the understanding a POSITA would have of U.S. Patent No. 6,239,765 ("Johnson").
- Ground 2: Claims 1, 4, and 13 of the '604 patent should be found unpatentable based on the understanding a POSITA would have of U.S. Patent No. 6,509,882 ("McKivergan").

IV. LEVEL OF SKILL IN THE ART

19. I understand that patents are interpreted from the perspective of a hypothetical POSITA at the time of the alleged invention. I also understand that the priority date of the '604 patent is alleged by the Patent Owner to be September 10, 2002 ("Priority Date"). As of this Priority Date, I was at least a person of ordinary skill in the art of the '604 patent, and I had personal knowledge of the technologies involved in the '604 patent.

20. I also understand that various factors are considered in determining the level of ordinary skill in the art. I understand that the factors include types of problems encountered in the art, prior solutions to those problems, rapidity with which innovations are made, sophistication of technology at the time of the invention, and educational levels and experience of persons working in the field and capable of understanding the applicable scientific and engineering principles. I understand that in determining the level of ordinary skill in the art, not all factors may be present or one or more factors may predominate.

21. According to the Patent Owner in the Litigation, a person of ordinary skill in the art ("POSITA") as of the earliest claimed priority date of September 10, 2002¹ would have had "at least a bachelor's degree in electrical engineering,

¹ While not disputed for purposes of the asserted Grounds, Petitioner reserves the right to dispute the priority claim of the Challenged Claims in other proceedings.

computer science, or a similar degree and at least four years of experience in applied electromagnetics with an emphasis on antennas” or “[a]lternatively, the person of ordinary skill in the art would have a master’s degree in electrical engineering (or similar discipline) and at least two years of similar experience.” Ex. 1009, ¶32.

22. At least as of the date of the Priority Date of the alleged invention, my education, experience, and professional knowledge qualify me to be a POSITA for the ’604 patent. I am qualified to provide opinions on what a POSITA would have known and understood at the time of the alleged invention (e.g., at least as of the Priority Date).

A. General Principles Known to a POSITA

23. There are several principles relating to the design, implementation, use, and ability to combine components that were well-known to a POSITA relating to security monitoring systems based on my own experiences and disclosures in the prior art. These principles are applicable to all the prior art discussed in this report. In combining references identified herein, a POSITA would recognize that there is an implicit motivation to combine features from different references in the prior art when the combination of references results in a product or process that is more desirable—for example because it is better, stronger, cheaper, cleaner, faster, lighter, smaller, more durable, or more efficient.

It is often the goal in design work to combine desirable features to create an improved product. This applies to the combinations discussed throughout this report when combining features would result in a better, more flexible, more robust security system.

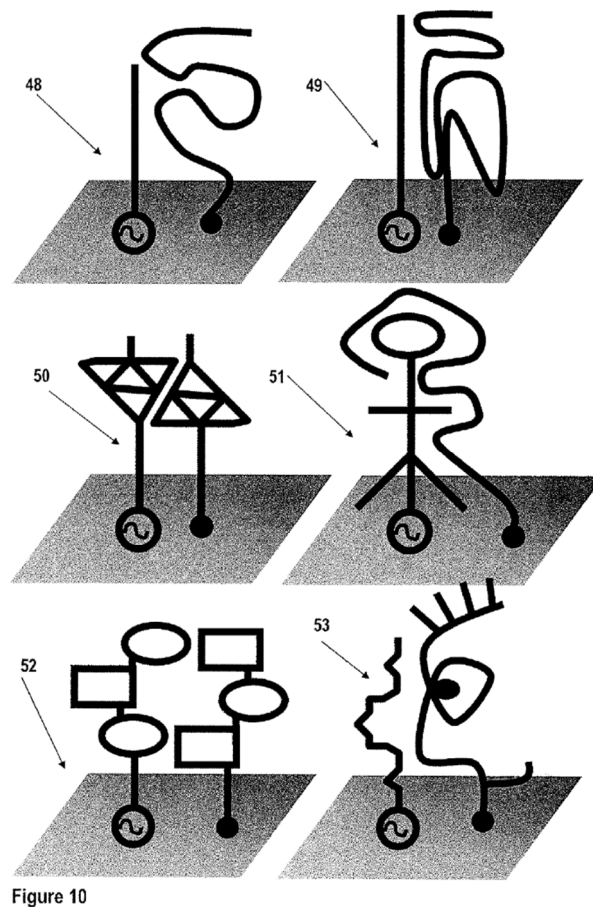
V. OVERVIEW OF U.S. PATENT NO8,994,604 (EX1001)

A. Description of the Specification

24. The '604 Patent, titled "Coupled Multiband Antennas," was filed on December 5, 2007 and issued on March 31, 2015. EX1001, cover page. I understand that the '604 patent issued from United States Patent Application No. 11/950,835, and claims priority to United States Patent Application No. 11/075,980 filed on September 10, 2002. I have used September 10, 2002 as the date of the alleged invention of the Challenged Claims for purposes of my analysis and opinions.

25. The '604 patent is directed to "an antenna comprising at least two radiating structures, said radiating structures taking the form of two arms, said arms being made of or limited by a conductor[] ... said two arms being coupled to each other through a region on first and second arms such that the combined structure of the coupled two-arms forms a small antenna with a broadband behavior, a multiband behavior or a combination of both effects." EX1001, 2:57-65. Coupling between the two radiating arms, in the context of the '604 patent, "is

obtained by means of the shape and spatial arrangement of said two arms, in which at least one portion on each arm is placed in close proximity to each other ... to allow electromagnetic fields in one arm being transferred to the other through said specific close proximity regions.” EX1001, 2:65-3:5. “Particular examples of coupled antennas using complex configuration and designs are [shown] in Drawings 48 to 53 in FIG. 10, but it appears clear to any skilled in the art that many other geometries could be used instead within the same spirit of the invention.” EX1001, 9:18-25 (emphasis added). Accordingly, as expressly noted in the ’604 patent, “[t]he shape and size of the arms [of the claimed antennas] could be of any type.” EX1001, 9:26.



EX1001, Figure 10.

26. As detailed below, however, it is my opinion that such a coupled multiband antenna system was well-known before the '604 patent.

B. Prosecution History of the '604 patent (EX1012)

27. I understand that during prosecution the '604 patent, the Examiner rejected claims as anticipated or obvious. EX1007, 47-57. And that the applicant amended the claims and proposed several new claims to overcome the Examiner's rejections. EX1007, 60-65. I also understand that the Examiner allowed the Challenged Claims, in particular, because the Examiner believed that the prior art

of record did not “teach, nor render obvious, [the claimed] orthogonal projection of the line segment onto a plane of the ground plane structure[, which] does not intersect the ground plane structure;” and “the first radiating arm, the second radiating arm, and the close proximity region [that] are configured to simultaneously provide the bandwidth required for the antenna system to operate in the multiple frequency bands[.]” EX1007, 203-04.

28. It is my opinion, however, that the prior art, including at least Johnson and McKivergan, does teach and/or render obvious each and every limitation recited in the Challenged Claims.

29. I understand that that the Examiner rejected claims based on McKivergan relatively early in the prosecution of the '604 patent. EX1007, 54-55. I also understand that the applicant cancelled all pending claims in response to the Examiner's rejection based on McKivergan and proposed a new set of claims. EX1007, 60-65. Moreover, I understand that the Examiner did not again substantively consider McKivergan during prosecution of the '604 patent, including with regard to the Challenged Claims.

VI. THE CHALLENGED CLAIMS OF THE '604 patent

30. I understand that claims 1, 3, 4, 9, and 13 of the '604 patent are being challenged. Claims 1, 3, 4, 9, and 13 of the '604 patent are reproduced below:

A. Claim 1

1. A wireless portable device comprising:

a printed circuit board comprising a ground plane structure;

an antenna system operating in multiple frequency bands, the antenna system comprising:

a first radiating arm comprising a first-radiating-arm first tip, a first-radiating-arm second tip, and a feeding terminal connected to the first-radiating-arm first tip, wherein the first radiating arm is not connected to the ground plane structure through a grounding terminal; and

a second radiating arm comprising a second-radiating arm first tip, a second-radiating-arm second tip, and a grounding terminal connected to the second-radiating-arm first tip, wherein the second radiating arm does not include a contact point with first radiating arm, wherein: the first radiating arm and the second radiating arm are coupled through a close proximity region from a first specific portion of the first radiating arm and from a second specific portion of the second radiating arm;

a length of a line segment between a point of the first specific portion and a point of the second specific portion is shorter than a distance between the feeding terminal and the grounding terminal;

an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure; and

the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide the bandwidth required for the antenna system to operate in the multiple frequency bands.

B. Claim 3

The wireless portable device of claim 1, wherein the close proximity region is located at a distance from the feeding terminal that is longer than $1/40$ of the longest free-space operating wavelength of the antenna system.

C. Claim 4

The wireless portable device of claim 1, wherein the first specific portion of the first radiating arm includes the first radiating-arm second tip.

D. Claim 9

The wireless portable device of claim 1, wherein the first radiating arm comprises a portion formed by ten or more connected segments, each of the connected segments forming an angle with its neighboring connected segment, the angle being smaller than 180 degrees, and the segments being shorter than $1/8$ of the longest free-space operating wavelength of the antenna system.

E. Claim 13

A wireless portable device comprising:

a printed circuit board comprising a ground plane structure;

an antenna system operating in multiple frequency bands and included within the wireless portable device, the antenna system comprising:

a first radiating arm comprising a first-radiating-arm first tip, a first-radiating-arm second tip, a feeding terminal connected to the first-radiating-arm first tip, and a first-radiating-arm first point; and

a second radiating arm comprising a second-radiating arm first tip, a second-radiating-arm second tip, and a grounding terminal connected to the second-radiating-arm

first tip, wherein: the second radiating arm does not include a contact point with the first radiating arm;

the first radiating arm and the second radiating arm are coupled through a close proximity region formed by a portion including the first-radiating-arm first point and the second-radiating-arm second tip;

a length of a line segment between the first-radiating arm first point and the second-radiating-arm second tip is shorter than a distance between a point of the feeding terminal and a point of the grounding terminal;

an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure; and

the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide a bandwidth required for the antenna system to operate in the multiple frequency bands.

VII. CLAIM CONSTRUCTION

31. I understand that when considering the meaning of claims subject to *inter partes* review, one must consider the claim language. I understand that claim terms are generally given their ordinary and customary meaning, as would be understood by one with ordinary skill in the art at the time of invention in the context of the specification, the prosecution history, and other claims. For my opinions in this declaration, unless otherwise stated, I have been asked to consider the Challenged Claims under their ordinary and customary meanings as understood by a POSITA at the time of the alleged invention. I have applied the above principles in forming my opinions provided in this declaration.

VIII. LEGAL PRINCIPLES

32. I am not an attorney and I have not been asked to express any legal opinions. Rather, in connection with the analysis presented in this declaration, I considered the following legal standards that counsel for Petitioner provided to me.

A. Burden of Proof

33. I understand that the Petitioner has the burden of proving the unpatentability of the patent claims by a preponderance of the evidence, which I understand as meaning more than 50% likely.

B. Anticipation

34. I understand that a claim is anticipated, and therefore not patentable, if each and every element of that claim is found in a single prior art reference. I further understand that, if a prior art reference does not explicitly disclose every element of a claim, the claim may still be anticipated and rendered invalid if the claim elements not explicitly disclosed are inherently disclosed. However, I understand that to inherently disclose an element, that element must be necessarily present in the prior art reference and that inherency cannot be established through mere probabilities or possibilities.

C. Obviousness

35. I understand that a claim is obvious, and therefore not patentable, if at the time of the invention, the subject matter of the claim as a whole would have been obvious to a person of ordinary skill in the art. I understand that a proper

obviousness analysis must consider the following four factors: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences between the claimed subject matter and the prior art; and (4) any objective indicia of non-obviousness.

36. I understand that a reason to combine that merely describes the resulting combination without explaining the particular reason why one of ordinary skill would combine the elements of the prior art in order to form Patent Owner's claimed invention is merely conclusory and based on impermissible hindsight reasoning. It is not enough to simply show that the references disclose each element of a claim; it is also necessary to identify a reason that would have prompted a person of ordinary skill in the art to combine the elements in the manner set forth in the claim. I understand that a prima facie case of obviousness requires more than describing the results of the proposed combination. Rather, the Petitioner must articulate a reason for making the proposed combination in the first instance. I further understand that it is not enough to conclude that, once the proposed combination is made, the result is predictable; an obviousness finding requires that the Petitioner provide a reason, supported by a rational foundation, which explains why one of ordinary skill would have chosen to make the particular combination in the first place.

37. I understand that, in analyzing the four obviousness considerations, a

party challenging a patent must show that: (1) each and every limitation of the claimed subject matter was disclosed in the combination of prior art references; (2) a person of ordinary skill in the art would have been motivated to combine the teachings of the prior art references to achieve the claimed subject matter; and (3) there would have been a reasonable expectation that the combination of such teachings would achieve the claimed subject matter.

38. I understand that, in addition to its analysis of the teachings of the prior art, the fact finder must consider the patent owner's proffer of objective indicia of non-obviousness, including: (1) commercial success; (2) professional approval and praise by others; (3) expressions of disbelief and skepticism of those skilled in the art upon learning of the invention; (4) licenses showing industry respect and commercial acquiescence to the invention; (5) copying; (6) long felt but unresolved need, and failure of others to solve the problem, including the passage of time between publication of the prior art and the invention; and (7) unexpected results. In reviewing the file history of the '604 patent and the other information discussed in this declaration, I am not currently aware of any evidence supporting any of the above factors.

IX. OVERVIEW OF CITED REFERENCES

39. Each of the below cited references relates generally to the field of antenna systems, including coupled antenna arrays for increased bandwidth of

operation. A POSITA would have been aware of all of these references and recognized the common attributes among them, especially because each relates to improvements over traditional antenna systems that lacked the improved isolation for different frequency bands provided by the multiband antennas discussed below.

A. “Johnson” EX1005

40. U.S. Patent No. 6,239,765 (“Johnson,” EX1005), issued on May 29, 2001. Johnson was not referenced during prosecution of the ’604 Patent.

B. “McKivergan” EX1006

41. U.S. Patent No. 6,509,882 (“McKivergan,” EX1006) published as U.S. Patent Publication No. 2002/0075187 on June 20, 2002. McKivergan was referenced during prosecution of the ’604 Patent. *See* EX1007, 54-55. However, McKivergan was not cited in any rejection that pertains to the Challenged Claims.

X. GROUNDS OF UNPATENTABILITY

42. As established below, it is my opinion that all features of the Challenged Claims were well known in the prior art.

A. Ground 1: Claims 1, 3, 4, 9, and 13 are Rendered Unpatentable by Johnson

1. Claim 1

i. “A wireless portable device comprising:”

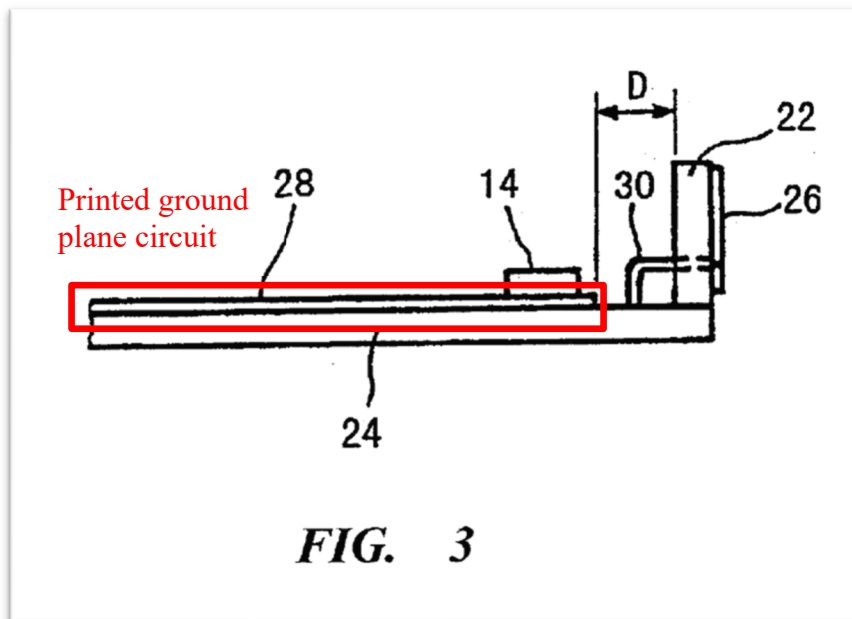
43. The “antenna assembly” of Johnson is designed to be used in “wireless portable device[s]” such as “cellular telephones.” For example, as

Johnson explains, the disclosed “antenna assembly” is “effective over two or more resonance frequency bands” “for [] wireless communication devices, such as a cellular telephone.” EX1005, 1:13-18.

ii. “a printed circuit board comprising a ground plane structure”

44. It is my opinion that the “second conductor trace 28” of Johnson is the claimed “printed circuit board.” Johnson discloses a device comprising conductive traces “printed on any number of conventional dielectric materials having a low to moderate dielectric loss such as plastics and fiberglass.” EX1005, 2:45-48.

45. Specifically, Johnson discloses an antenna assembly 20 with a second conductor trace 28 or circuit ground trace 28, which “is the printed ground plane circuit of the [antenna assembly].” EX1005, 2:18-26. For example, as can be seen in annotated FIG. 3 (below), Johnson depicts the printed ground plane circuit 28 of the disclosed antenna assembly. 1005, FIG. 3 (annotated).



iii. **“an antenna system operating in multiple frequency bands, the antenna system comprising:”**

46. It is my opinion that Johnson discloses that its antenna assembly 20 operates in multiple frequency bands. *See, e.g.*, EX1005, 1:28-29 (“FIG. 7 illustrates a front elevational view of a dual band antenna assembly”) (emphasis added), 5:25-27 (“feedpoint 32a is for high frequency band, while the feedpoint 32b is for a lower frequency band”). In fact, Johnson explains that antenna assembly 20 can operate within “multiple frequency wireless communication devices, for instance devices operating over the GPS (1575 MHz), cellular telephone (824–890 MHz and 860-890 MHz), PCS device (1710–1880 MHz, 1750–1870MHz, and 1850–1990 MHz), cordless telephone (902-928MHz), or

BLUETOOTH specification (2.4-2.5 GHz.) frequency ranges.” 1:48-55 (emphasis added).

- iv. **“a first radiating arm comprising a first-radiating-arm first tip, a first-radiating-arm second tip, and a feeding terminal connected to the first-radiating-arm first tip, wherein the first radiating arm is not connected to the ground plane structure through a grounding terminal”**

47. It is my opinion that Johnson’s low-frequency conductive trace 26b constitutes the claimed first radiating arm. Specifically, Johnson describes an antenna device that “functions across a pair of frequency bands for dual band transceiver devices.” EX1005, 5:16-18. The device includes a low-frequency conductive trace 26b configured for the “lower frequency band” of the antenna’s operating frequency. EX1005, 5:16-28.

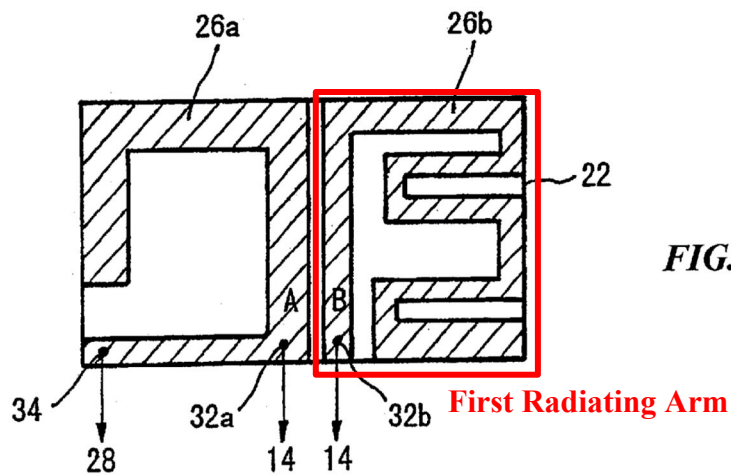
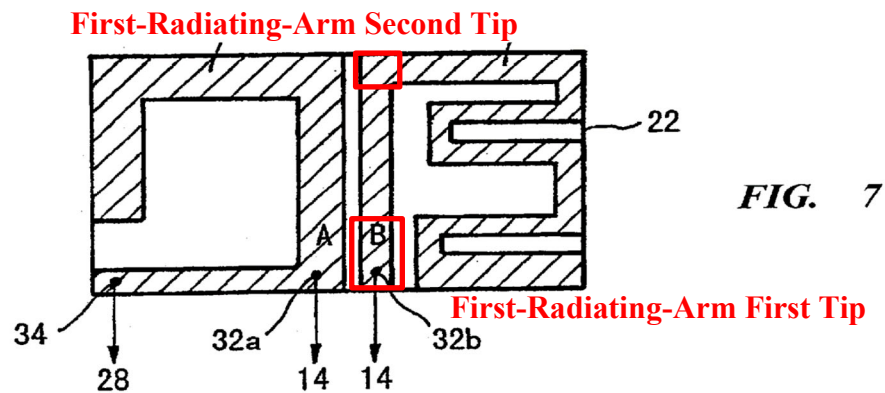


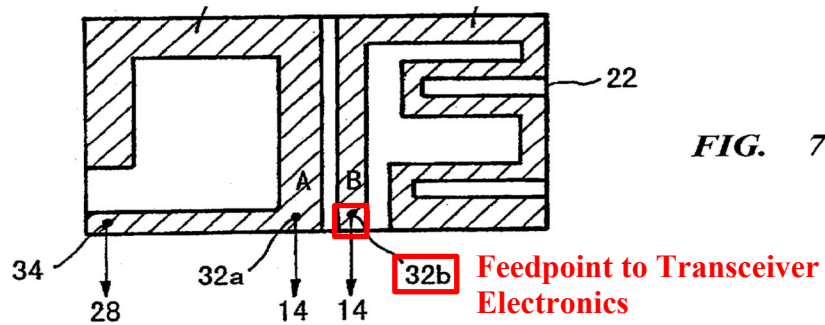
FIG. 7

48. First, it is my opinion that Johnson’s low-frequency conductive trace 26b also has the claimed first and second “radiating arm tips.” As I explain above, I understand that the Patent Owner has construed the term “radiating arm tip” as recited by the claims of the ’604 Patent to mean a terminal portion or extremity of an antenna. *Supra* VII. I also understand that the ’604 patent does not provide any clear definition for “radiating arm tip.” Furthermore, I understand that the word “tip” only appears twice in the specification of the ’604 patent both of which comport with my application of this definition of “radiating arm tip.” EX1001, 3:14-15 (“the antenna [of Drawing 4] is mounted on a ground-plane (112) and it is fed at one of the tips (102) of arm (110)”), 3:24-25 (“The antenna system [of Drawing 5] is mounted on a ground-plane (112) and it is fed at one of the tips (102) or arm (100)”).

49. Accordingly, when applying the Patent Owner’s position regarding the construction of “tip” in the Parallel Litigation as I understand it, it is my opinion that annotated figure 7 below shows that Johnson’s antenna system includes a first-radiating-arm first tip and a first-radiating-arm second tip as recited in claim 1.



50. Second, it is my opinion that, in Johnson Figure 7, a feeding terminal is connected to first tip of the low-frequency conductive trace 26b (“first radiating arm”). Specifically, Johnson’s low-frequency conductive trace 26b includes a “feedpoint[]” at 32b, which is a connection “between the first conductive trace 26[b] and the transceiver electronics 14.” EX1005, 5:24-26.



51. Thus, it is my opinion that Johnson discloses a “feeding terminal connected to the first-radiating-arm first tip” as recited in claim 1.

52. Third, it is my opinion that the low-frequency conductive trace 26b (“first radiating arm”) is not connected to the ground plane structure through a grounding terminal. As can also be seen in FIG. 7, the low-frequency conductive element 26b is only connected, at the feedpoint 32b to transceiver electronics 14 without any connection to the “circuit ground trace 28” (“ground plane structure”) or “ground connection 34” to “circuit ground trace 28.” See EX1005, 5:1-5; 3:45-46. The high-frequency conductive trace 26a, however, *is connected* to the ground plane structure (“circuit ground trace 28”) via the ground connection 34. And, as explained above, it is my opinion that the “circuit ground trace 28” is the “ground plane structure” recited in the claims. *Supra* X.A.1.ii.

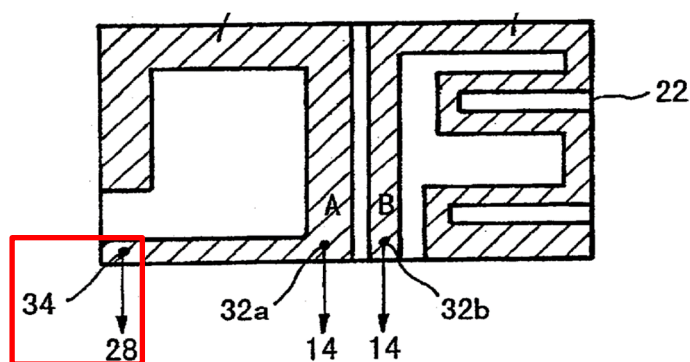


FIG. 7

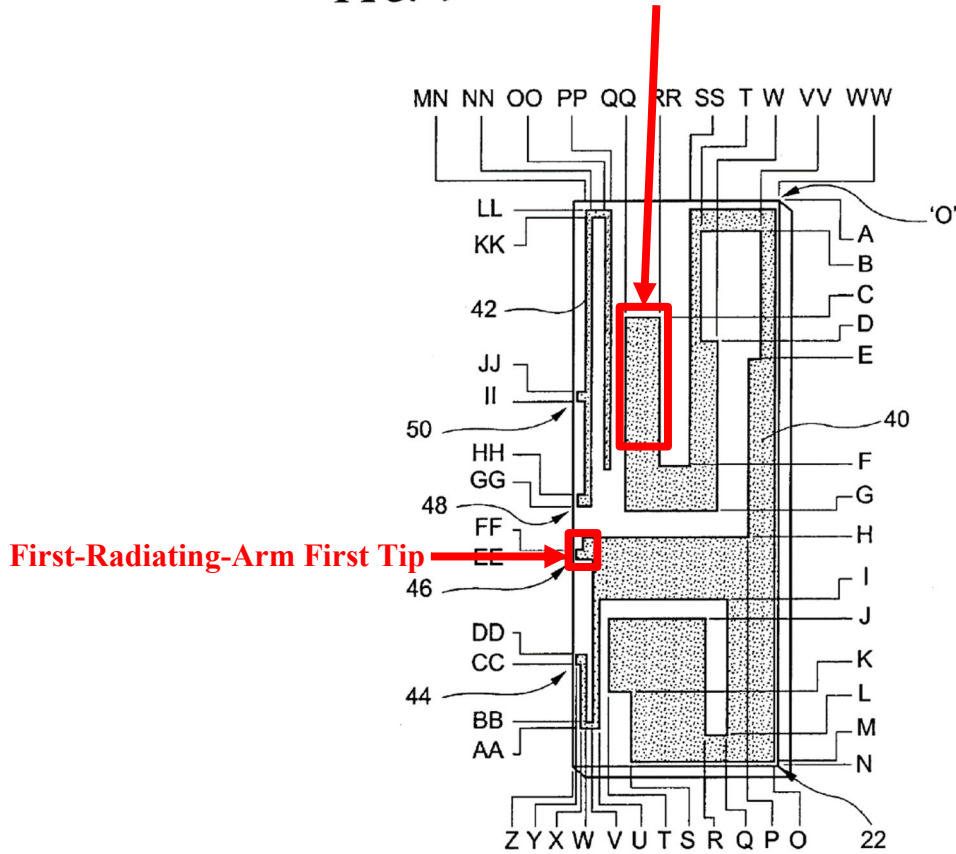
Ground Connection to Circuit Ground Trace

53. Thus, when applying the Patent Owner’s position regarding the construction of “tip” in the Parallel Litigation as I understand it, it is my opinion that Johnson discloses “wherein the first radiating arm is not connected to the ground plane structure through a grounding terminal” as recited in Claim 1 of the ’064 Patent.

54. Additionally, it is also my opinion that a POSITA implementing the antenna assembly of Figure 7 would have considered the embodiment shown in Johnson’s Figure 9, which includes the claimed first radiating arm and the first-radiating-arm tips as indicated in Annotated Figure 9 below.

FIG. 9

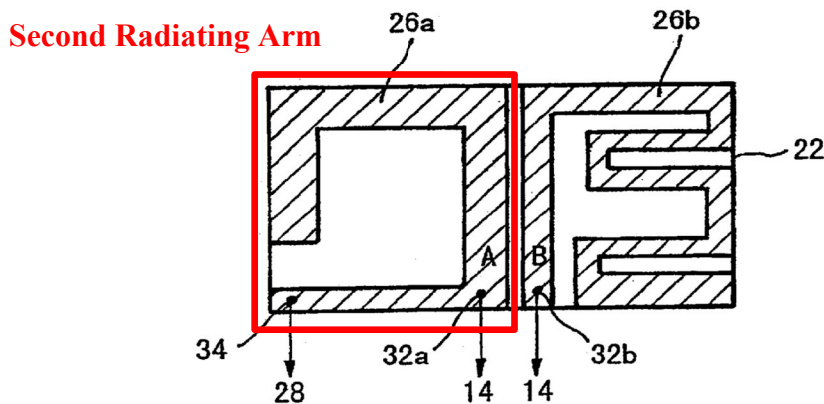
First-Radiating-Arm Second Tip



55. It is my opinion that a POSITA would consider using the particular trace design shown in Figure 9, including the first and second first-radiating-arm tips shown in Annotated Figure 9 above, because of the greater bandwidth provided by that arrangement of the two antenna arrangements and omitting the ground connection to the high-frequency trace 42, as disclosed by Johnson. EX1005, 5:27-28 (“A ground connection is **not** required for the high frequency portion [of the antenna assembly 20]”) (emphasis added).

- v. “a second radiating arm comprising a second-radiating-arm first tip, a second-radiating-arm second tip, and a grounding terminal connected to the second-radiating-arm first tip, wherein the second radiating arm does not include a contact point with first radiating arm, wherein:”

56. It is my opinion that Johnson’s high-frequency conductive trace 26a constitutes the claimed second radiating arm. *See, e.g.*, EX1005, FIG. 7. The antenna device shown in figure 7 includes a second conductive trace 26a configured for a “high frequency band” of the dual band antenna’s operating frequency. EX1005, 5:16-28.



57. First, my opinion is that Johnson’s high-frequency conductive trace 26a includes a second-radiating-arm first tip and a second-radiating-arm second tip. As shown below, and applying the Patent Owner’s position regarding the construction of “tip” in the Parallel Litigation (discussed above) as I understand it,

Figure 7 discloses the first and second second-radiating-arm tips.

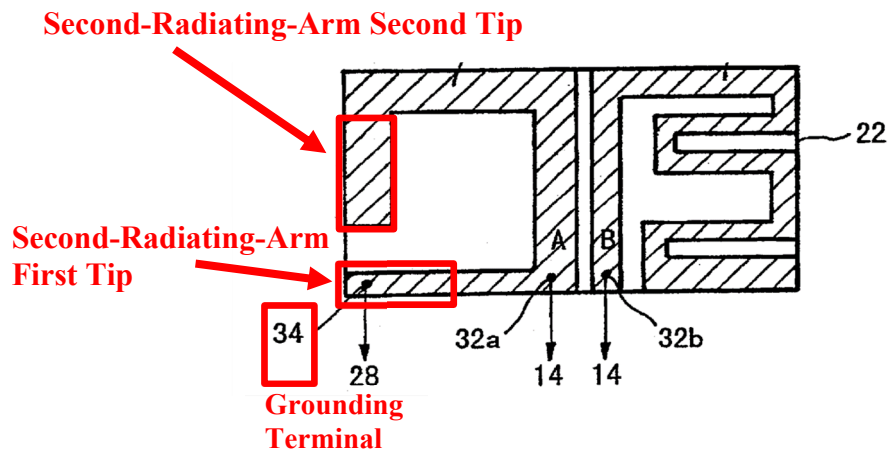


FIG. 7

58. Second, my opinion is that a grounding terminal is connected to the first tip of high-frequency conductive trace 26a (“second radiating arm”), as shown in annotated Figure 7 below. Specifically, the grounding terminal 34 shown in Figure 7 is the connection between the tip of the high-frequency conductive trace 26a and the ground circuit trace 28, which is the “ground plane structure” recited by the claims (as explained above supra X.A.1.ii). EX1005, annotated Figure 7 (below).

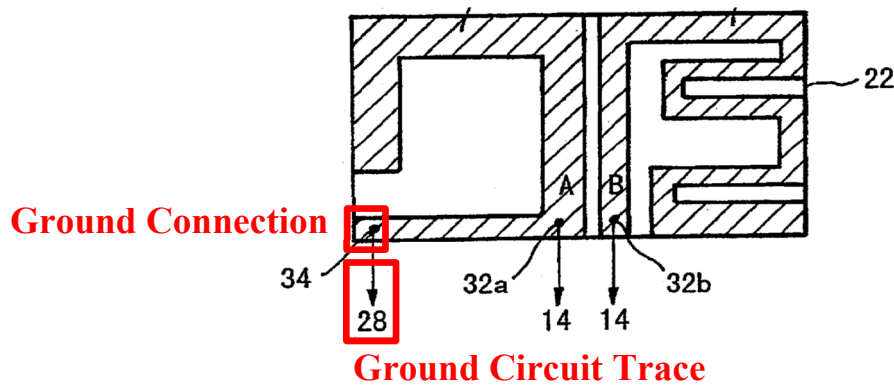


FIG. 7

59. Third, it is my opinion that the high-frequency conductive trace 26a (“second radiating arm”) does not include a contact point with low-frequency conductive element 26b (“first radiating arm”). And that Johnson’s high-frequency conductive trace 26a includes a “ground connection 34” to “circuit ground trace 28” which is a connection between the second conductive trace 26a and the “the ground plane of the second planar element 24[.]” EX1005, 4:59-60 and 5:24-26. As can also be seen in annotated figure 7 (above), Johnson discloses “a grounding terminal connected to the second-radiating-arm first tip” as recited in claim 1.

60. Moreover, the high-frequency conductive element 26a includes only one other connection, which is to the transceiver electronics 14 via the feedpoint 32a. The high-frequency conductive element 26a does not include any other connections, including any connection to the (physically separate) low-frequency conductive element 26b. Thus, it is my opinion that Johnson meets the “the second radiating arm does not include a contact point with first radiating arm” element of

Claim 1.

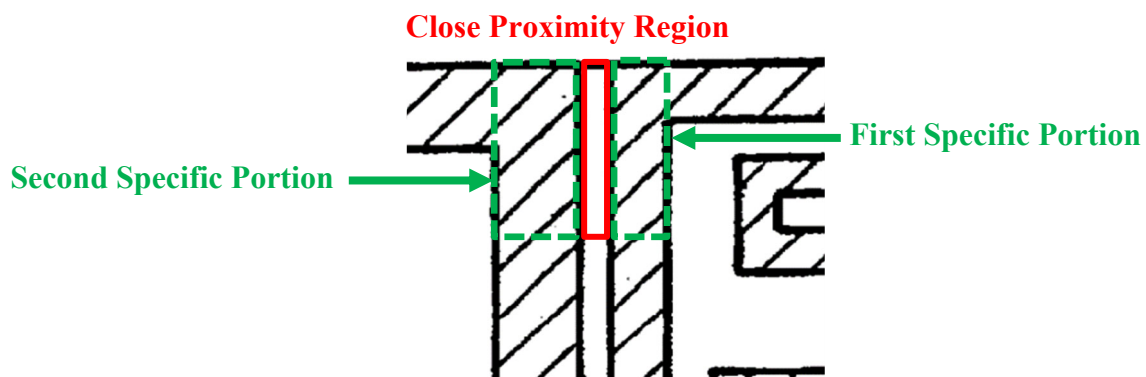
- vi. **“the first radiating arm and the second radiating arm are coupled through a close proximity region from a first specific portion of the first radiating arm and from a second specific portion of the second radiating arm”**

61. Johnson discloses that the low-frequency conductive trace 26b (“first radiating arm”) and high-frequency conductive trace 26a (“second radiating arm”) are coupled through the recited “close proximity region.” I understand that, for purposes of this matter, the Petitioner has adopted the Patent Owner’s position in the Parallel Litigation regarding the construction of the “couple through a close proximity region” and the “close proximity” elements of the Challenged Claims. I further understand that the Petitioner has done so for the sake of argument and I have done likewise where appropriate in my petition (as noted at the relevant portions of this declaration). I understand the Patent Owner’s position to be that both terms are not indefinite and do not require specific construction. EX1004, 47, 69. Additionally, it is my understanding that the ’604 Patent describes the “close proximity region” as being “a portion on each [radiating] arm [that are] placed in close proximity to each other (for instance, at a distance smaller than a tenth of the longest free-space operating wavelength) to allow electromagnetic fields in one arm being transferred to the other through said specific close proximity regions.” EX1001, 3:1-5 (emphasis added). Accordingly, it is my opinion that being able to

“allow electromagnetic fields in one arm [to be] transferred to the other” is the primary feature of the recited “close proximity region.” EX1001, 3:1-5.

Additionally, it is my opinion that the “specific portion” of the radiating arms is merely that portion of the radiating arm where at least a portion of electromagnetic fields are transferred from one radiating arm to the other. *Id.* And, according to the size of the region between the conductive traces 26a and 26b as can be seen in Figure 7, it is my opinion that the close proximity region between the high-frequency conductive trace 26a and the low-frequency conductive trace 26b (as I show in annotated Figure 7 below) is small enough to allow coupling of electromagnetic waves between the two traces 26a, 26b.

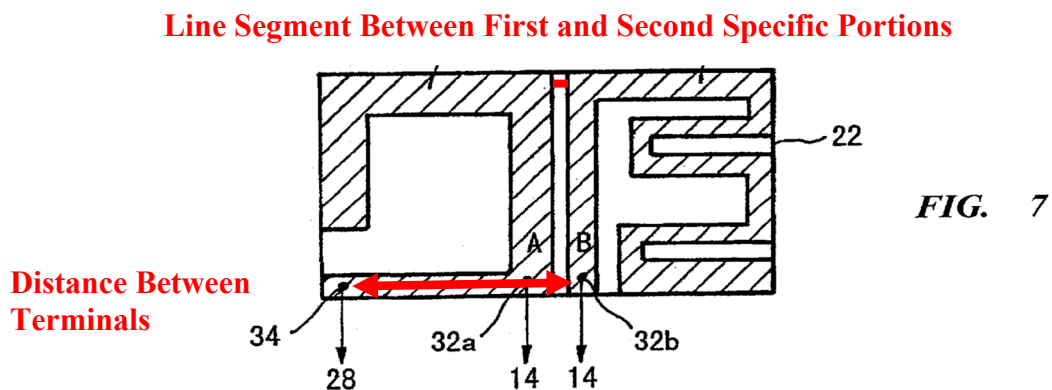
62. As discussed above (and shown below), Figure 7 depicts a multiband antenna device with two radiating arms disposed in close proximity and configured to operate in tandem. EX1005, Figure 7.



63. Accordingly, it is my opinion that Johnson meets this limitation.

- vii. “a length of a line segment between a point of the first specific portion and a point of the second specific portion is shorter than a distance between the feeding terminal and the grounding terminal;”

64. It is also my opinion that in Figure 7 of Johnson, the length of a line segment between the first and second specific portions of conductive elements (26a, 26b) is shorter than the distance between the feedpoint 32b (“feeding terminal”) and the ground connection 34 (“grounding terminal”). To illustrate this, I have added the following lines to annotated Figure 7 (below): (1) a line connecting the first specific portion of the of the first radiating arm to the second portion of the of the second radiating arm and (2) a line connecting feedpoint 32b (“feeding terminal”) and the ground connection 34 (“grounding terminal”).



65. As can easily be seen, the distance between the terminals is far greater than the distance between the first and second specific portions. Thus, as shown

above, it is my opinion that a length of a line segment between a point of the first specific portion and a point of the second specific portion is shorter than a distance between the feeding terminal and the grounding terminal.

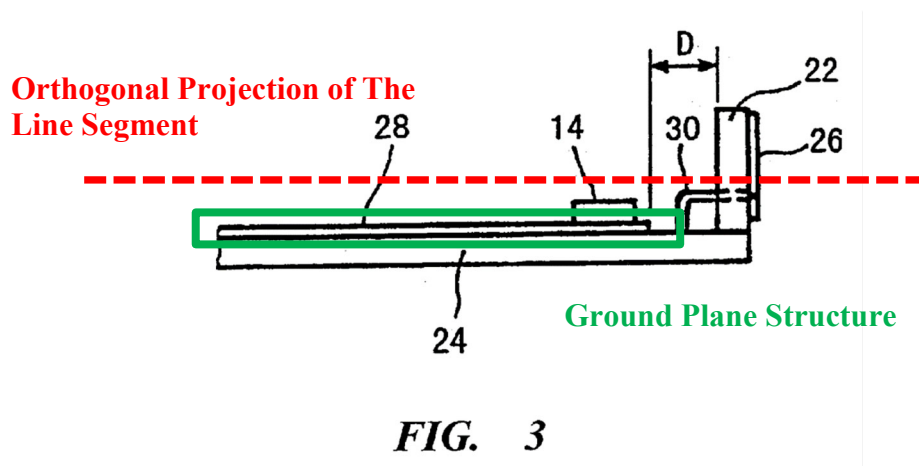
viii. “an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure; and”

66. It is my opinion that an orthogonal projection of the line segment (discussed above) onto a plane of the printed ground plane circuit 28 (“ground plane structure”) does not intersect the printed ground plane circuit 28. The orthogonal projection of the line segment (shown below in annotated Figure 3 below) is a projection of the line segment, rotated 90 degrees (e.g., orthogonal to the line segment shown above in annotated Figure 7) on the same plane as the printed ground structure (*i.e.*, along the same dimension on which the printed ground circuit 28 is oriented).

67. As mentioned previously, the ground circuit trace 28 is the claimed “ground plane structure.” *Supra* X.A.1.ii. Accordingly, Johnson discloses the antenna assembly shown in Figure 3 with the planar element 22 that is shown in Figure 7 oriented perpendicular to the ground circuit trace 28. Stated differently, the planar element 22, where the conductive elements 26a and 26b are located, is disposed in an orthogonal orientation relative to the ground plane structure 28.

EX1005, 4:35-37. Accordingly, it is my opinion that Figure 3 of Johnson meets

this limitation, as shown in annotated Figure 3, below.



- ix. **“the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide the bandwidth required for the antenna system to operate in the multiple frequency bands”**

68. For the reasons explained below, it is my opinion that Johnson discloses this limitation. *See, e.g.*, EX1005, 1:28-29 (“FIG. 7 illustrates a front elevational view of a dual band antenna assembly”) (emphasis added), 5:25-27 (“feedpoint 32a is for high frequency band, while the feedpoint 32b is for a lower frequency band”). Additionally, Johnson’s antenna assembly 20 can operate within “multiple frequency wireless communication devices, for instance devices operating over the GPS (1575 MHz), cellular telephone (824–890 MHz and 860–890 MHz), PCS device (1710–1880 MHz, 1750–1870MHz, and 1850–1990 MHz),

cordless telephone (902-928MHz), or BLUETOOTH specification (2.4-2.5 GHz.) frequency ranges.” 1:48-55 (emphasis added). Thus, it is my opinion that Johnson’s antenna device meets this limitation.

2. Claim 3

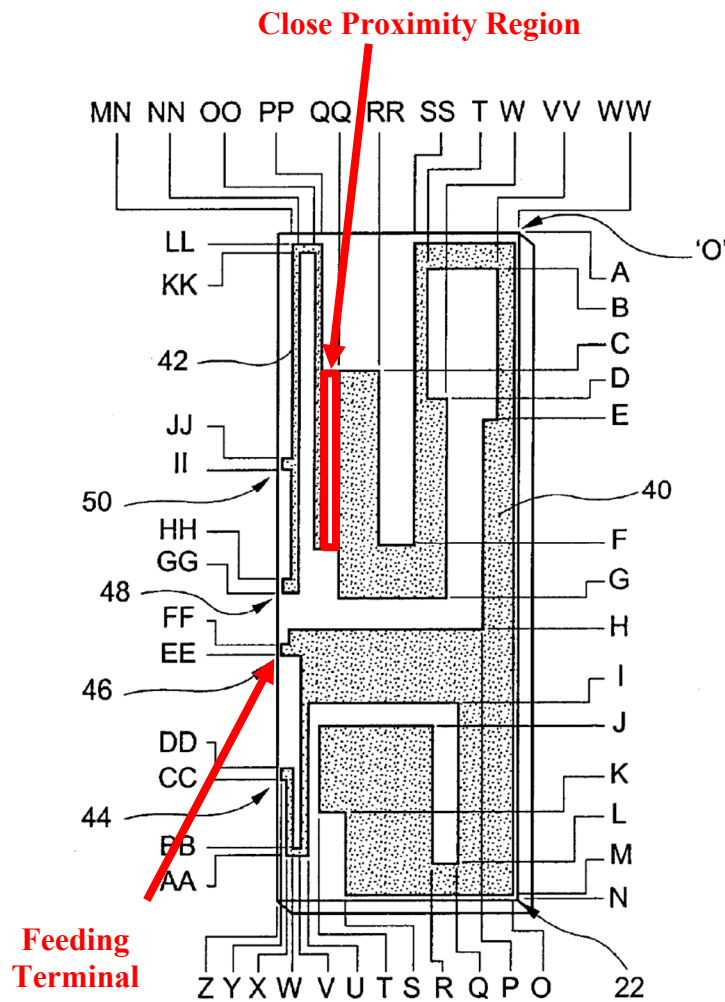
- i. “The wireless portable device of claim 1, wherein the close proximity region is located at a distance from the feeding terminal that is longer than 1/40 of the longest free-space operating wavelength of the antenna system.”**

69. Johnson discloses the sizing of the antenna elements that are needed for the desired applications. EX1005, 3:57-62. More specifically, Johnson explains that its disclosure includes alternative versions of the antenna assembly 20 described above that are “scaled in proportion to provide operation at other frequencies[.]” EX1005, 3:57-60. Moreover, Johnson teaches the use of an impedance matching network with a length that is based on a fraction of the operating wavelength of the antenna device (20). EX1005, 5:1-8.

70. Johnson’s Figure 9 discloses an antenna assembly with a proximity region located a distance from the feeding terminal (feedpoint 46) that is more than 1/40 of the longest free-space operating wavelength of the antenna system 20. *See* EX1005, 5:35-50, TABLE 1, and annotated FIG. 9 (below). Specifically, it is my opinion that the distance from the proximity region of Figure 9 is at least equal to the distance from point FF to point F. *Id.* It is my opinion that, based on the values

given in TABLE 1, Johnson discloses the distance from FF to F being equal to 0.145161 meters and that $1/40^{\text{th}}$ of the longest wavelength of operation, which corresponds to a frequency of 824Mhz, is approximately 0.00910 meters, or less than the 0.145161 meter distance from the feedpoint (point FF) to the close proximity region (point F), as shown in annotated Figure 9 below and Table 1.

FIG. 9

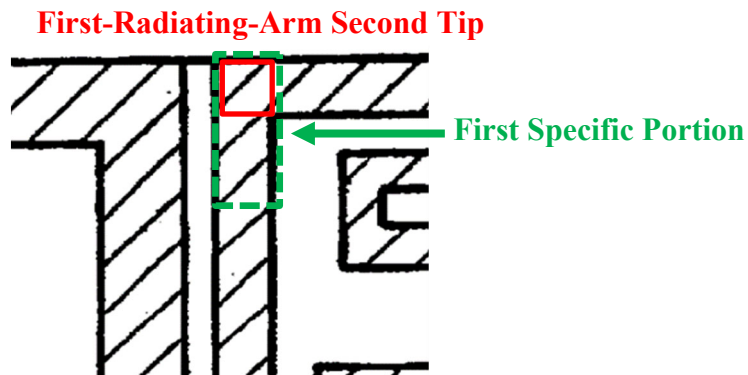


71. Accordingly, it is my opinion that a POSITA would have considered a scaled version of the antenna device 20 shown in Figure 7 that is scaled according to the dimensions of the embodiment explicitly disclosed in Figure 9.

3. Claim 4

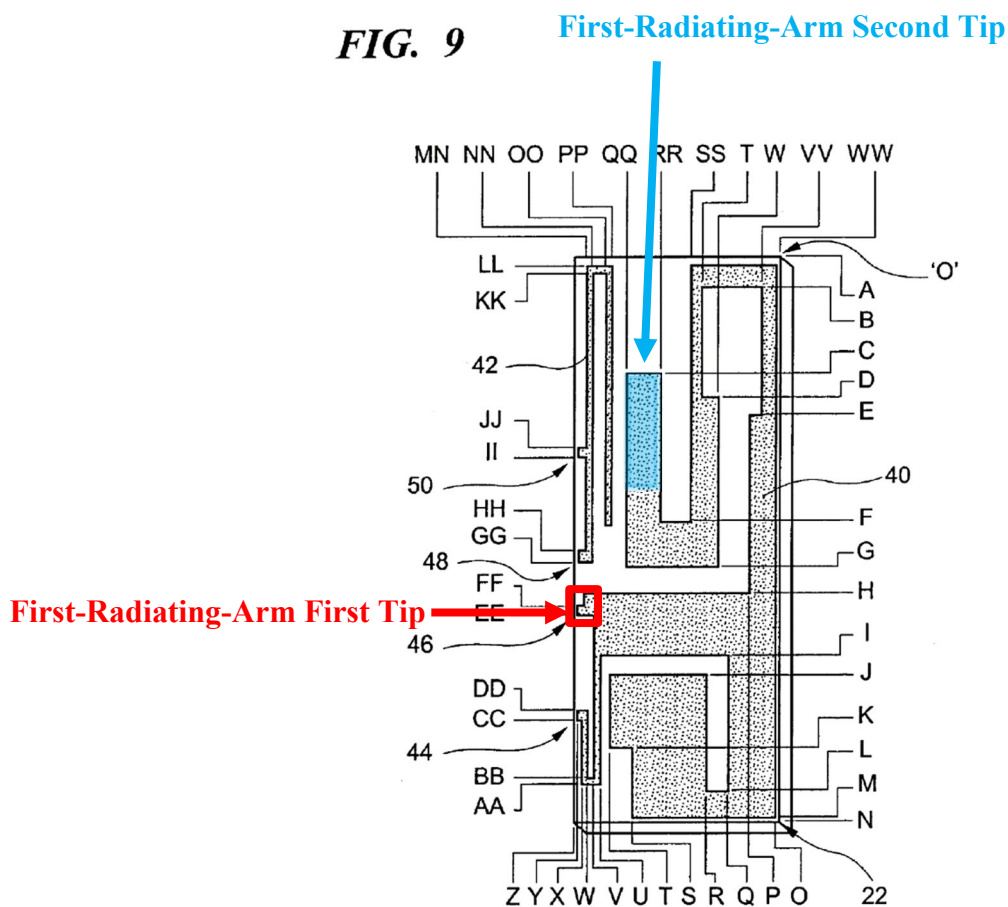
- i. **“The wireless portable device of claim 1, wherein the first specific portion of the first radiating arm includes the first-radiating-arm second tip.”**

72. For at least the reasons explained below, it is my opinion that Johnson discloses this limitation in Figure 7. *Supra* X.A.1.iii-V. As can be seen in annotated Figure 7 below, the “first-radiating-arm second tip” is within the “first specific portion of the first radiating arm”

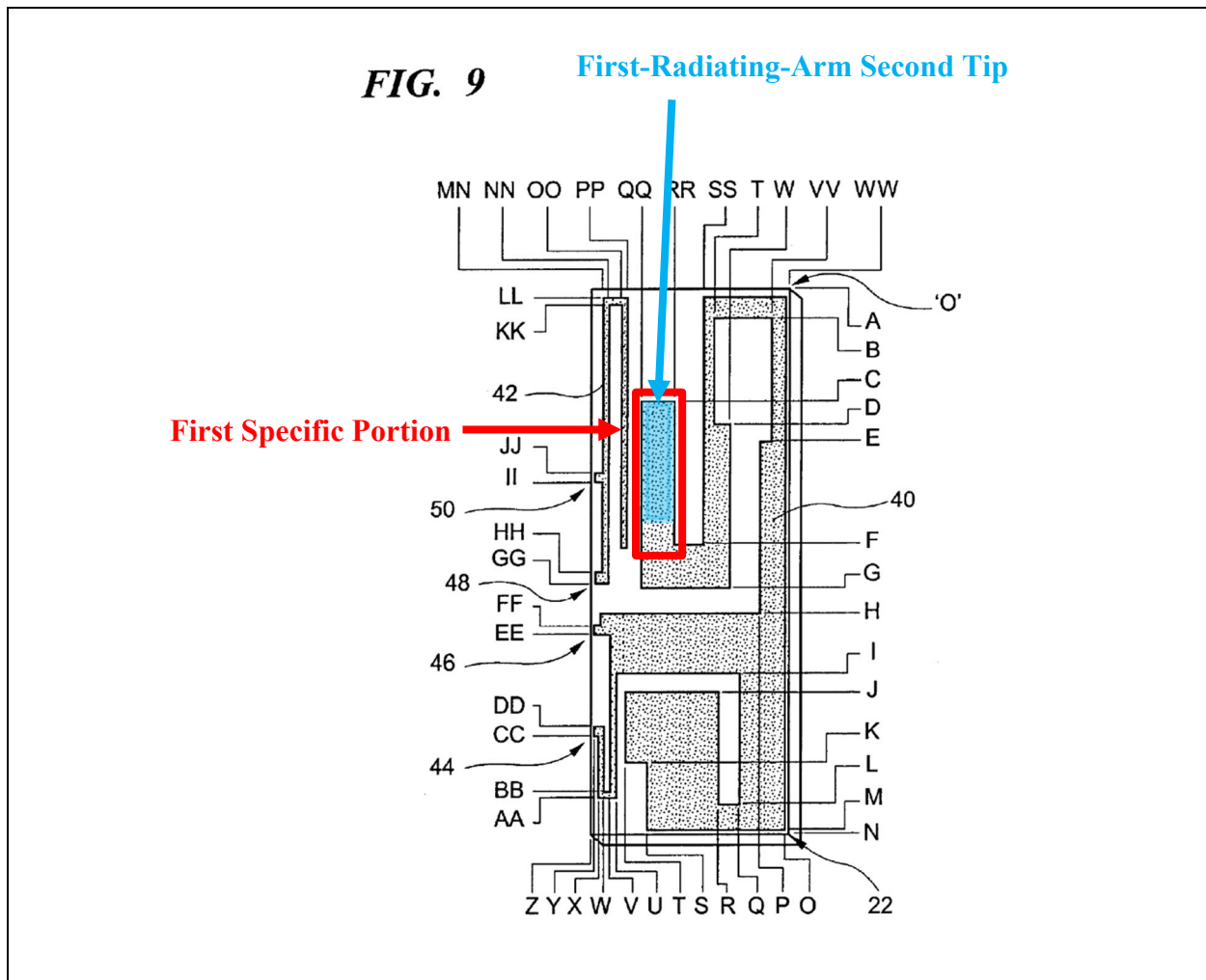


73. Moreover, as explained above, it is also my opinion that a POSITA would have considered the embodiment shown in Johnson’s Figure 9 when

implementing the conceptual antenna system shown in Figure 7. And, as also explained above, it is my opinion that Figure 9 includes the claimed first radiating arm and first-radiating-arm tips as indicated in Annotated Figure 9 below, when implementing the antenna assembly 20 of Figure 7.



74. It is also my opinion that the first specific portion of the first-radiating-arm of the antenna assembly in Figure 9 would also include the first-radiating-arm second tip recited in the Challenged Claims, as shown in annotated Figure 9 below.



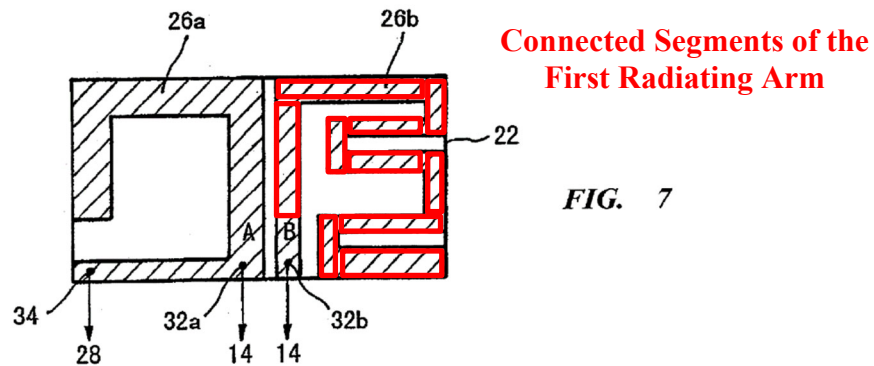
75. It is my opinion that a POSITA would consider using the particular trace design shown in Figure 9, including the first and second First-Radiating-Arm tips shown in Annotated Figure 9 above, because of the greater bandwidth provided by that arrangement of the two antenna arrangements and omitting the ground connection to the high-frequency trace 42, as disclosed by Johnson. EX1005, 5:27-28 (“A ground connection is **not** required for the high frequency portion [of the antenna assembly 20]”) (emphasis added).

76. Accordingly, it is my opinion that Johnson's Figure 7 meets this limitation.

4. Claim 9

- i. "The wireless portable device of claim 1, wherein the first radiating arm comprises a portion formed by ten or more connected segments, each of the connected segments forming an angle with its neighboring connected segment, the angle being smaller than 180 degrees, and the segments being shorter than $\frac{1}{8}$ of the longest free-space operating wavelength of the antenna system.**

77. It is my opinion, as explained below, that Johnson's low-frequency conductive trace 26b shown in Figure 7 meets this limitation. As shown in Annotated Figure 7 (below), Johnson's low-frequency conductive trace 26b is a "meandering first conductor trace" and consists of ten segments, which are each connected at a 90 degree angle. Moreover, it is my opinion that the total length of the low-frequency conductive trace 26b would be, at most, $\frac{1}{4}$ of the longest free-space wavelength for the antenna. Because the low-frequency trace 26b is made up of 10 segments that, together, equal $\frac{1}{4}$ the length of the longest wavelength, each of the ten segments is likewise equal to approximately $\frac{1}{10}$ of $\frac{1}{4}$ (or $\frac{1}{40^{\text{th}}}$) of the longest operating wavelength. Thus, each of the ten segments that make up the low-frequency conductive trace 26b is shorter than $\frac{1}{8}$ of the longest free-space operating wavelength. EX1005, 4:21-22, Figure 7.



78. Additionally, as I explained above, Johnson describes that, for the antenna device 20, the distance between feedpoint 32 and ground trace 28 can be “approximately 0.03” times “a wavelength within the range of [the] antenna operating frequencies.” EX1005, 5:4-8. Further showing that the lengths of the ten connected segments of trace 26b (shown above in red) are each shorter than $1/8^{\text{th}}$, or 0.125 times, the longest operating wavelength.

5. Claim 13

- i. **“A wireless portable device comprising: a printed circuit board comprising a ground plane structure”**

79. It is my opinion that this limitation is disclosed for at least the same reasons discussed with respect to Claim 1 above. *See* Section X.A.1.i-ii.

- ii. **“an antenna system operating in multiple frequency bands and included within the wireless portable device, the antenna system comprising:”**

80. It is my opinion that this limitation is disclosed for at least the same

reasons discussed with respect to Claim 1 above. *See* Section X.A.1.i-X.A.1.iii; EX1005, 3:63-65 (“FIG. 1 illustrates an antenna assembly 20 disposed within a wireless communication device”).

- iii. **“a first radiating arm comprising a first-radiating-arm first tip, a first-radiating-arm second tip, a feeding terminal connected to the first-radiating-arm first tip, and a first-radiating-arm first point; and”**

81. It is my opinion that this limitation is disclosed for at least the same reasons discussed with respect to Claim 1 above. *See* Section X.A.1.iv.

- iv. **“a second radiating arm comprising a second-radiating-arm first tip, a second-radiating-arm second tip, and a grounding terminal connected to the second-radiating-arm first tip, wherein: the second radiating arm does not include a contact point with the first radiating arm”**

82. It is my opinion that this limitation is disclosed for at least the same reasons discussed with respect to Claim 1 above. *See* Section X.A.1.v.

- v. **“the first radiating arm and the second radiating arm are coupled through a close proximity region formed by a portion including the first-radiating-arm first point and the second-radiating-arm second tip;”**

83. It is my opinion that this limitation is disclosed for at least the same reasons discussed with respect to Claim 1 above. *See* Section X.A.1.vi.

- vi. **“a length of a line segment between the first-radiating-arm first point and the second-radiating-arm second tip is shorter than a distance between a point of the feeding terminal and a point of the grounding terminal;”**

84. It is my opinion that this limitation is disclosed for at least the same reasons discussed with respect to Claim 1 above. *See* Section X.A.1.vii.

- vii. **an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure; and”**

85. It is my opinion that this limitation is disclosed for at least the same reasons discussed with respect to Claim 1 above. *See* Section X.A.1.viii.

- viii. **“the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide a bandwidth required for the antenna system to operate in the multiple frequency bands.”**

86. It is my opinion that this limitation is disclosed for at least the same reasons discussed with respect to Claim 1 above. *See* Section X.A.1.ix.

B. Ground 2: Claims 1, 4, and 13 are Rendered Unpatentable by McKivergan

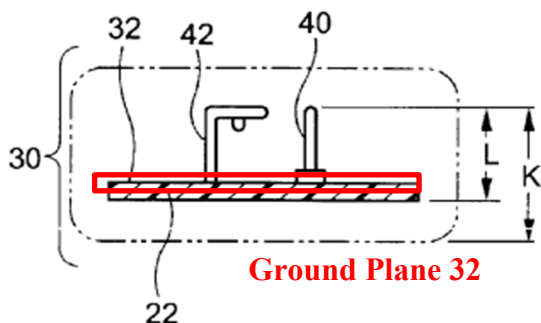
87. It is my opinion that McKivergan teaches and/or renders obvious each and every limitation recited in claims 1, 4, and 13.

1. Claim 1

i. “A wireless portable device comprising: a printed circuit board comprising a ground plane structure”

88. It is my opinion that McKivergan teaches an antenna assembly on a “printed wiring board (PWB) 22” and used within “a wireless communications device (10),” which is depicted in FIG. 1. EX1006, 5:10-20. Moreover, McKivergan’s antenna assembly 30 includes a ground plane 32, which may be carried by the printed PWB 22[,]” such as the one shown in annotated Figure 6a below.

FIG. 6a



ii. “an antenna system operating in multiple frequency bands, the antenna system comprising:”

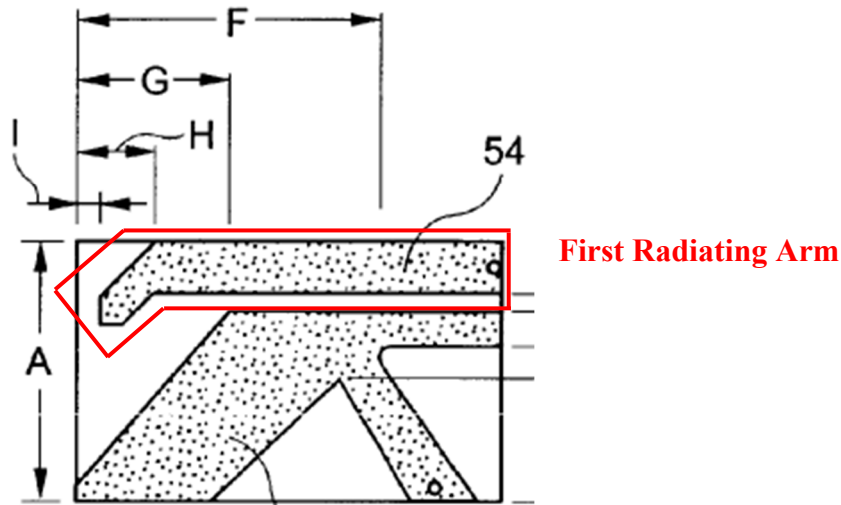
89. It is also my opinion that McKivergan’s antenna assembly operates at multiple frequency bands and, as a result, satisfies this limitation. More specifically, it discloses antennas for operation across a bandwidth of 1710–

2500MHz. Correspondingly, the ground plane 32 has dimensions of approximately $0.45\lambda \times 0.25\lambda$, also where λ is the wavelength of the lowest frequency (1710 MHz) in the bandwidth of 1710–2500 MHz, which is a bandwidth that includes multiple different frequency bands. EX1006, 7:34-40 (disclosing “an antenna [that can] be configured to cover the U.S. cell band (824–894)MHz, PCS/DCS bands (1710–1990) MHz and Bluetooth frequency band (2.4-2.5)GHZ.”).

- iii. **“a first radiating arm comprising a first-radiating-arm first tip, a first-radiating-arm second tip, and a feeding terminal connected to the first-radiating-arm first tip, wherein the first radiating arm is not connected to the ground plane structure through a grounding terminal”**

90. For at least the reasons explained below, it is my opinion that this limitation is met by Figure 4a of McKivergan. More specifically, the driven element (54) of McKivergan Figure 4a, which is shown in annotated Figure 6a below, constitutes the first radiating arm, as recited in the claims.

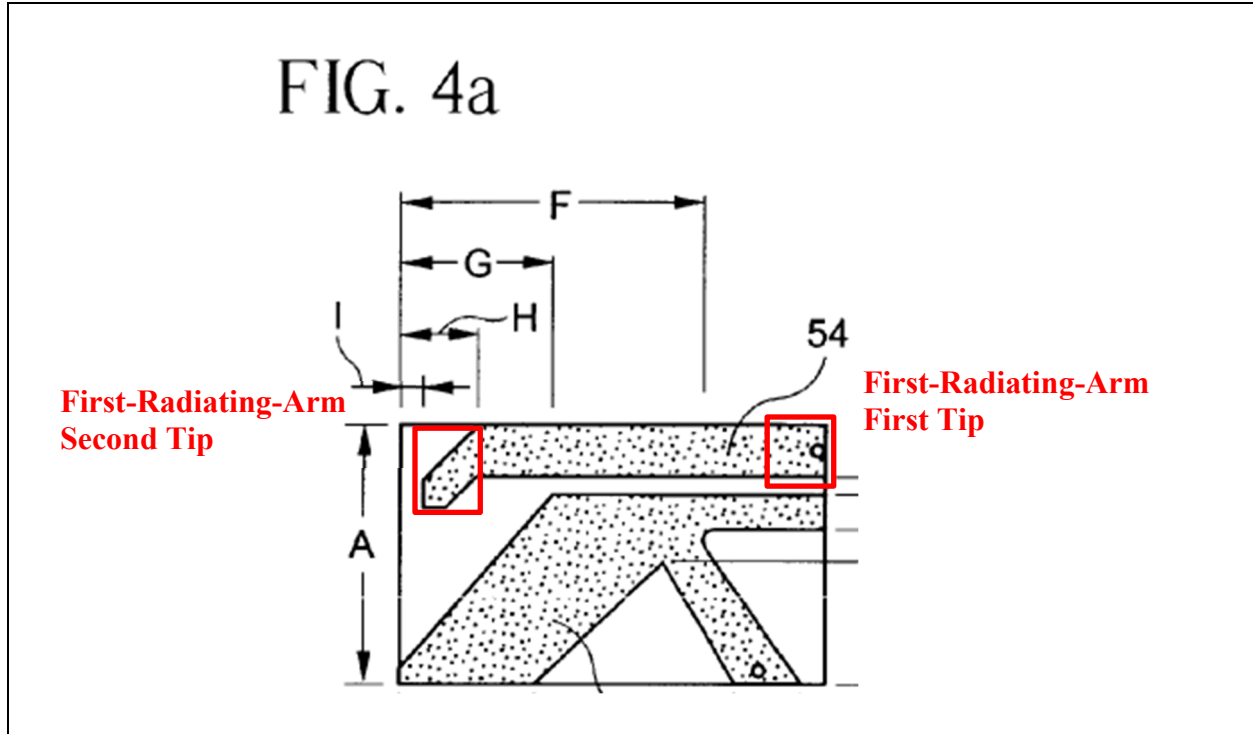
FIG. 4a



91. As explained previously, it is my opinion that the Patent Owner's position construes the term "radiating arm tip" as recited by the claims to mean a terminal portion or extremity of an antenna. Furthermore, it is my opinion that the '604 patent does not provide any definition to a POSITA for the term "radiating arm tip." Indeed, the word "tip" only appears twice throughout the specification of the '604 patent both of which comport with the broad definition of "radiating arm tip" reflected in the annotated figures below. EX1001, 3:14-15 ("the antenna [of Drawing 4] is mounted on a ground-plane (112) and it is fed at one of the tips (102) of arm (110)"), 3:24-25 ("The antenna system [of Drawing 5] is mounted on a ground-plane (112) and it is fed at one of the tips (102) or arm (100)").

92. Regardless, it is my opinion that Figures 4a and 6a satisfy this limitation. McKivergan expressly discloses a first tip of the driven element (54) at

a feed point 62 and a second tip 60 at the opposing end 58 of the driven element 54 shown in annotated Figure 6a below. EX1006, 5:21-36 (disclosing that “[t]he driven element 54, illustrated in this embodiment as a trace 54, includes opposing ends 56, 58 with one end including a tip 60 and the other end including a feed point 62”) (emphasis added). And the driven element 54 does not include a connection to the ground plane (unlike parasitic element 70), as can be seen in the annotated Figure 6a below.

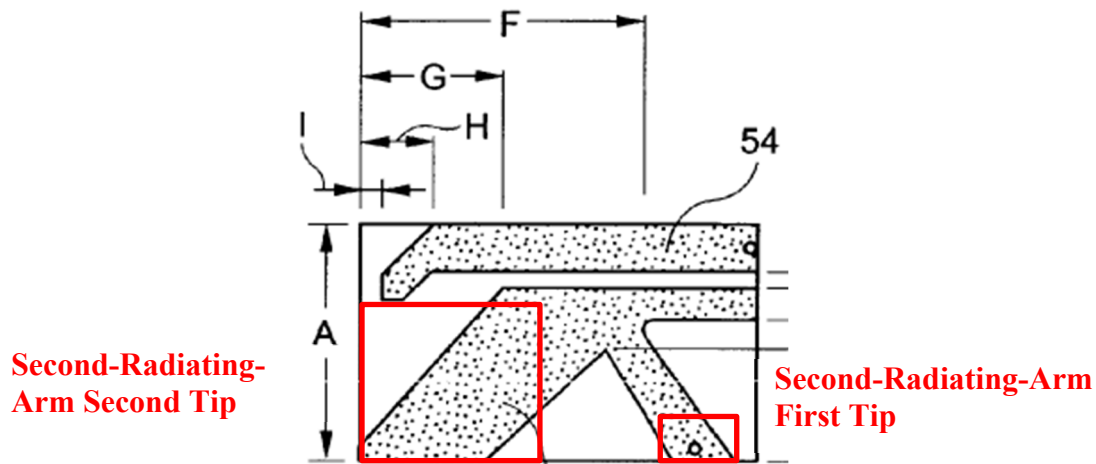


- iv. “a second radiating arm comprising a second-radiating-arm first tip, a second-radiating-arm second tip, and a grounding terminal connected to the second-radiating-arm first tip, wherein the second radiating arm does not include a contact point with first radiating arm,

wherein:”

93. It is my opinion that McKivergan teaches this limitation. *See, e.g.*, EX1006, Figures 2, 4a, 6a. In particular, the antenna device shown in figure 2 includes a second parasitic trace (70) comprising a second-radiating-arm first tip (second segment 74) and a second-radiating-arm second tip (third segment 76), and a grounding terminal (grounding connection point 78) that is connected to the second-radiating-arm first tip and, as can be seen, the parasitic element (70) does not include any contact point with the driven element (54). EX1006, 5:21-36.

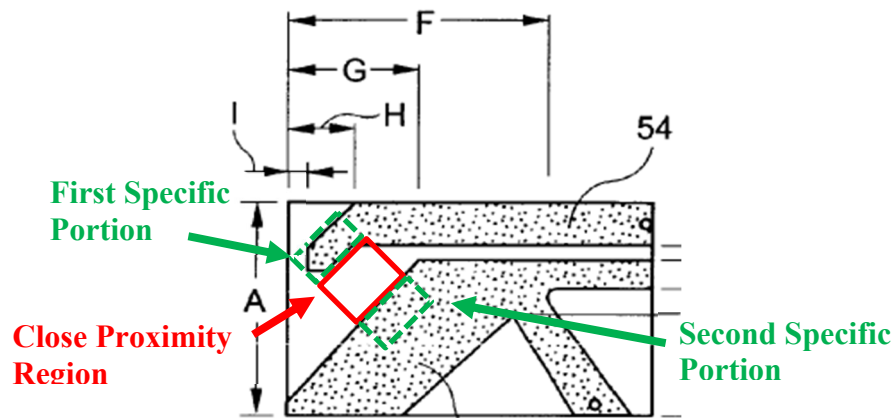
FIG. 4a



- v. “the first radiating arm and the second radiating arm are coupled through a close proximity region from a first specific portion of the first radiating arm and from a second specific portion of the second radiating arm”

94. It is my opinion that McKivergan satisfies this limitation also, as shown in annotated Figure 4a, below.

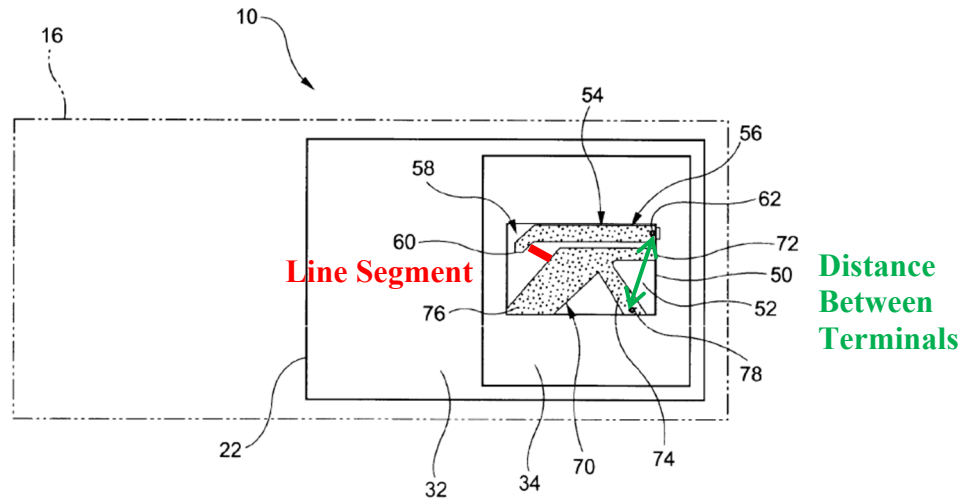
FIG. 4a



- vi. “a length of a line segment between a point of the first specific portion and a point of the second specific portion is shorter than a distance between the feeding terminal and the grounding terminal;”

95. It is my opinion that McKivergan likewise satisfies this limitation, as shown in annotated Figure 2 below.

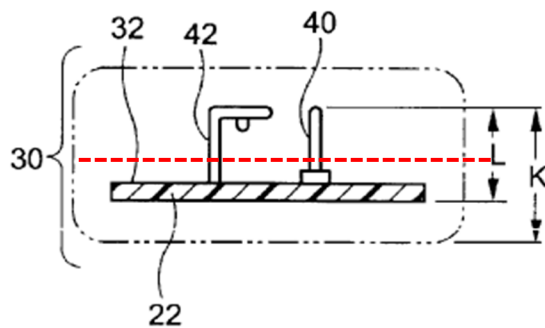
FIG. 2



- vii. “an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure; and”

96. Additionally, it is my opinion that McKivergan meets this limitation as shown in annotated Figure 6a below.

FIG. 6a



97. Alternatively, a POSITA would consider the structure disclosed in

Johnson and would naturally consider combining it with McKivergan's antenna assembly of Figure 4a, for the same reasons discussed above regarding Figures 7 and 9 of Johnson (*e.g.*, to provide greater bandwidth and, as a result, improved telecommunication capabilities for mobile devices). *Supra* Section X.A.1.vii.

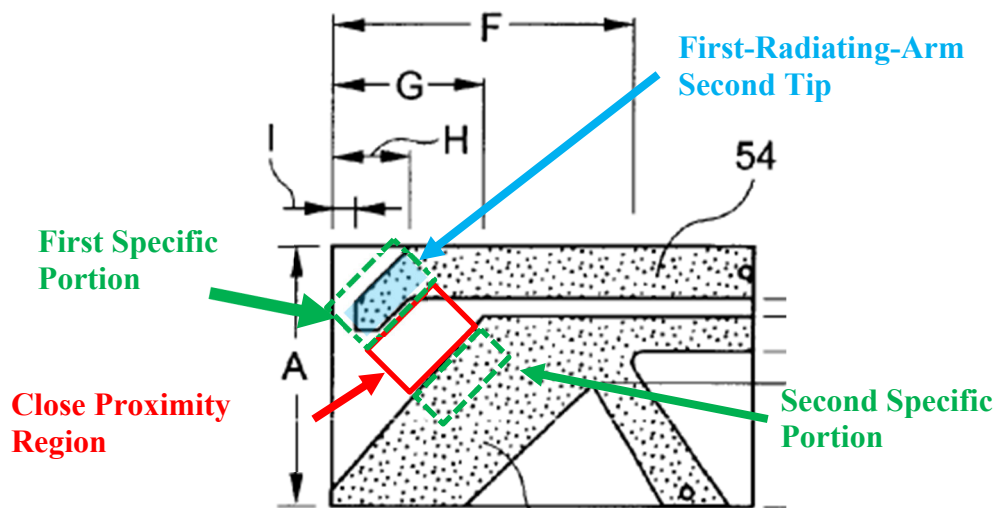
viii. “the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide the bandwidth required for the antenna system to operate in the multiple frequency bands.”

98. As discussed above, it is my opinion that McKivergan's antenna assembly is configured to operate in multiple different frequency bands and, as a result, satisfies this limitation. *Supra* Section X.B.1.ii;

2. Claim 4: “The wireless portable device of claim 1, wherein the first specific portion of the first radiating arm includes the first-radiating-arm second tip.”

99. It is also my opinion that McKivergan meets this limitation as shown in annotated Figures 4a below.

FIG. 4a



3. Claim 13

- i. **“A wireless portable device comprising: a printed circuit board comprising a ground plane structure”**

100. It is my opinion that this limitation is disclosed for at least the same reasons discussed with respect to Claim 1 above. *See* Section X.B.1.i.

- ii. **“an antenna system operating in multiple frequency bands and included within the wireless portable device, the antenna system comprising:”**

101. It is my opinion that this limitation is disclosed for at least the same reasons discussed with respect to Claim 1 above. *See* Section X.A.1.i-X.B.1.ii.

- iii. **“a first radiating arm comprising a first-radiating-arm first tip, a first-radiating-**

arm second tip, a feeding terminal connected to the first-radiating-arm first tip, and a first-radiating-arm first point; and”

102. It is my opinion that this limitation is met by McKivergan for at least the same reasons discussed with respect to claim 1 above. *See* Section X.A.B.iii.

- iv. “a second radiating arm comprising a second-radiating-arm first tip, a second-radiating-arm second tip, and a grounding terminal connected to the second-radiating-arm first tip, wherein: the second radiating arm does not include a contact point with the first radiating arm”**

103. It is my opinion that this limitation is met by McKivergan for at least the same reasons discussed with respect to claim 1 above. *See* Section X.B.1.iv.

- v. “the first radiating arm and the second radiating arm are coupled through a close proximity region formed by a portion including the first-radiating-arm first point and the second-radiating-arm second tip;”**

104. It is my opinion that this limitation is met by McKivergan for at least the same reasons discussed with respect to claims 1 and 4 above. *See* Section X.B.1.v and X.B.2.

- vi. “a length of a line segment between the first-radiating-arm first point and the second-radiating-arm second tip is shorter than a distance between a point of the feeding terminal and a point of the**

grounding terminal;”

105. It is my opinion that this limitation is met by McKivergan for at least the same reasons discussed with respect to claim 1 above. *Supra* Section X.B.1.vi.

vii. an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure; and”

106. It is my opinion that this limitation is met by McKivergan for at least the same reasons discussed with respect to claim 1 above. *Supra* Section X.B.1.vii.

viii. “the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide a bandwidth required for the antenna system to operate in the multiple frequency bands.”

107. It is my opinion that this limitation is met by McKivergan for at least the same reasons discussed with respect to claim 1 above. *Supra* Section X.B.1.viii.

XI. CONCLUSION

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

Dated: October 24, 2023

By: /Emmanouil M. Tentzeris/
Dr. Manos Tentzeris