

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GEOTAB INC. AND GEOTAB USA, INC.,
Petitioners,

v.

FRACTUS, S.A.
Patent Owner.

Case No. IPR2025-00928
Patent No. 8,456,365

DECLARATION OF DAVID M. POZAR, Ph.D.
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW

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I, David M. Pozar, Ph.D., declare:

1. I have been retained by Wolf, Greenfield & Sacks, P.C., counsel for Geotab Inc. and Geotab USA, Inc. (“Petitioners” or “Geotab”), to assess claims 1-42, 44-45 (the “challenged claims”) of U.S. Patent No. 8,456,365 (“the ’365 patent”) (EX1001). I am being compensated for my time at my standard rate, plus actual expenses. My compensation is not dependent in any way upon the outcome of the inter partes review of the ’365 patent.

I. PERSONAL AND PROFESSIONAL BACKGROUND

2. My qualifications for forming the opinions set forth in this declaration are summarized below and explained in more detail in my current curriculum vitae, provided as EX1004. EX1004 also includes a list of my publications.

3. I am currently Professor Emeritus in the Department of Electrical and Computer Engineering at the University of Massachusetts Amherst. I received my Ph.D. in Electrical Engineering in 1980 from the Ohio State University and my M.S. and B.S. degrees from the University of Akron in 1976 and 1975, respectively, each in Electrical Engineering.

4. My work experience includes the National Security Agency (1974), the Ecole Polytechnique Fédérale de Lausanne, Switzerland (1988), the University of Massachusetts Amherst (1980–present) and numerous consulting activities throughout the U.S. and Europe.

5. My research areas include antenna engineering, microwave engineering, and wireless systems. I have published over 100 refereed journal publications in these areas, as well as four books, most of which are on the subject of wireless systems, printed antennas, phased arrays, transient radiation, and/or electromagnetics. Of particular note is my textbook, MICROWAVE ENGINEERING, first published in 1990, and currently in its fourth edition, with translations in Chinese, Greek, and Korean. *See* David M. Pozar, Microwave Engineering, 2d ed. (John Wiley: 1997). This book is presently the most popular text for university courses in microwave engineering throughout the world. Another one of my books is entitled, Microstrip Antennas: The Analysis and Design of Microstrip Antennas and Arrays (1995). In this book, which I coedited and which, in part, collects subject matter from numerous articles that I authored, I combined over 15 years of microstrip antenna research into one volume that covers the theory, design and modeling of microstrip antennas and microwave systems.

6. I have taught microwave engineering at the undergraduate and graduate level for 25 years, as well as short courses to industry and government. My awards include: IEEE Distinguished Achievement Award (2020), Life Fellow of the IEEE (2018), four IEEE best paper awards (2003, 1998, 1988, 1986), the University of Massachusetts' Chancellor's Medal (2003), Distinguished Faculty Lecturer (2003), Outstanding Teacher Award (1997), Outstanding Senior Faculty

Award (1995), Issac Koga Gold Medal (1987), IEEE Third Millennium Medal (2000), NSF Presidential Young Investigator Award (1984), and several other awards for teaching and research.

7. Several aspects of my work are directly relevant to the patents and prior art referenced in this declaration:

- D. Pozar and E. Newman, “Analysis of a monopole mounted near or at the edge of a half-plane,” in *IEEE Trans. Antennas and Propagation*, vol. 29, no. 3, pp. 488-495, May 1981.
- In 1984, I invented the aperture coupled microstrip antenna. See D. M. Pozar, “Microstrip Antenna Aperture Coupled to a Microstrip Line,” *Electronics Letters*, vol. 21, pp. 49-50, January 17, 1985.
- A student of mine and I developed the H-shaped coupling slot for improved aperture coupled antennas. See D. M. Pozar and S. D. Targonski, “Improved Coupling for Aperture Coupled Microstrip Antennas,” *Electronics Letters*, vol. 27, pp. 1129-1131, June 1991.
- A student of mine and I were the first to publish in the public domain the design of an aperture coupled stacked microstrip antenna. See F. Croq and D. M. Pozar, “Millimeter Wave Design of Wideband Aperture Coupled Stacked Microstrip Antennas,” *IEEE Trans. Antennas and Propagation*, vol. 39, pp. 1770-1776, December 1991.
- My students and I also developed a variety of other aperture coupled stacked microstrip patch antenna configurations. See S. D. Targonski, R. B. Waterhouse, and D. M. Pozar, “Wideband Aperture Coupled Stacked Patch Antenna Using Thick Substrates,” *Electronics Letters*, vol. 32, pp. 1941-1942, October 1996; D. M. Pozar and S. M. Duffy, “A Dual-Band Circularly Polarized Aperture Coupled Stacked Microstrip Antenna for Global Positioning Satellite,” *IEEE Trans. Antennas and Propagation*, vol. 45, pp. 1618-1625, November, 1997.

- My colleagues and I developed some of the earliest dual-band dual-polarized arrays using microstrip antennas. See R. Pokuls, J. Uher, and D. M. Pozar, “Dual Frequency and Dual Polarization Microstrip Antennas for SAR Applications,” *IEEE Trans. Antennas and Propagation*, vol. 46, pp. 1289-1296, September 1998.

8. I have also worked as a consultant in designing antennas for cellular telephone base stations.

9. Because of my knowledge and experience relevant to the technology at issue in this Declaration, in my opinion I am well qualified to offer the opinions that I express in this declaration.

II. MATERIALS REVIEWED AND CONSIDERED

10. I have reviewed the '365 patent, its prosecution history, and the prior art and other documents and materials cited herein. For ease of reference, the full list of documents that I have considered is provided at Appendix A: Materials Considered. I have also considered the documents cited and referenced herein, even if not included in the exhibit list below. Each of these exhibits is a type of document that experts in my field would have reasonably relied upon when forming their opinions and would have had access to either through the applicable patent office and/or well-known libraries, conferences, publications, organizations, and websites in the field as further discussed herein.

11. My opinions, as explained below, are based on my years of education, research, experience, and background in the field of “multi-band monopole internal

and external antennas” (EX1001, 1:17-18), as well as my investigation and study of relevant materials for this declaration. When developing the opinions set forth in this declaration, I assumed the perspective of a person having ordinary skill in the art, as set forth in Section VIII.B below. In forming my opinions, I have studied and considered the materials identified in the table in the Appendix Listing of Exhibits listed above.

III. MY UNDERSTANDING OF PATENT LAW

12. In developing my opinions, I discussed various relevant legal principles with Petitioners’ attorneys. I understood these principles when they were explained to me and have relied upon such legal principles, as explained to me, in the course of forming the opinions set forth in this declaration. My understanding in this respect is as follows:

13. I understand that “*inter partes* review” (IPR) is a proceeding before the United States Patent & Trademark Office for evaluating the patentability of an issued patent’s claims based on prior-art patents and printed publications.

14. I understand that, in this proceeding, Petitioner has the burden of proving that the challenged claims of the ’365 patent are unpatentable by a preponderance of the evidence. I understand that “preponderance of the evidence” means that a fact or conclusion is more likely true than not true.

15. I understand that, in IPR proceedings, claim terms in a patent are given their ordinary and customary meaning as understood by a person of ordinary skill in the art (“POSA”) in the context of the entire patent and its prosecution history. If the specification or prosecution history provides a special definition for a claim term that differs from the meaning the term would otherwise possess, that special definition applies. If a claim element is expressed as a “means” for performing a specified function, I understand that it covers the corresponding structure described in the specification and equivalents of the described structure. I have applied these standards in preparing the opinions in this declaration.

16. I understand that determining whether a particular patent or printed publication constitutes prior art to a challenged patent claim can require determining the effective filing date (also known as the priority date) to which the challenged claim is entitled. I understand that for a patent claim to be entitled to the benefit of the filing date of an earlier application to which the patent claims priority, the earlier application must have described the claimed invention in sufficient detail to convey with reasonable clarity to the POSA that the inventor had possession of the claimed invention as of the earlier application’s filing date. I understand that a disclosure that merely renders the claimed invention obvious is not sufficient written description for the claim to be entitled to the benefit of the filing date of the application containing that disclosure.

17. I understand that for an invention claimed in a patent to be patentable, it must be, among other things, new (novel—i.e., not anticipated) and not obvious from the prior art. My understanding of these two legal standards is set forth below.

A. Anticipation

18. I understand that, for a patent claim to be “anticipated” by the prior art (and therefore not novel), each and every limitation of the claim must be found, expressly or inherently, in a single prior-art reference. I understand that a claim limitation is disclosed for the purpose of anticipation if a POSA would have understood the reference to disclose the limitation based on inferences that a POSA would reasonably be expected to draw from the explicit teachings in the reference when read in light of the POSA’s knowledge and experience.

19. I understand that a claim limitation is inherent in a prior art reference if that limitation is necessarily present when practicing the teachings of the reference, regardless of whether a person of ordinary skill recognized the presence of that limitation in the prior art.

B. Obviousness

20. I understand that a patent claim may be unpatentable if it would have been obvious in view of a single prior-art reference or a combination of prior-art references.

21. I understand that a patent claim is obvious if the differences between the subject matter of the claim and the prior art are such that the subject matter as a whole would have been obvious to a person of ordinary skill in the relevant field at the time the invention was made. Specifically, I understand that the obviousness question involves a consideration of:

- the scope and content of the prior art;
- the differences between the prior art and the claims at issue;
- the knowledge of a person of ordinary skill in the pertinent art; and
- if present, objective factors indicative of non-obviousness, sometimes referred to as “secondary considerations.” To my knowledge, the Patent Owner has not asserted any such secondary considerations with respect to the ’365 patent.

22. I understand that in order for a claimed invention to be considered obvious, a POSA must have had a reason for combining teachings from multiple prior-art references (or for altering a single prior-art reference, in the case of obviousness in view of a single reference) in the fashion proposed.

23. I further understand that in determining whether a prior-art reference would have been combined with other prior art or with other information within the knowledge of a POSA, the following are examples of approaches and rationales that may be considered:

- combining prior-art elements according to known methods to yield predictable results;
- simple substitution of one known element for another to obtain predictable results;
- use of a known technique to improve similar devices in the same way;
- applying a known technique to a known device ready for improvement to yield predictable results;
- applying a technique or approach that would have been “obvious to try,” *i.e.*, choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success.
- known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art;
- some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior-art reference or to combine prior-art reference teachings to arrive at the claimed invention. I understand that this teaching, suggestion or motivation may come from a prior-art reference or from the knowledge or common sense of one of ordinary skill in the art.

24. I understand that a universal motivation known in a particular field to improve technology can provide a motivation to combine prior art references even absent any hint or suggestion in the references themselves. I also understand that obviousness is determined in light of all the facts and that a given course of action often has simultaneous advantages and disadvantages, and that this does not necessarily obviate motivation to combine teachings from multiple references.

25. I understand that for a single reference or a combination of references to render the claimed invention obvious, a POSA must have been able to arrive at the claimed invention by modifying, implementing, or combining the teachings of the applied references.

C. Claim Interpretation

26. I understand that determining whether a claimed invention is novel and non-obvious requires comparing the prior art to the claim. In this section, I discuss the interpretations I have applied to certain claim terms in my analysis.

27. I have been informed that patent claims are construed from the viewpoint of a person of ordinary skill in the art at the time of the alleged invention. I have been informed that patent claims generally should be interpreted consistent with their plain and ordinary meaning as understood by a person of ordinary skill in the art in the relevant time period (*i.e.*, at the time of the purported invention, or the so called “effective filing date” of the patent application), after

reviewing the patent claim language, the specification, and the prosecution history (*i.e.*, the intrinsic record).

28. I have further been informed that a person of ordinary skill in the art must read the claim terms in the context of the claim itself, as well as in the context of the entire patent specification. I understand that in the specification and prosecution history, the patentee may specifically define a claim term in a way that differs from the plain and ordinary meaning. I understand that the prosecution history of the patent is a record of the proceedings before the U.S. Patent and Trademark Office, and may contain explicit representations or definitions made during prosecution that affect the scope of the patent claims. I understand that an applicant may, during the course of prosecuting the patent application, limit the scope of the claims to overcome prior art or to overcome an examiner's rejection, by clearly and unambiguously arguing to overcome or distinguish a prior art reference, or to clearly and unambiguously disavow claim coverage.

29. In interpreting the meaning of the claim language, I understand that a person of ordinary skill in the art may also consider "extrinsic" evidence, including expert testimony, inventor testimony, dictionaries, technical treatises, other patents, and scholarly publications. I understand this evidence is considered to ensure that a claim is construed in a way that is consistent with the understanding of those of skill in the art at the time of the alleged invention. This can be useful for technical

terms whose meaning may differ from its ordinary English meaning. I understand that extrinsic evidence may not be relied on if it contradicts or varies the meaning of claim language provided by the intrinsic evidence, particularly if the applicant has explicitly defined a term in the intrinsic record.

30. I understand that determining whether a claimed invention is novel and non-obvious requires comparing the prior art to the challenged claim. In this Declaration, I apply the above standards to the terms in the challenged claims. The meanings of specific terms are discussed below in connection with evaluating the disclosure in the priority documents.

IV. DESCRIPTION OF THE RELEVANT FIELD AND THE RELEVANT TIME FRAME

31. I have reviewed the '365 patent (EX1001) and its prosecution history (EX1002).

32. I have been instructed by counsel for Petitioners to assume the relevant timeframe for my analysis of the prior art in this Declaration is on or before December 5, 2003.

33. Based on my review of this material, I believe that the relevant general field for the purposes of the '365 patent is “multi-band monopole internal and external antennas.” *See* EX1001, 1:17-18.

V. UNPATENTABILITY GROUND

34. The Ground of unpatentability that I have considered in this declaration is the combination of Tran (EX1005) and Teng (EX1006), which I discuss further below in Section IX.

35. I have been instructed by counsel for Petitioners to assume that Tran (EX1005) and Teng (EX1006) are each prior art to the '365 patent's earliest-alleged priority date (December 5, 2003).

VI. PERSON OF ORDINARY SKILL IN THE ART ("POSA")

36. I have been informed and understand that for purposes of assessing whether prior art references disclose every element of a patent claim (thus "anticipating" the claim) and/or would have rendered the claim obvious, the patent and the prior art references must be assessed from the perspective of a person having ordinary skill in the art ("POSA") to which the patent is related, based on the understanding of that person at the time of the patent claim's priority date.

37. I have been informed and understand that various factors may be considered in assessing the level of a POSA, including (1) educational level of the inventor; (2) type of problems encountered in the art; (3) prior art solutions to those problems; (4) rapidity with which innovations are made; (5) sophistication of the technology, and (6) educational level of workers active in the field. I have also been informed and understand that not all of these factors may be present in every

case, and one or more of these or other factors may predominate in a particular case. I have further been informed and understand that these factors are not exhaustive but are merely a guide to determining the level of ordinary skill in the art. I have applied this standard throughout my declaration.

38. The '365 patent involves technology in the field of “multi-band monopole internal and external antennas.” EX1001, 1:17-18. I have been asked to provide my opinions as to the state of the art in this field before December 2003. I use this time frame because I have been informed by counsel that Patent Owner Fractus’s earliest-alleged conception date is December 5, 2003.

39. Fractus has defined a POSA as follows:

[A] person with at least a bachelor’s degree in electrical engineering, computer science, or a similar degree and at least four years of experience in applied electromagnetics with an emphasis on antennas. Alternatively, 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.

EX1009, 8-9, ¶32. I agree with this definition of a POSA and have applied the above definition of a POSA in this declaration. The basis for my familiarity with the level of ordinary skill is my own technical experience and my interaction with students and professionals in the field of multi-band monopole internal and external antennas (and the field of internal and external antennas more broadly)

who were at this level of skill as of December 2003. *See* §I above. I am well-aware of the knowledge that a POSA would have had at the time this patent was written as I have been actively consulting, teaching, and carrying out research with such students and/or professionals for approximately 25 years prior to December 2003.

40. My opinion identifying the POSA's level of ordinary skill is consistent with the problems encountered in the art, the prior art solutions to those problems, the rapidity with which innovations are made, the sophistication of the technology, and the educational level and professional capabilities of workers in the field. This is shown, among other things, by the prior art references described in the Ground below (§IX).

41. By December 2003, POSAs were well underway to designing mobile devices having internal, multi-band antennas for cellular (also referred to as a Wireless Wide Area Network, or WWAN) and/or local wireless (also referred to as a Wireless Local Area Network, or WLAN) connectivity standards, as discussed in Tran (EX1005) and Teng (EX1006), which I further discuss below (§IX). *See also, e.g.*, EX1014, [0002]-[0006]; EX1015, [0001]-[0008]; EX1019, 1:18-2:53. POSAs were thus aware of various problems that arise in designing and integrating multiband antennas in mobile devices (as evidenced, e.g., in Tran, Teng, EX1014, EX015, and EX1109), and were actively designing various solutions prior to

December 2003 based on evolving mobile device form factors and cellular (WWAN) and wireless (WLAN) connectivity standards.

42. As summarized above with regards to my qualifications and experience (§I above), I possessed at least the level of skill of a POSA at the time of the alleged invention of the '365 patent.

43. I have worked with many people who fit the characteristics of the POSA, and I am familiar with their level of skill in and around December 2003. When developing the opinions set forth in this declaration, I assumed the perspective of a POSA as set forth above

44. Except as noted below whenever I offer an opinion in this declaration about the knowledge of a POSA, the manner in which a POSA would have understood the claims of the '365 patent or its description, the manner in which a POSA would have understood the prior art, or what a POSA would have been led to do based on the prior art, I am referencing the December 2003 timeframe, even if I do not say so specifically in each case.

VII. THE '365 PATENT

A. Embodiments

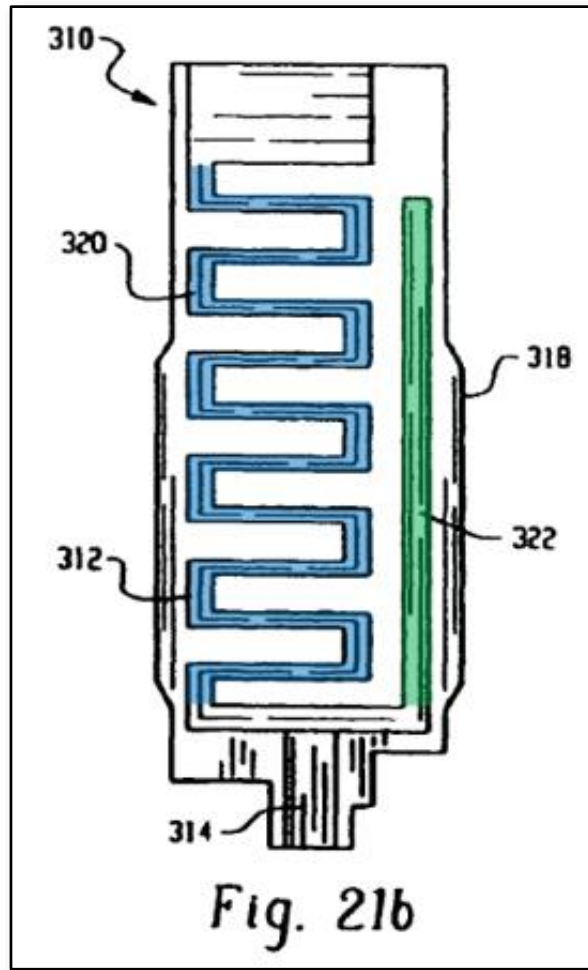
45. The '365 patent concerns “multi-band monopole antennas... for use in mobile communications devices” (e.g., “cellular telephones” or personal digital assistants (PDAs)). EX1001, 1:17-22. The patent says “inverted-F” antennas—

antennas roughly shaped like a capital “F”—“performed adequately” as “internally-mounted antenna[s],” but were “typically bandwidth-limited” because they experienced “problematic amounts of electromagnetic interference.” EX1001, 1:34-39.

46. Every Challenged Claim requires an antenna arm with “a grid-dimension curve.” See Appendix B (Claim List). The term “grid-dimension curve” has no ordinary meaning in the art.

47. The patent says “the term grid dimension ... describe[s] a curve geometry having a grid dimension that is greater than one (1),” which is calculated using a formula discussed below in §VIII.B.2. EX1001, 7:16-18. “The larger the grid dimension, the higher the degree of miniaturization that may be achieved” because grid dimension measures antenna compactness. EX1001, 7:18-21. But as the ’365 patent admits, Fractus did not invent antennas that the specification describes as “space-filling or grid dimension” because the patent alleges that there existed antennas that were already “known” to experience “reduce[d]” “interference.” EX1001, 1:39-44.

48. Figure 21b (annotated below) shows an antenna with a “grid dimension section 320 [blue] and a linear section 322 [green]” both connected to a “feeding port 314” for coupling to conventional communication circuitry like a transmitter/receiver. EX1001, 8:52-64.



49. The '365 patent says its multi-band antennas are useful for mobile communications devices having conventional components, like a housing and circuit board for mounting the electronics and ground plane layer. EX1001, 5:35-48.

B. Challenged Claims

50. The '365 patent has 45 claims, all reciting a “mobile communication device.” The independent claims are Claims 1, 15, and 31. In Appendix B

(attached to this declaration), I have provided a claim list, with labels added to some limitation for convenience.

51. I have been instructed by counsel to apply the prior art listed above to claims 1-42 and 44-45. My application of the prior art to these claims is set forth in my analysis below.

52. Consistent with my understanding of patent law discussed above in §III, my analysis in §IX below considers the scope and content of the prior art, the differences between the prior art and the claims, the level of ordinary skill set forth above (§VI), and additional evidence listed in Appendix A showing the knowledge of a POSA prior to December 2003.

53. My analysis including the annotated figures shows that claims 1-42 and 44-45 would have been obvious to a POSA based on Tran (EX1005) and Teng (EX1006), as explained below in §IX.D.

VIII. CLAIM INTERPRETATION

54. I apply relevant claim constructions below in relation to the claim elements in which they appear. Where I do not discuss a particular claim construction, I apply the ordinary meaning that the claim term would have had to a POSA at the time of invention.

A. “*a common conductor*” (Claims 1-14, 25-30, 37-42, 44)

55. I am told that at least one district court has construed terms in challenged claims. See EX1011, 13-14 (“ADT Litigation”); EX1012. In the ADT Litigation, the court construed “*a common conductor*” to mean “a conductor common to two or more radiating arms.” EX1011, 13-14. In Section below, it is my opinion that Ground 1 meets the court’s construction or any other reasonable construction consistent with the ’365 patent’s specification.

B. “*grid-dimension curve*” (Claims 1-42, 44-45)

56. Every independent claim (1, 15, and 31) recites the term “*grid-dimension curve*” and therefore I understand that it is a limitation of every Challenged Claim. (I may sometimes refer to the term “*grid dimension curve*” as “GDC.”)

57. I understand that in the ADT Litigation, Fractus offered a construction of this term (EX1008, 27-30), which I discuss in §VIII.B.1 below.

58. I also understand the defendant (ADT) in the ADT litigation agreed to Fractus’s construction (EX1013, 34) and that the court did not separately construe the term (EX1011, 29-30). In my opinion, a POSA would not have understood “*grid-dimension curve*” in the manner that Fractus identified in the ADT litigation. In short, Fractus’s construction is incorrect and inconsistent with the way that a

POSA would have understood the term, for the reasons I discuss in §VIII.B.1 below.

59. In §VIII.B.2 below, I discuss Petitioners’ construction of “*grid-dimension curve*,” which in my opinion correctly describes how a POSA would have understood the term in view of the specification and file history.

60. However, as I discuss below in §IX.D, the Ground 1 combination of the Tran and Teng references meets both Fractus’s *GDC* construction and the correct construction (i.e., Petitioners’ construction).

1. Fractus’s *grid-dimension curve* construction

61. In the ADT litigation, Fractus offered the follow construction of “*grid-dimension curve*,” with bracketed numbers added for convenience:

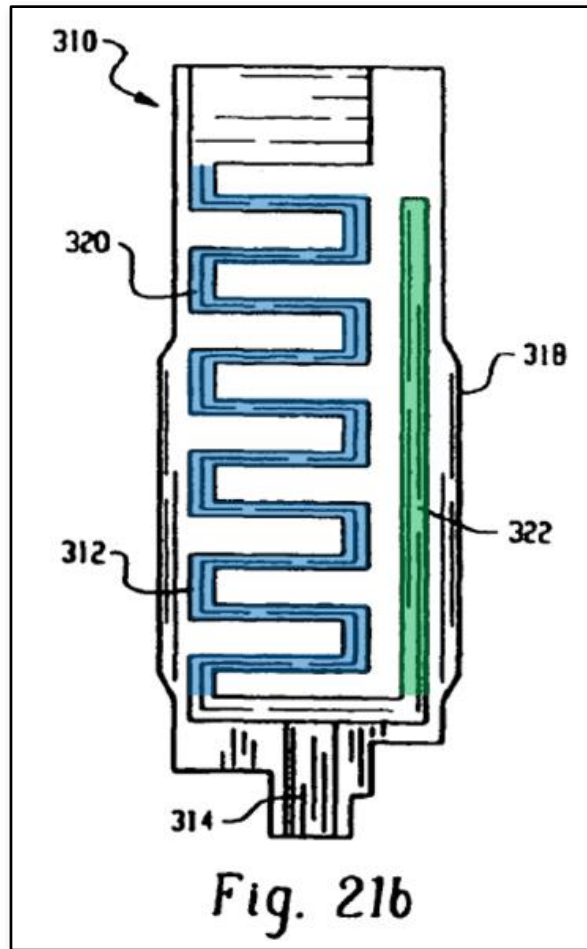
[1] A curve which is not self-similar, [2] which possesses a geometry having a grid dimension that is greater than one (1), and, [3] if the curve has any periodicity, the period is defined by a non-periodic curve that includes at least ten connected segments in which no two adjacent and connected segments define a longer straight segment.

EX1008, 27. In my opinion, Fractus’s construction is incorrect, and a POSA would have concluded that Fractus’s construction was incorrect. Part [1]’s requirement that the curve cannot be “self-similar” is unsupported by the ’365 patent specification, which does not use the term “self-similar.” Part [3]’s requirement of “at least ten segments” is described by the specification as a

“character[istic]” of a “space-filling curve,” not of a grid-dimension curve, which the patent says “**may**... meet the requirements of a space-filling curve” but a grid-dimension curve need not meet the requirements of a space-filling curve. EX1001, 3:10-13, 7:22-24. I also understand that under the principle of claim differentiation, Fractus’s construction Part [3] improperly renders limitation [20F] superfluous. See Appendix B (Claim List). Even though Fractus’s construction is incorrect, as I discussed above (§VIII.B.1), Ground 1 meets Fractus’s (and Petitioners’) construction (as I discuss below in §IX.D).

2. Petitioners’ *grid-dimension curve* construction

62. The ’365 patent says Figure 21b (highlighted below) has a “**grid dimension section 320** [blue] and a linear section 322 [green]” (EX1001, 8:61-64), however the patent does not provide dimensions for Figure 21b’s antenna to allow confirmation that its dimensions meet the requirements of a grid-dimension curve required by each party’s constructions (e.g., that it has a grid-dimension value greater than 1).



63. The '365 patent says “the term *grid dimension curve* is used to describe **a curve geometry having a grid dimension that is greater than one (1)**” (EX1001, 7:16-18) and that “[t]he grid dimension of a curve may be calculated as follows” (I have added bracketing below for convenience):

[1] **A first grid having square cells of length L1** is positioned over the geometry of the curve, such that the grid completely covers the curve. [1a] The number of cells (N1) in the first grid [1b] that enclose at least a portion of the curve [1c] are counted. [2] Next, **a second grid having square cells of length L2** is similarly positioned to completely cover the geometry of the curve, and [2a] the number of cells (N2) in

the second grid [2b] that enclose at least a portion of the curve [2c] are counted. [3] In addition, the first and second grids should be positioned within a minimum rectangular area enclosing the curve, such that no entire row or column on the perimeter of one of the grids fails to enclose at least a portion of the curve. [4] **The first grid should include at least twenty-five cells,** and [5] **the second grid should include four times the number of cells as the first grid.** Thus, **the length (L2) of each square cell in the second grid should be one-half the length (L1) of each square cell in the first grid.** [6] The grid dimension (Dg) may then be calculated with the following equation:

$$Dg = -\frac{\log(N2) - \log(N1)}{\log(L2) - \log(L1)}$$

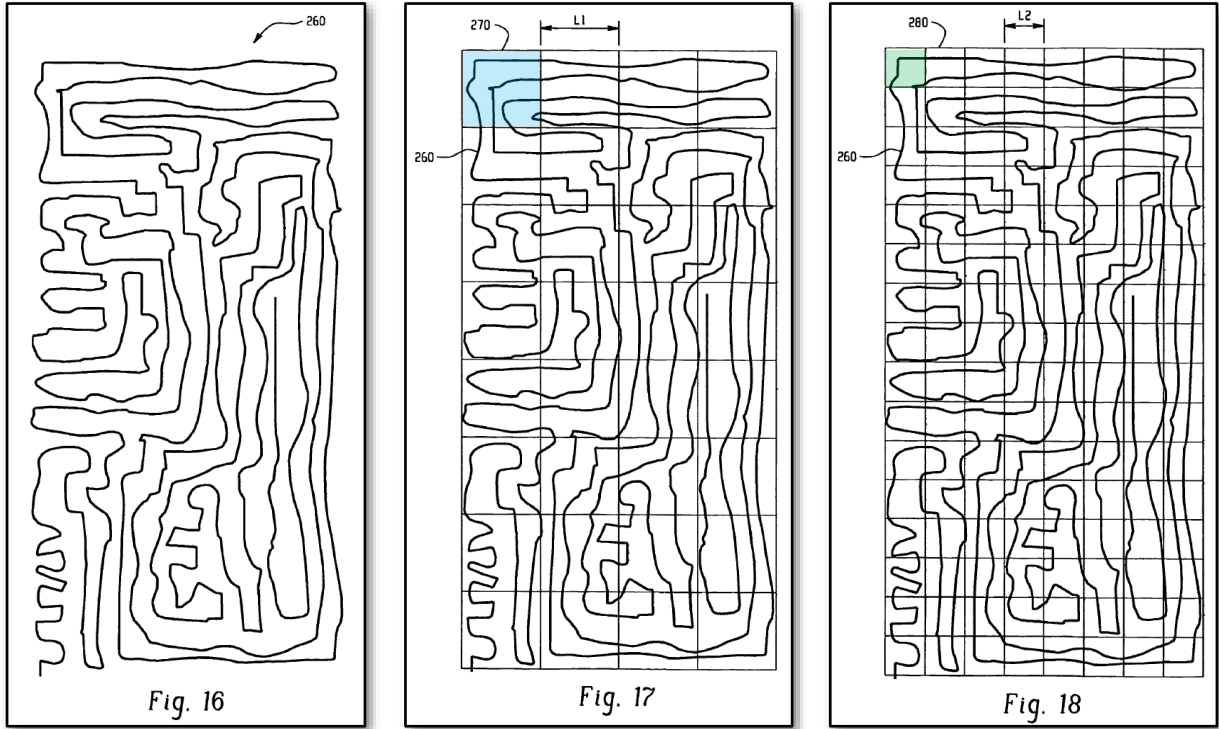
EX1001, 6:59-7:15.

64. Using Figure 16's curve (below left), the patent describes:

- **a first grid** (Figure 17, which I have highlighted below-middle): with N1="thirty-two (32) square cells" of length L1 (one square highlighted blue below-middle); and
- **a second grid** (Figure 18, which I have highlighted below-right): with N2="one hundred twenty-eight (128)" square cells of length L2, such

that L1 is “twice the length [of] L2” (i.e., $L1 = 2 \times L2$)¹ (one square highlighted green below-right).

EX1001, 7:26-49.



65. Using the grids in Figures 17-18, grid-dimension (D_g) for Figure 16’s curve is calculated as follows:

$$D_g = - \left(\frac{\log(N2) - \log(N1)}{\log(L2) - \log(L1)} \right) = - \left(\frac{\log(128) - \log(32)}{\log(L2) - \log(2 \times L2)} \right)$$

¹ The ’365 patent at 7:33-36 and 7:45-49 has an obvious typo. The patent says L1 should equal “twice the length” L2—and L2 being “one-half the length (L1)” (EX1001, 7:7-9)—which means $L1=2 \times L2$, not “ $L2=2 \times L1$,” as incorrectly stated in the patent at 7:33-36 and 7:45-49.

$$= -\left(\frac{\log(4)}{\log(1/2)}\right) = -\left(\frac{2 \log(2)}{(-1) \log(2)}\right) = 2.$$

EX1001, 7:27-59.^{2, 3}

66. In view of the foregoing, a POSA would understand that the term “*grid dimension curve*” means “a curve geometry **having a grid dimension that is greater than one (1)**” (EX1001, 7:16-18) – where “grid dimension” can be calculated using the below equation (from EX1001, 7:11-15), where L1, L2 and N1, N2 meet the requirements labelled [1]-[6] above (from EX1001, 6:59-7:10).

$$D_g = -\frac{\log(N2) - \log(N1)}{\log(L2) - \log(L1)}$$

IX. GROUND 1: THE TRAN+TENG COMBINATION RENDERS OBVIOUS CLAIMS 1-42 AND 44-45

A. Tran (EX1005)

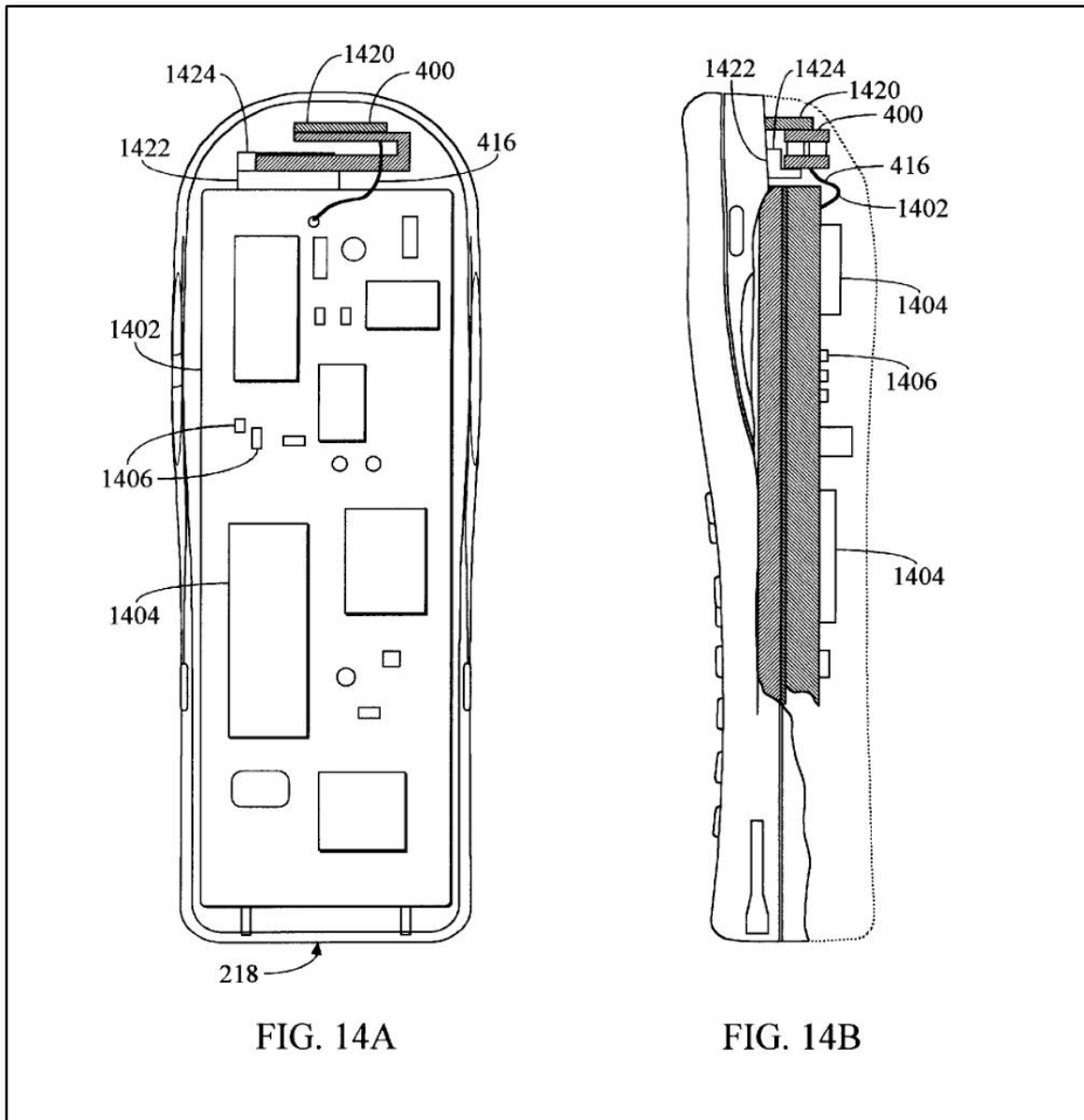
67. Tran discloses “multiple frequency,” “improved bandwidth,” “internal antennas for wireless devices” like “mobile cellular” “phones” for communication over “multiple frequency” bands. Tran, Abstract, 1:9-58. Tran’s antennas are dual-band antennas supporting a “cellular frequency band” from 825-960 MHz and “the PCS frequency band” from 1.85-1.99 GHz. Tran, Figs. 10-11, 12:56-67,

² A POSA understands that $\log(A) - \log(B) = \log(A/B) = -\log(B/A)$.

³ For convenience, I will refer to a grid’s total number of square cells with label N_{Total} . Thus, for example, for Figure 17, $N1_{\text{Total}}=32$ and for Figure 18, $N2_{\text{Total}}=128$.

13:15-18. Thus, Tran is in the field of multi-band internal antennas for use in mobile communications devices, and is reasonably pertinent to problems with prior art mobiles devices having bandwidth-limited internal antennas or external antennas.

68. Tran's Figures 14A-14B (below) "illustrate" "cutaway section views" of antenna 400 "within" a mobile phone. Tran, 13:28-30. The mobile phone has components like "integrated circuits or chips 1404" "for performing the various functions needed or desired" (like a "transceiver"), and those components are supported by a printed circuit board (PCB), and all are arranged "inside of housing 102." Tran, 13:28-57.



B. Teng (EX1006)

69. Teng’s title is “Planar Monopole Folded Into A Compact Structure For Very-Low-Profile Multiband Mobile-Phone Antenna.” Teng, 22. As shown in Figure 1 (below), Teng discloses “a novel very-low-profile” antenna “consisting of three branch strips” “folded into a rectangular-box-like compact structure for

applications in multi-band mobile phones” that support communication over three conventional mobile-phone frequency bands: GSM (in particular the so-called “GSM900” band), DCS (“Digital Cellular Communications”), and PCS (“Personal Communications Services”). Teng, 23. Thus, Teng is in the field of internal, multiband monopole antennas for use in mobile communication devices, and is reasonably pertinent to problems in the prior art mobile devices having bandwidth-limited internal antennas or externally mounted antennas.

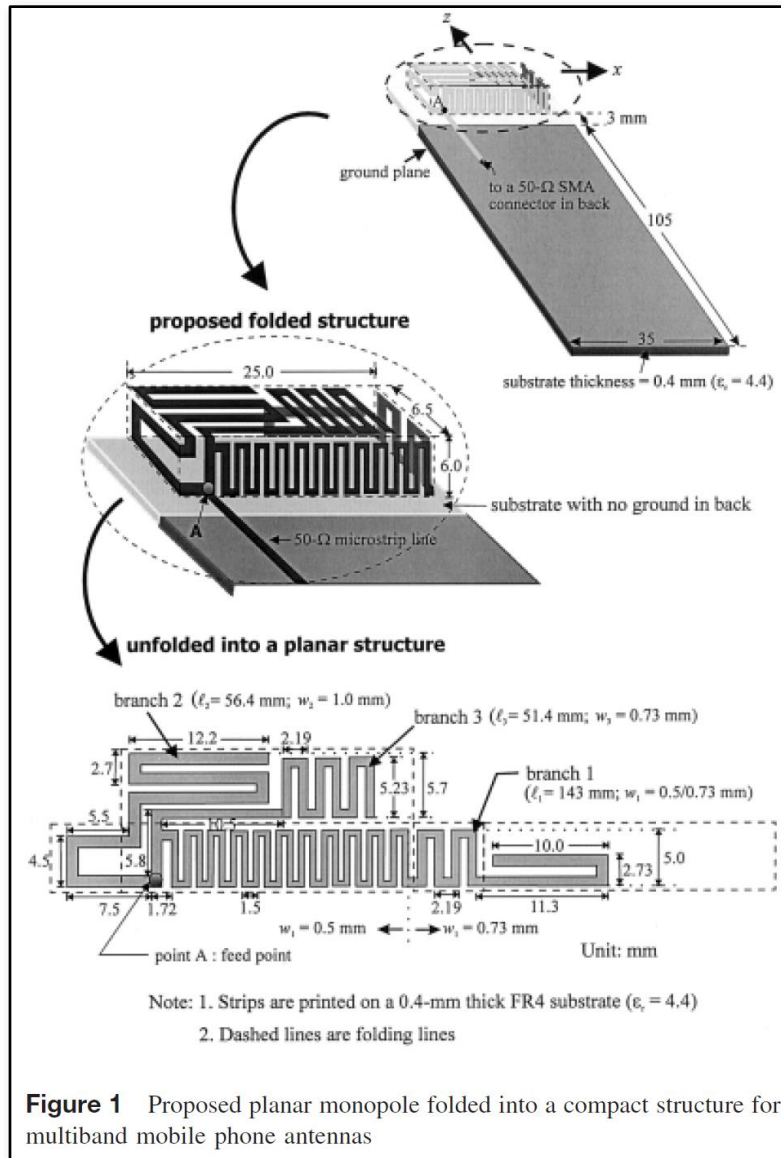


Figure 1 Proposed planar monopole folded into a compact structure for multiband mobile phone antennas

70. Teng says that each branch “generat[es] a resonant mode” for a respective frequency band (e.g., Branch 1 resonates around “900 MHz for GSM operation”). Teng, 23. Teng’s “proposed antenna is mounted on the top portion of an FR4 substrate... which can be considered as the circuit board of a practical mobile handset.” Teng, 24. Teng’s Figure 1 above says Teng’s antenna has “[s]trips printed a 0.4-mm thick FR4 substrate,” which Teng says “can be

considered as the circuit board of a practical mobile handset” and, as shown above, the antenna is mounted over a portion of the “substrate with no ground in back” (Teng, 24).

C. Tran+Teng Combination

71. In my opinion, a POSA considering the teachings of Tran and Teng together would have had reason to implement a multi-band cellular telephone having, among other conventional components of a mobile device, a PCB, ground plane layer, antenna, and the telephone’s communication circuitry, with those components inside the device’s housing of the type disclosed by Tran, but using Teng’s compact, low-profile multiband-antenna design.

72. **First**, a POSA would have recognized that Teng’s “very-low-profile” “compact structure” – which “achieve[s] a much-reduced antenna height” of “6.5 mm” (Teng, 23) – would have furthered Tran’s desire to use “small” multi-band antennas (Tran, 1:24-37) that could be integrated into a mobile phone’s housing to avoid the need for an external antenna that Tran says (and POSAs knew) could be easily damaged and would often times “catch[] on objects” (Tran, 1:59-65).

73. Teng’s compact antenna ($6.5 \times 6 \times 25 \text{ mm}^3$ (Teng, 25)) is substantially smaller than Tran’s internal antenna ($4.9 \times 0.4 \times 0.3 \text{ inches}^3 \cong 124 \times 10 \times 8 \text{ mm}^3$ (Tran, 12:23-41)). Thus, a POSA would have recognized that Teng’s antenna would have beneficially supported even further reduction in the

mobile phone's device size (and/or provided additional space in the housing to integrate additional circuitry to perform additional functionality) because, as Tran recognizes (and POSAs knew), "the size of the antenna can play an important role in decreasing the size of the device" and "device aesthetics and manufacturing costs." Tran, 1:33-37.

74. **Second**, Teng itself teaches the desirability of using Teng's antenna in "multiband mobile phones." Teng, 25. Thus, Teng itself would have motivated a POSA to identify a suitable mobile-device housing and related components (e.g., communication circuitry) to further Teng's desire to design an antenna for use in "a practical mobile handset." Teng, 24.

75. **Third**, Tran's antenna operated on the so-called GSM850 and PCS1900 bands. Tran, FIG. 10, 12:23-27, 12:56-67. In addition to the PCS1900 band, Teng's antenna supported two cellular bands – a "GSM band (890-960 MHz), [and] the DCS band (1710-1880 MHz)" – and thus supported three (as opposed to two) frequency bands. Teng, 24. POSAs would have recognized the benefit of adding to a mobile phone, like Tran's, the capability of operating on additional frequency bands. My opinion in this regard is corroborated by EX1014, which states as background information that "the demand for wireless terminal equipment, such as mobile stations, **supporting several wireless systems** is also

on the increase.” EX1014, [0002]-[0003] (referring to “small radio devices, such as mobile stations”).

76. Moreover, the GSM850 (824-894 MHz) and PCS1900 (1850-1990 MHz) bands supported by Tran’s antenna were used in North America, whereas GSM900 (890-960 MHz) and DCS1800 (1710-1880 MHz) supported by Teng’s antenna were used in, for example, Europe. Thus, a POSA would have had reasons to use Teng’s antenna in Tran’s device to produce a phone that could be used in (and sold for) the GSM systems made for Europe, while also able to communicate in North America on the PCS1900 band. My opinion in this regard is corroborated by EX1015, which states as background information that “**GSM 850 operates in the United States**, in the cellular band,” where “[t]ransmission (Tx) is 824 to 849 MHz, reception (Rx) is 869 to 894 MHz” (i.e., from 824-894 MHz, which is Tran’s lower band) and “**GSM 900 operates in Europe**, with Tx from 890 to 915 MHz, and Rx from 935 to 960 MHz” (i.e., from 890-960 MHz, which is Teng’s lower band). EX1015, [0002].

77. **Fourth**, a POSA would have found the combination of Tran and Teng discussed above and further below to be nothing more than combining prior art elements (Teng’s compact multiband antenna with Tran’s mobile device designed for multiband communications) according to known techniques for integrating mobile-phone antennas and related communication circuitry inside the device’s

housing, to yield the predictable result of a mobile-phone device with an internal antenna capable of transmitting over three frequency bands.

78. In my opinion, a POSA would have implemented Tran in view of Teng by mounting Teng's multiband folded antenna onto the mobile device's PCB because Tran discloses mounting its multiband antenna to the PCB along with mounting on the PCB the mobile device's communication circuitry, and enclosing all of those components within the housing of the mobile-communications device (Tran, 5:46-59), and Teng similarly teaches mounting its antenna to "an FR4 substrate," which Teng says "can be considered as the circuit board of a practical mobile handset" (Teng, 24).

79. Based on Teng's disclosure, the portion of the PCB below the antenna would not comprise a portion of the ground plane layer, as shown in Teng's Figure 1 (antenna over portion of "substrate with **no ground in back**"). A POSA would have implemented the mobile device's communications circuitry (e.g., a transceiver) as discussed in Tran to support communications over the three frequency bands supported by Teng's antenna (GSM, PCS, DCS) which was well within a POSA's capability because those were common, conventional frequency bands for mobile devices in the early 2000s, with communication circuitry available to support those frequency bands. Teng, 23. My opinion in that regard is corroborated by EX1015, which discloses as background information a circuit

topology for prior art mobile communication devices, where the “handset can operate in three modes: GSM 900, GSM 1800, or WCDMA” and “supports GSM in four frequency bands.” EX1015, [0007]-[0008].

80. For convenience, I will refer to a mobile device implemented as described above as “Tran+Teng” or the “Tran+Teng combination.” In my opinion, a POSA would have reasonably expected success in implementing Tran+Teng because doing so was well within a POSA’s capabilities. As I discussed above, Teng’s antenna is “compact,” and even smaller than Tran’s, and Teng explicitly discloses that its antenna is intended for use in a “practical mobile handset.” Teng, 24. In addition, Tran discloses a mobile phone device and housing that already includes an internal antenna and communications circuitry mounted on a PCB and within the mobile’s device’s housing, and thus it would have required only ordinary skill for a POSA to integrate an alternative antenna of comparable dimensions and one or more alternative types of communication circuitry (e.g., transceiver or transmitter plus receivers) for the frequency bands on which Tran+Teng’s antenna is capable of operating. My opinion in that regard is corroborated by EX1015, which (as I’ve noted above) discloses as background information a circuit topology for prior art devices, where the “handset can operate in three modes: GSM 900, GSM 1800, or WCDMA” and “supports GSM in four frequency bands.” EX1015, [0007]-[0008].

D. Mapping to Claims 1-42, 44-45

1. Claim 1

a. Limitation [1PRE]: A *mobile communication device*, comprising:⁴

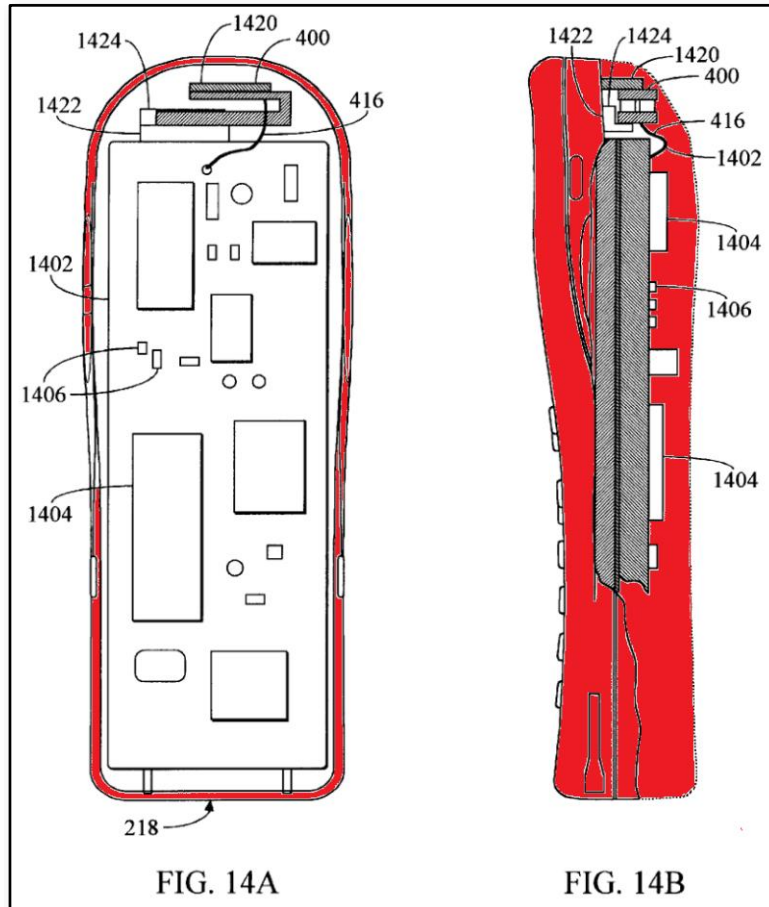
81. Tran+Teng (which I discussed above in §IX.C) is a mobile cellular phone as taught by Tran and suggested by Teng. Tran, 13:28-42, Figs. 14A-14B; Teng, 22 and 24-25 (Teng’s “proposed antenna” is for use in “a practical *mobile* handset”). A mobile cellular phone is an example *mobile device* identified in the ’365 patent (EX1001, 1:18-21) and thus meets the plain meaning of *a mobile communication device*, which I understand is how the district court construed this term in the ADT litigation. See EX1011, 12.

b. Limitation [1A]: a *device housing*;

82. Tran+Teng’s mobile phone is a *device* and it comprises Trans’s *housing*, which I have highlighted in red below in Tran Figures 14A-14B. Tran’s house is a *device housing* that houses other components of the phone like the antenna, PCB and communication circuitry, which I discuss further below in Sections IX.D.1.c-d, f, n. Tran’s housing is a *device housing* that houses other components of the phone like the antenna, PCB and communication circuitry, which I discuss further below in Sections IX.D.1.c-d, f, n. See also §IX.C above

⁴ For convenience, I have italicized claim language.

(where I discuss the Tran+Teng combination); Tran, Figures 14A-14B (highlighted below).

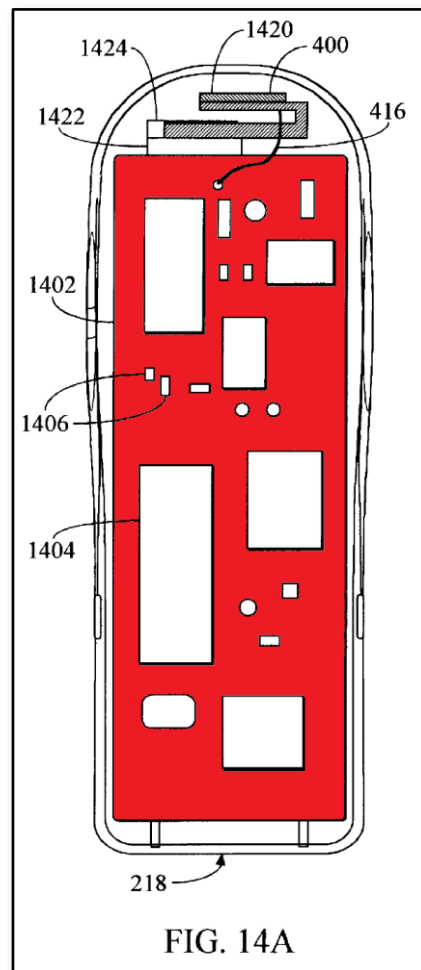


83. I note that Tran’s Figures 14A-14B above do not identify a number for the housing that is shown in those figures (highlighted red above). However, Tran says that Figures 14A-14B show Tran’s antenna “invention mounted within the phone of FIG. 1,” and that Figures 14A-14B include Figure 1A-1B’s “housing 102.” Tran, 13:28-30. The primary difference between the housing in Tran’s Figure 1B and Figure 14B, for example, is that the Figure 1B’s housing has a (prior art) external antenna (104 and 106) mounted to the housing, whereas Figure 14B’s

housing does not include that external antenna (because Figure 14B includes Tran's internally mounted antenna). The portion of Figures 14A-14B that I've highlighted above correspond to housing 102 shown in Tran's Figures 1A-1B.

c. Limitation [1B]: a printed circuit board:

84. Tran+Teng comprises Tran's "***printed circuit board***" 1402, which I have highlighted in red below from Tran's Figure 14A. *See also* §IX.C (above; where I discuss the Tran+Teng combination).



d. Limitation [1C] *the [PCB] comprising: a ground plane layer;*

85. Tran+Teng's PCB comprises *a ground plane layer* as was well-known for PCBs and taught by Tran and Teng. For example, Tran says that its PCB includes "metallic conductor ***layer[s]***" 1414, 1418, "either" of which "could form a ***ground layer*** or ***ground plane*** for board 1402, **as would be known in the art.**"

Tran, 13:43-57. Thus, the ground plane in Tran's PCB is implemented as a metallic ***layer*** (i.e., it is a *ground plane layer*). Similarly, Teng says that its antenna is for mounting on "circuit board of a practical mobile handset" that is partially made with a "***ground plane*** in back." Teng, 24. POSAs would have understood Teng to be disclosing (or at least suggesting) that its ground plane is a *ground plane layer* because, as noted above, Tran teaches that *ground plane layers* were the known way to implement ground planes on mobile-device PCBs.

86. My opinion in this regard is further corroborated by EX1041 ("Sadler"), [0012], which discloses that a "ground plane" is "typically the [PCB] of the phone." Sadler (EX1041), further discloses that "[t]he antenna may use the printed circuit board of the mobile terminal as the ground plane." Sadler, [0015] Sadler also corroborates my opinion by disclosing that "[i]n conventional cellular telephones, the printed circuit board 106 acts as a ground plane for numerous electrical components positioned within the housing 100, and especially those components positioned on the printed circuit board 106." Sadler, [0043].

87. It was also well known to POSAs that a PCB ground plane's placement relative to the antenna impacts antenna performance. My opinion in this regard is corroborated by Sadler (EX1041), which discloses that the antenna placement relative to ground plane affects antenna resonance. Sadler, [0004]; *see also* Sadler, [0046] (describing parasitic tuning from antenna placement over ground plane), [0049] (similar). My opinion in this regard is further corroborated by EX1030, which discloses that a "grounding electrode [] formed on the entire bottom surface" of a "surface-mounted antenna" will cause the antenna to "lose[] omni-directionality because of capacitance coupled to the radiation electrode." EX1030, [0069]-[0071]. A POSA understood that the amount of capacitance coupling depends on, for example, the size, shape, location, and orientation of the ground plane with respect to the antenna. Thus, EX1030 corroborates my opinion that a POSA understood that where the ground plane is located with respect to Teng's antenna could impact the antenna's performance.

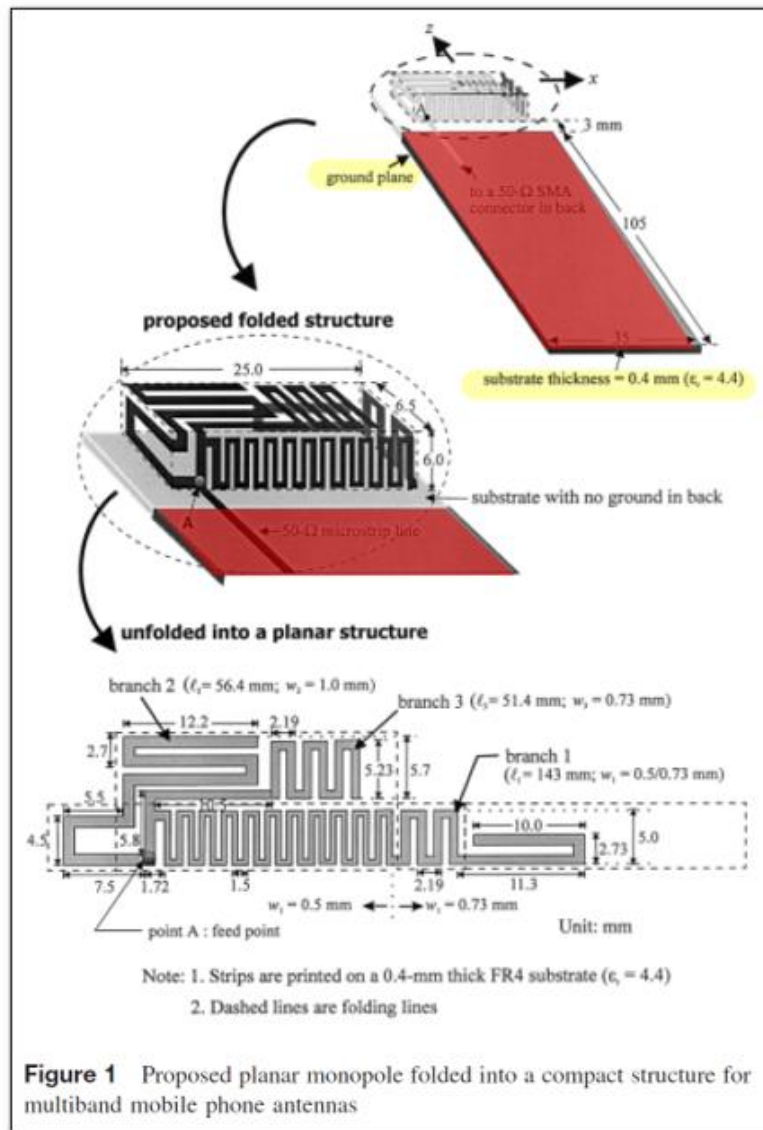
88. EX1030 further discloses for its antenna that because "[t]he structure in which the radiation electrode 33 is formed only on an upper surface 1 c of the substrate 1 is **smaller in capacitance coupling to the ground conductor of the circuit board** than the structure in which the radiation electrode 33 is formed also on a side surface, **so that the former provides a higher gain.**" EX1030, [0097]. EX1030 similarly discloses that because its antenna is "mounted onto an area of

the circuit board **free from a ground conductor, the maximum characteristics are expected**, though it may be mounted onto a ground conductor with its characteristics sacrificed to some extent.” EX1030, [0117]. Those disclosures further corroborate my opinion that the size and location of the ground plane can impact the antenna’s performance (e.g., its “gain”).

89. My opinion in this regard is further corroborated by EX1027. EX1027 discloses “meanderline-loaded antennas” (EX1027, [0061]) (i.e., antennas having similar overall design as Teng’s branches) and discloses that “[t]hose skilled in the art will realize” that “**the dimensions, geometry and material** of the antenna components (the periodic slow wave structures 20, the horizontal conductor 14, **the ground plane 16** and the vertical conductors 12) can be modified by the antenna designer **to create an antenna having different antenna characteristics at other frequencies or frequency bands**” (EX1027, [0063]). Thus, EX1027 further corroborates my opinion that POSAs understood that the dimensions, geometry, and material of the ground plane can affect an antenna’s characteristics.

90. Because Tran+Teng uses Teng’s antenna to achieve the results Teng describes (see §IX.C above), and because Teng says “the top portion” of its substrate “has **no ground plane in back**” and the “antenna **should be placed... away from**” the substrate “portion with a ground plane in back” (Teng, 24),

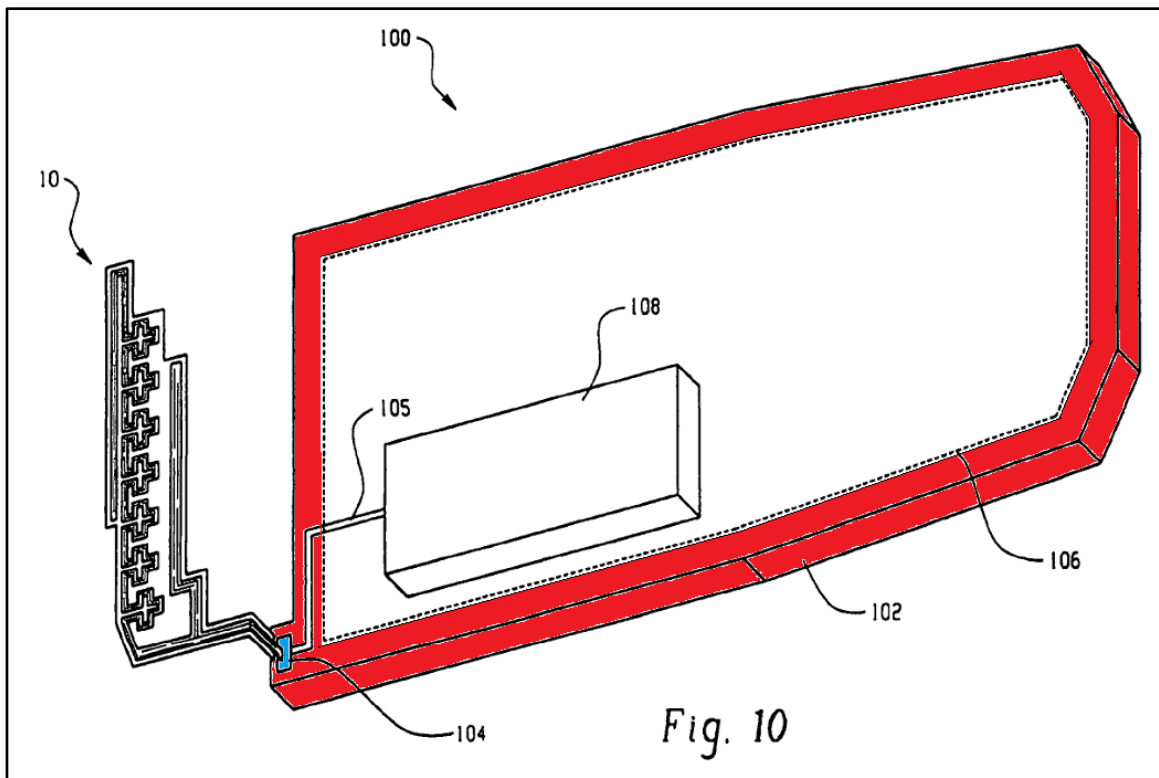
POSAs would have implemented Tran+Teng in the manner Teng discloses so that no portion of the *ground plane layer* is underneath the antenna, as shown in Teng Figure 1 (highlighted below).



e. Limitation [1D]: [PCB comprising] a feeding point;

91. The '365 patent says that its "circuit board 102 [which I have highlighted red below] includes a feeding point 104 [highlighted blue]" that is

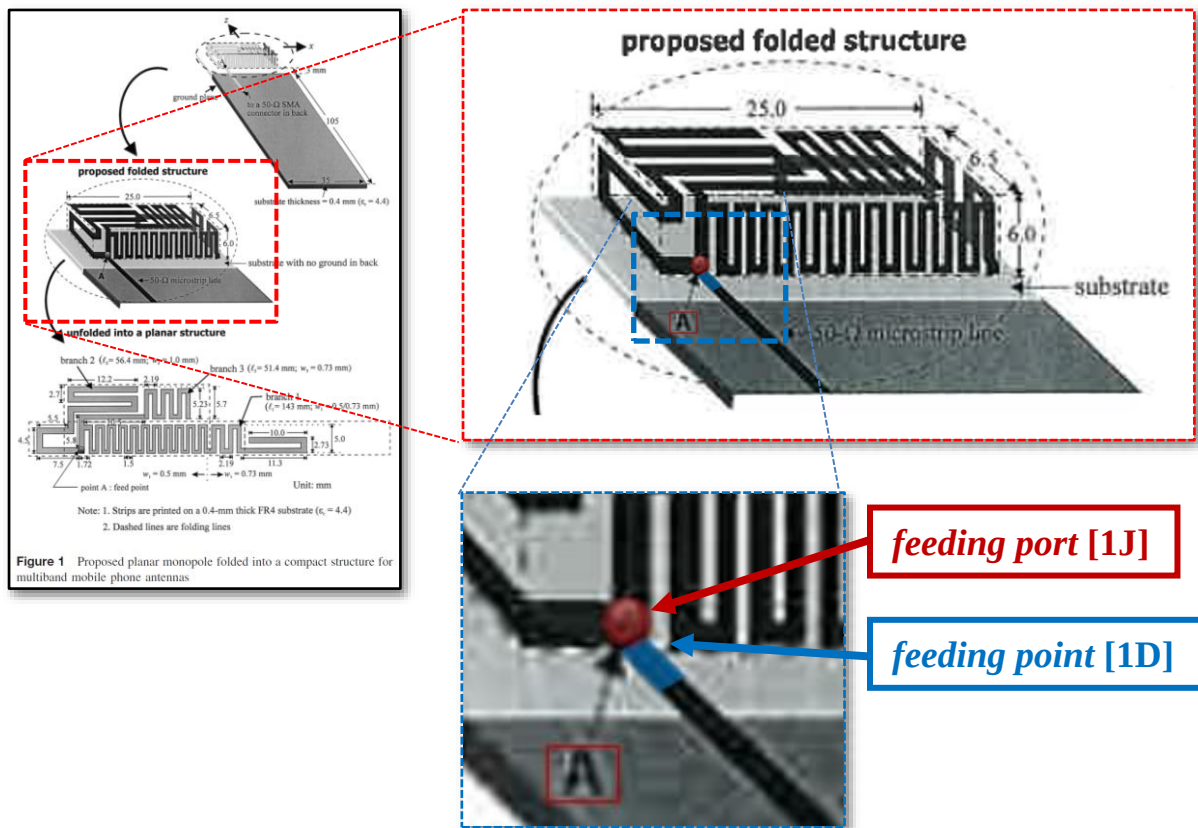
coupling communication circuitry 108 to antenna 10. EX1001, 4:49-62, FIGs. 1, 10 (highlighted below). The '365 patent says feeding point 104 may be “a metallic bonding pad” coupled to “circuit traces 105” that connect the communication circuitry to the antenna. EX1001, 4:55-58. Thus, a POSA would understand that the *feeding point* is a conventional conductive element on the PCB for coupling the communication circuitry to the antenna (which I discuss further below §IX.D.1.g ([1F])).



92. Tran+Teng’s PCB comprises a feeding point to provide a pathway for RF signals between Tran+Teng’s antenna assembly and its communications circuitry, as illustrated in Teng. *See also* §IX.D.1.j ([1I]) (below; where I discuss

the connections to the common conductor). For example, Teng’s Figure 1 (which I annotated in detail below) illustrates that Teng’s “antenna can [] be easily ***fed at Point A*** with the use of a 50-Ω microstrip line printed **on** the FR4 substrate.”

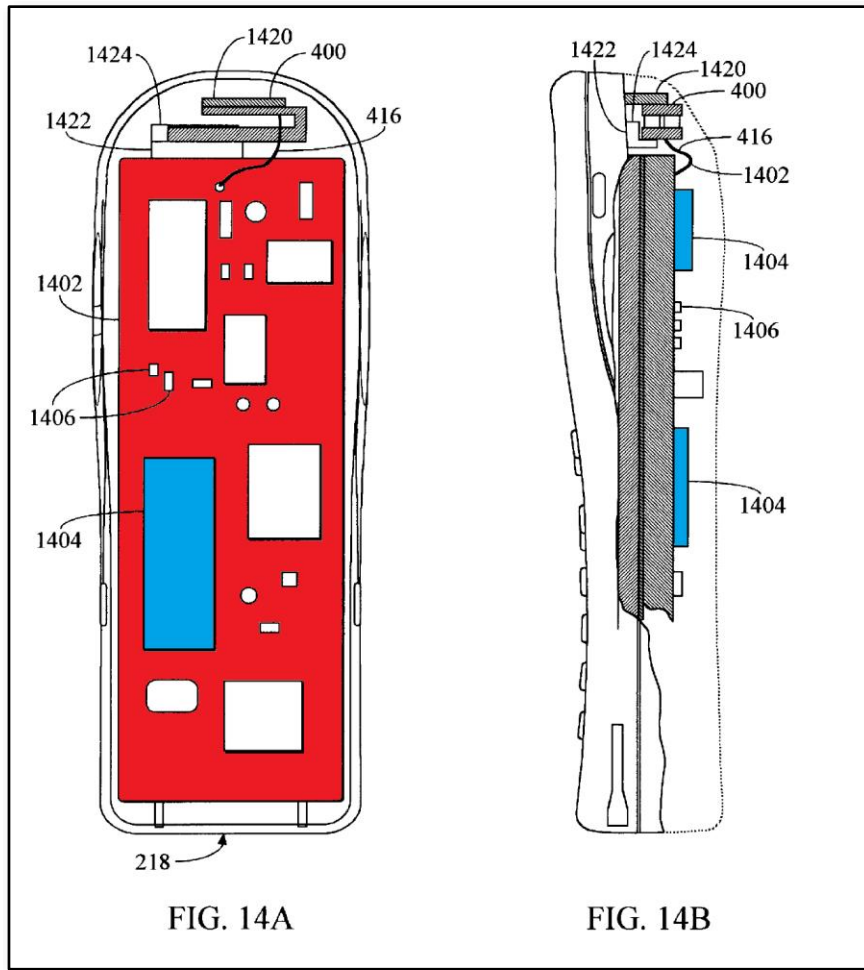
Teng, 24. While Teng labels point A on the antenna element as the “feed point,” in Limitation [1D]’s terminology the point **on the substrate** where Point A couples to the microstrip is Teng’s PCB’s ***feeding point***. (As I discuss further below in §IX.D.1.k ([1J]), Point A is a “***feeding port***” in claim 1’s terminology.)



f. **Limitation [1E]: *[PCB comprising] a communication circuitry, the communication circuitry being mounted on the printed circuit board;***

93. Tran+Teng's PCB (which I have highlighted in red below) has "integrated circuits or chips 1404" (highlighted blue) that are "supported [*i.e., mounted*] on" the *PCB*, as shown in Tran Figures 14A-14B (which I have highlighted below), "for performing the various functions needed or desired." Tran, 13:28-37. The Tran+Teng phone's mobile-phone-service functionality would have been implemented via "a signal unit [], such as a transceiver ... or radio circuitry" (*i.e., communication circuitry*) to process signals transmitted/received on Tran+Teng's frequency bands (which I discussed above in §IX.C and further below in §IX.D.1.h ([1G])). Tran, 8:41-55.

94. Moreover, it would have been the conventional way in the prior art to implement a mobile communication device by having the *communication circuitry mounted on the device's PCB*. My opinion in this regard is corroborated by Sadler (EX1041), which discloses a mobile communication device with a "transceiver unit 24 [that] comprises a transmitter 30, receiver 40, and antenna assembly 50" and Sadler notes that "[t]he transceiver circuitry or radio communications circuit **is typically contained on a printed circuit board 106** (FIGS. 3-4) disposed in the phone's housing 100." Sadler, [0031].

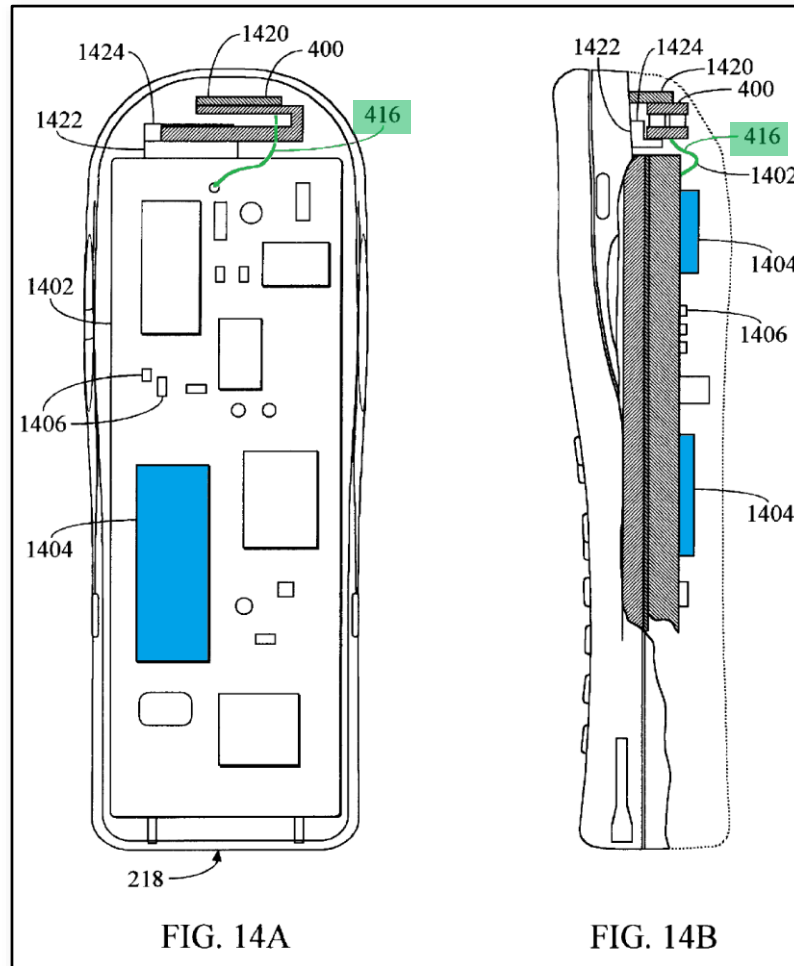


g. Limitation [1F]: wherein the communication circuitry is coupled to the feeding point and to the ground plane layer;

95. Tran+Teng’s *communication circuitry is coupled to the antenna’s feeding point*, as discussed by Tran and Teng, as I discuss below.

96. Tran+Teng (§IX.C) implements a mobile phone device as shown in Tran’s Figure 14A-14B (which I have highlighted below), which has a coaxial feed 416 (highlighted green) that, as in Tran’s Figure 4 embodiment, couples the antenna to “a signal unit ... such as a transceiver.” Tran, 8:37-43. In Tran’s

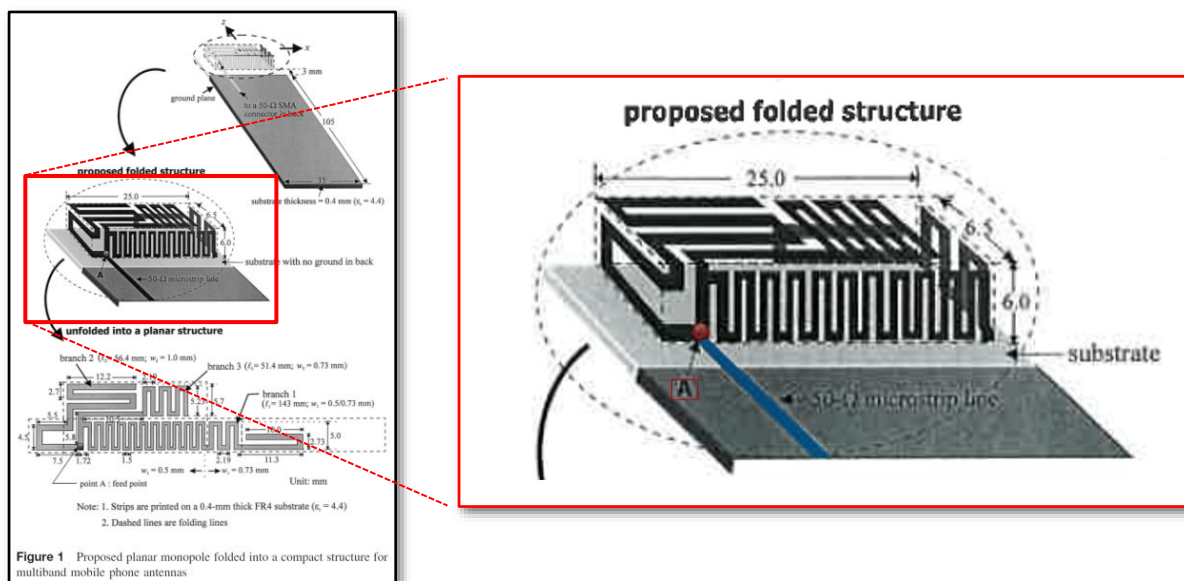
Figures 14A-14B, the transceiver(s) coupled to the antenna are implemented in integrated circuit(s) 1404 (highlighted blue) mounted on the PCB, as discussed above in §IX.D.1.f ([1E]). Thus, the PCB has a feeding point that is coupled to the coaxial feed 416 (green) to feed signals to the antenna.



97. Teng's PCB also has a *feeding point*, which I have highlighted blue in Figure 1 below. See also §IX.D.1.e ([1D]) (above; where I discuss Teng's PCB). In Teng, the microstrip line (highlighted blue below) on the PCB that drives the feeding point connects to test circuitry (Teng, 24-25), but in Tran+Teng this would

represent a PCB trace to the communications circuitry. My opinion in that regard is corroborated by EX1017, which discloses as background information that “[a] power-driven transmitter and/or receiver network (**i.e., transceiver**) is **generally coupled to the microstrip antenna via feed point and feed line.**” EX1017, 1:27-29.

98. In implementing Tran+Teng, it would have been a design choice to a POSA whether to connect the PCB’s feeding point to the antenna via a coaxial wire, as in Tran, or via a solder or other conventional bond between the antenna and the feeding point, as discussed in Teng. In my opinion, POSAs had reason to choose Teng’s approach because it would have avoided a bulkier coaxial wire, and thus would have been consistent with Tran’s desire to reduce the size of the antenna and associated components (Tran, 1:24-36).



99. As I discussed above, Tran+Teng has a ground plane layer. See §IX.C (above; where I discuss the Tran+Teng combination), §IX.D.1.d ([1C]) (above; where I discuss Tran+Teng’s ground plane layer). In my opinion, POSAs would have coupled the communication circuitry in Tran+Teng to the ground plane layer, just like in Tran, because it was well known to POSAs to use a ground plane to “function[] as a ground potential for the radio-device’s *communication circuitry*” (EX1019, 2:6-16) to ensure proper performance of the communication circuitry. My opinion in this regard is further corroborated by the following references:

- EX1020, which discloses that “[e]lectrical signals to and from any device **typically require two conductors**; typically a trace **and a ground plane** in [the] PCB,” where the “ground plane is typically a conductive layer of [the] PCB.” EX1020, 4:5-8. Thus, EX1020 corroborates my opinion that it would have been obvious to couple Tran+Teng’s communication circuitry to the ground plane layer, because, as EX1020 discloses, it is typically required for a device (like communication circuitry) to have a ground plane (typically implemented as a PCB layer).
- EX1021, which discloses as background information that “Printed circuit boards (PCBS) are commonly used to provide a mechanical structure on which discrete electronic components, such as integrated circuits, resistors, capacitors and the like, are mounted and interconnected. The interconnections in a PCB are provided by layers of patterned traces of

metal, typically copper, on and in the PCB. ... Typically, in a four layer PCB i.e. one having four patterned layers of metal traces, the two inner most layers provide a common electrical power plane and **a common electrical ground plane, respectively, for all the circuitry on the PCB.** The operation of circuitry on a multi-layered PCB, especially where there signals at high frequencies of around 50 [M]egahertz or more, causes voltage fluctuations between the power and ground planes. Such fluctuations, often referred to as **electromagnetic interference (EMI) or noise, is undesirable. The common ground** and common power planes in a multi-layered PCB **have a capacitance value which helps to reduce EMI**, however for most applications a larger capacitance is required to further reduce the EMI to meet EMI standards set by state regulatory bodies.” EX1021, 1:12-2:2. Thus, EX1021 also corroborates my opinion that it would have been obvious to couple Tran+Teng’s communication circuitry to the ground plane layer, because, as EX1021 discloses, ground plane layers typically function as a common electrical ground for all the circuitry, to serve as a reference voltage for configuring the circuitry. As EX1021 discloses, the common ground also beneficially helps to reduce electromagnetic interference (EMI), when coupled to the communication circuitry.

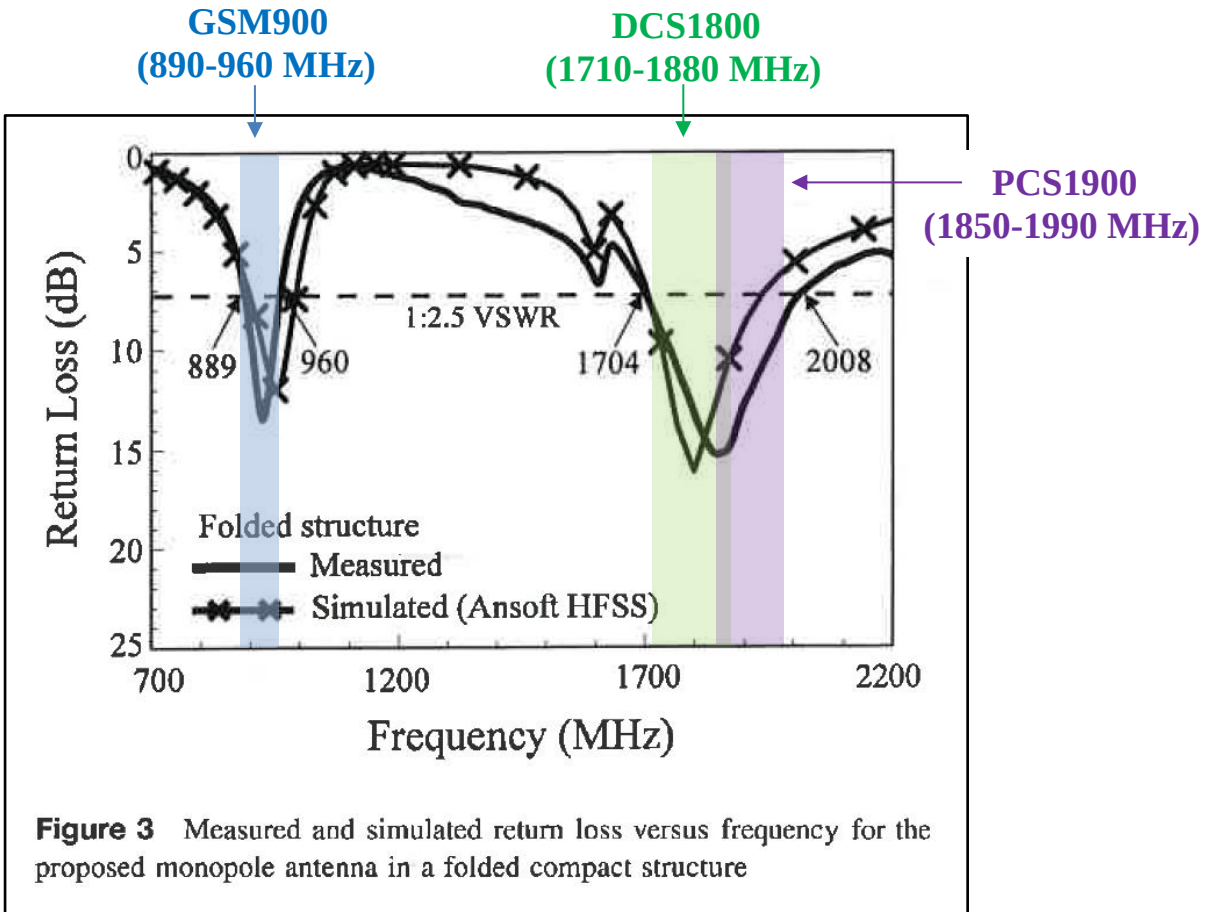
h. Limitation [1G]: *a multi-band antenna capable of operating at multiple frequency bands, the multi-band antenna including an antenna element;*

100. Tran+Teng (see §IX.C above) uses Teng’s monopole

“GSM/DCS/PCS multiband mobile-phone antenna” for which “the obtained impedance bandwidths cover the required bandwidths of the GSM band (890-960

MHz), the DCS band (1710-1880 MHz), and the PCS band (1850-1990 MHz).”

Teng, 22 (Abstract). For example, Teng discloses that “[f]rom the obtained results in Figure 3 [which I have annotated below], the lower band has a bandwidth (1:2.5 VSWR) of 889-960 MHz [highlighted blue below], covering the required GSM band. For the upper band, a bandwidth of 1704-2008 MHz is obtained, which covers the required DCS and PCS bandwidths [green and purple highlighted below, respectively].” Teng, 24. Tran+Teng’s antenna element is thus “*capable of operating at multiple frequency bands*” and, therefore, meets Limitation [1G].



101. Teng's Figure 1 (which I have annotated below) illustrates that Teng's antenna has an *antenna element*, which Teng illustrates in a planar-structure (blue-highlighted) and a folded-structure (red-highlighted) form, which further meets Limitation [1I], as I discuss below in §IX.D.1.j.

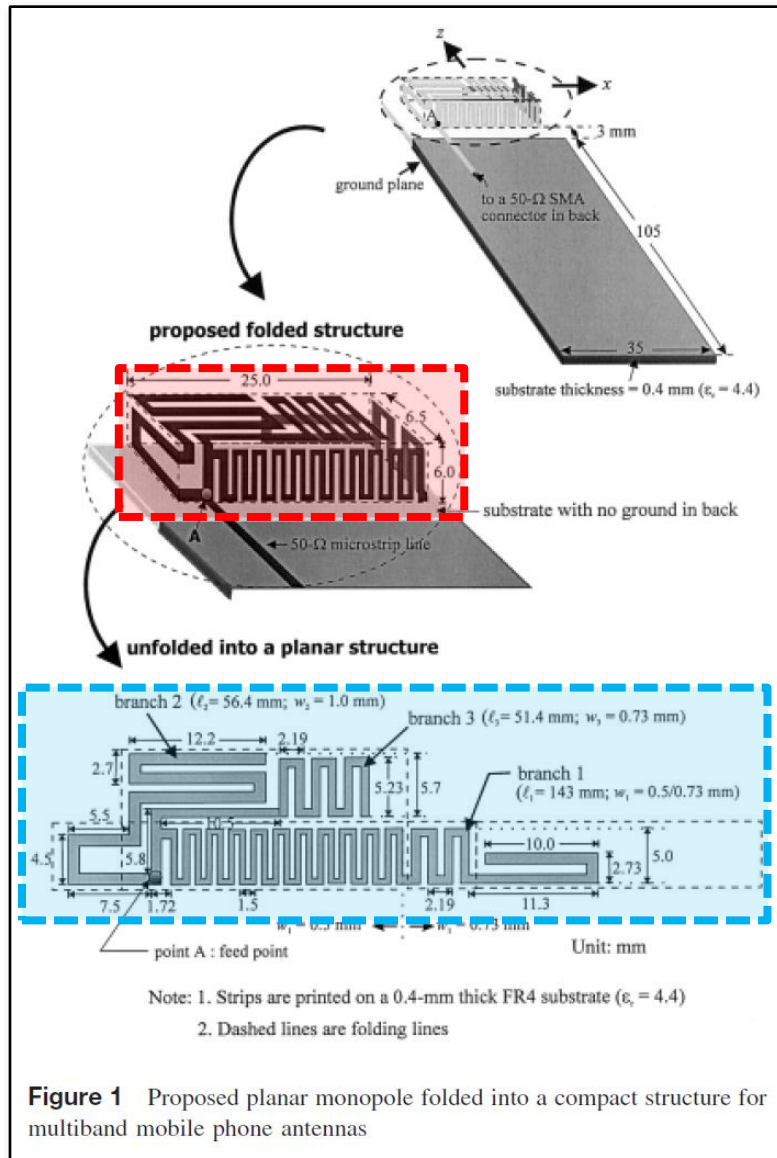


Figure 1 Proposed planar monopole folded into a compact structure for multiband mobile phone antennas

i. Limitation [1H]: wherein the antenna element operates in cooperation with the ground plane layer;

102. The '365 patent does not explain how its (or any) *antenna element operates in cooperation with the ground plane layer*. Thus, a POSA would have understood that the '365 patent is relying on POSAs' background knowledge of how an antenna element operates in cooperation with a ground plane layer.

103. Teng discloses that its antenna has three branches that are “designed to operate as quarter-wavelength structures.” Teng, 22 (Abstract). POSAs knew quarter-wavelength antennas *operate in cooperation with the ground plane layer* to exhibit electromagnetic-radiation properties comparable to corresponding half-wavelength dipole antennas and provide a signal-return path and ground reference for communication circuitry coupled to the antenna. My opinion in this regard is corroborated by the following references:

- EX1022, which discloses as background information that in a “quarter-wavelength monopole antenna ... [t]he physical antenna length is a quarter-wavelength, **but when placed above a ground plane the antenna performance resembles that of a half-wavelength dipole.**” EX1022, [0005]. Thus, EX1022 corroborates my opinion that it was part of a POSA’s background knowledge that monopole antennas, like Tran+Teng’s antenna, would conventionally operate in cooperation with the ground plane layer to provide antenna performance like a half-wavelength dipole antenna, but without requiring the dimensions of a half-wavelength dipole.
- EX1018, which discloses as background information that for “[p]atch antennas, a type of microstrip antenna,” “[t]o complete the antenna structure, the dielectric substrate is covered with metal on one side, (the **ground plane**) [T]he substrate fulfills an electrical function by concentrating electromagnetic fields and preventing unwanted radiation in the associated circuits.” EX1018, [0003]. Thus, EX1018 also corroborates my opinion that it was within a POSA’s background

knowledge that microstrip antennas, a type of printed antenna, would conventionally operate in cooperation with the ground plane layer to concentrate EM fields and/or prevent unwanted radiation in associated circuits (e.g., communication circuitry).

- EX1019, which discloses as background information for “meander-line antennas,” that “the ground plane element also functions as a ground potential for the radio-device’s communication circuitry.” EX1019, 2:6-16. Thus, EX1019 also corroborates my opinion that it was within a POSA’s background knowledge that meander-line antennas, like Tran+Teng’s antenna, would operate in cooperation with the ground plane layer to provide a common ground potential for the device’s communication circuitry.

j. *Limitation [1I]: the antenna element comprising: a common conductor; a first radiating arm connected to the common conductor; a second radiating arm connected to the common conductor;*

104. Tran+Teng (see §IX.C above) uses Teng’s antenna element, which is “printed on a thin FR4 substrate” and formed from a *conducting* material that radiates/resonates RF energy. Teng, 23. Teng discusses an electromagnetic “coupling effect between two adjacent or meandered sections” of the antenna element, which corroborates that it is formed of conductive material because POSAs would have understood that that coupling effect results from using conducting material (like metal), rather than a non-conducting material (like plastic), which would not experience a coupling effect because a non-conducting

material cannot have conductive currents. Teng, 23. My opinion in this regarding is corroborated by EX1014, which discloses as background information that when there are “two radiators,” “when power is fed to a first radiator, some of this power transfers to a second radiator, which impairs the radiation power of both radiators and causes additional power consumption for the mobile station.” EX1014, [0005]. A POSA would have understood that the power transfer described in EX1014 is an example of a coupling effect like that discussed in Teng, and that the radiators would be made of conducting material (in order to radiate energy).

105. Even if Teng’s antenna was not comprised of conducting material, a POSA would have found using *conducting* material would been the obvious and conventional way to print antennas onto a substrate, as discussed in Teng. My opinion in this regard is corroborated by Tran, which discloses that Tran’s antenna can be “constructed by etching or depositing a **metallic** [*conductive*] strip on two sides of a dielectric substrate.” Tran, 11:35-39. My opinion is further corroborated by the following references:

- EX1017, which discloses as background information that it was known to have a “microstrip antenna” (which is a type of printed antenna), which “include[es] a radiating element,” which “is an electrically **conductive material**.” EX1017, 1:11-18. EX1017 further discloses producing its radiating element by having a material “adhered, sprayed, screened, or vapor deposited on the substrate layer as is well known in the art,” where the “**conducting radiator** [] is preferably copper foil but can be **other**

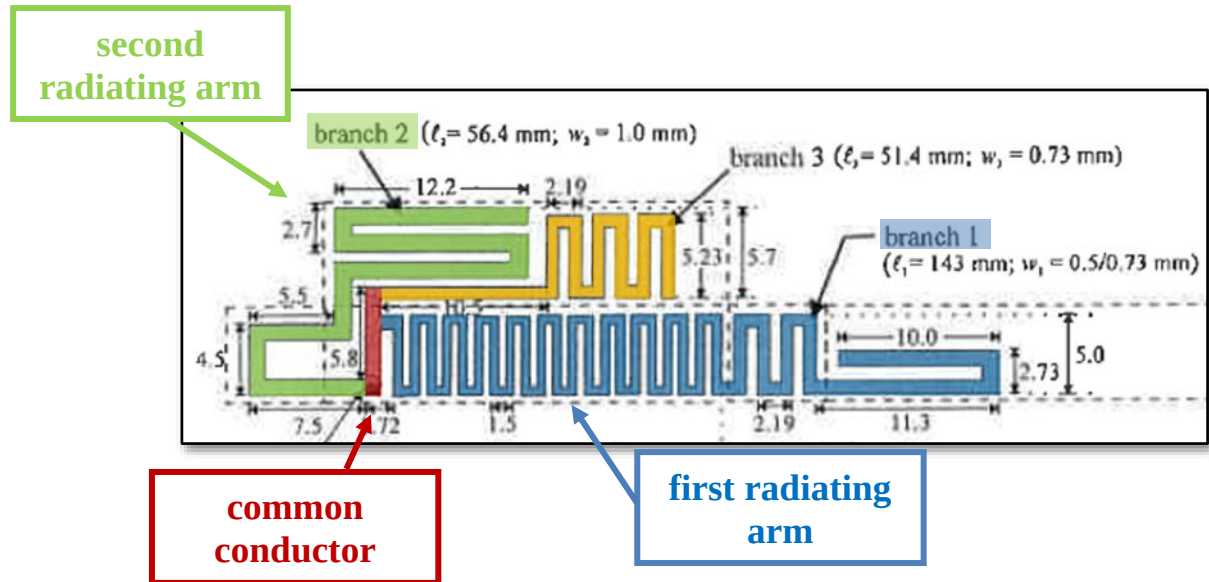
materials with excellent conductive properties, such as silver or gold.”
EX1017, 4:12-24.

- EX1022, which discloses as background information that “[p]rinted or **microstrip antennas** are constructed using the principles of printed circuit board processing, where **conductive layers** on one or more dielectric substrates **are patterned, masked and etched to form the antenna elements. The conductive layers** or interconnecting vias **serve as the radiating element(s).**” EX1022, [0006].

106. Teng’s *antenna element* has three branches, which I have highlighted below in blue, green and orange in Teng’s Figure 1 (which includes annotated detail below), with each branch strip originating from a common, conductive trunk (which I have highlighted red below), which is *a common conductor*. Teng, 23-24. Teng discloses that RF signals transmitted to and received from the antenna branches are “fed at Point A,” which corroborates that all of the branches are connected to the antenna element’s Point A (i.e., Point A is a common point connected to each branch.

107. Teng further discloses that each branch is designed to *radiate* over a respective frequency band and, thus, each branch is a *radiating arm*. Teng, 23. Teng’s Figure 1 (which I has annotated detail below) illustrates branch 1 (*first radiating arm*, highlighted blue) *connected to the common conductor* (highlighted red) and branch 2 is a *second radiating arm* (highlighted green) *connected to the*

common conductor (highlighted red). Teng, 23-24, Fig. 1. They are all connected because the entire antenna element is printed from a common (metal) material and, as shown in Figure 1, there are no discontinuities between the strip line of the common conductor and the strip lines of each antenna branch.

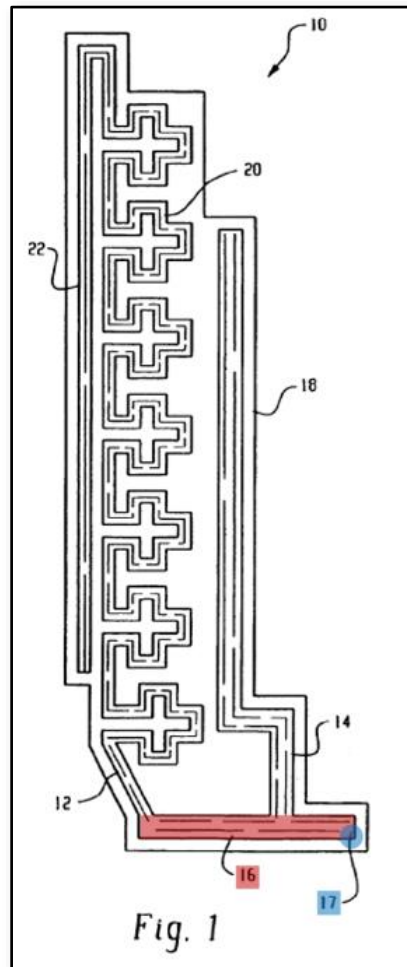


108. The red-highlighted portion of Teng's antenna element above is a *common conductor* because it is common to multiple radiating arms (e.g., branches 1 to 3) and conducts signal between each branch and feed point A, as I discussed above. See §VIII.A (above; claim construction of “a common conductor”).

- k. **Limitation [1J]: wherein the common conductor includes a feeding port, the feeding port being coupled to the feeding point;**

109. The '365 patent says

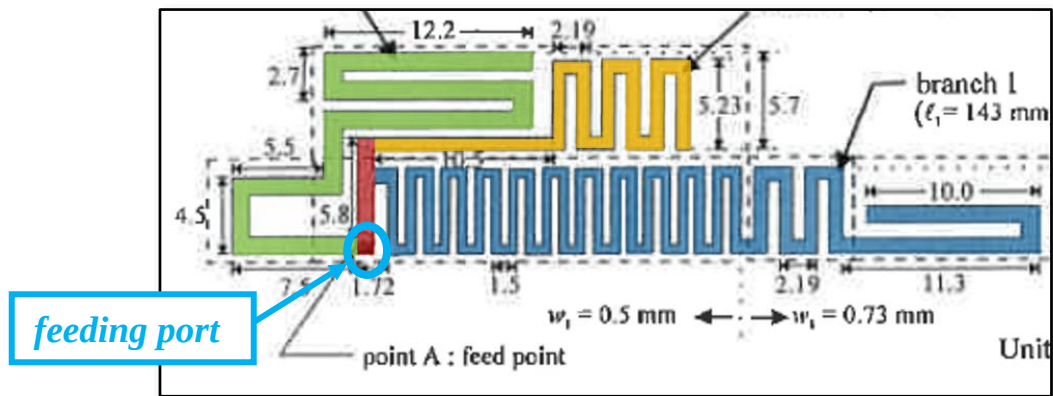
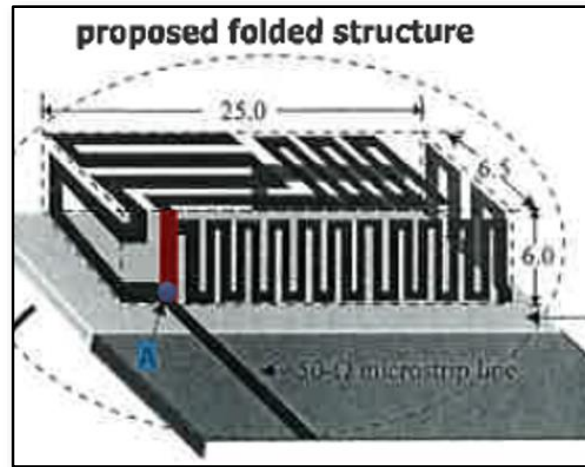
Figure 1 (which I have annotated on the right) shows two radiating arms 12, 14 that are “coupled to a feeding port 17 [highlighted blue] through a common conductor 16 [highlighted red].” EX1001, 2:54-59, Fig. 1 (annotated).



110. The '365 patent says “feeding port 17 of the antenna 10 may ... be coupled to the feeding point 104... by bonding the feeding port 17 directly to the feeding point 104.” EX1001, 5:18-23. Thus, the claimed feeding port is met by a portion of the common conductor coupled (e.g., bonded) to the PCB’s feeding point.

111. Additionally, a “feed port” was known in the art to “refer[] to the point of electrical contact between the conducting antenna elements and signal processing electronics.” EX1023, 5:38-41. A POSA knew that an example “feed port” included “a metallized hole through the ground plane[], the dielectric substrate[], and the conducting antenna element.” EX1023, 5:41-50.

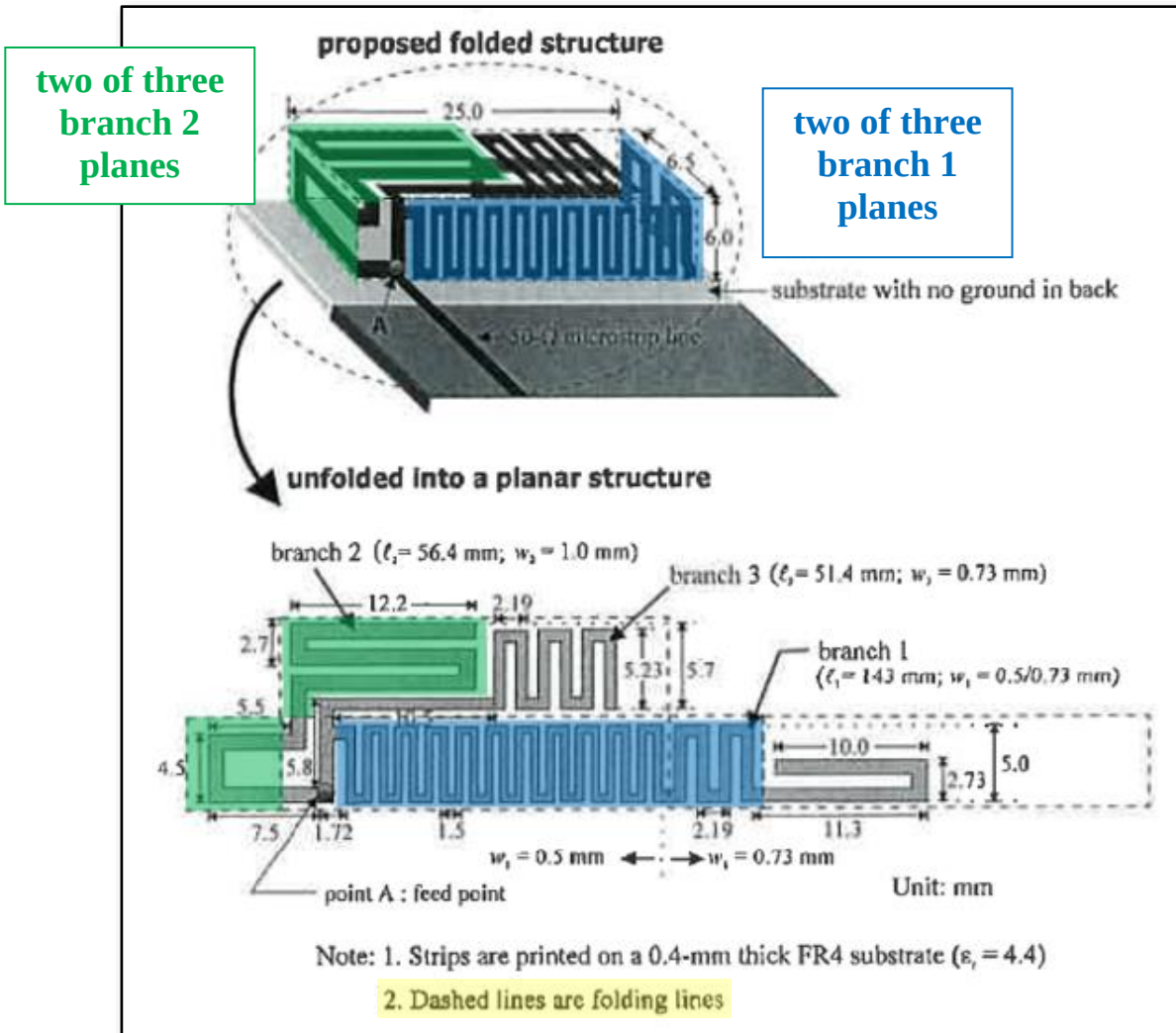
112. Teng’s Figure 1 (which includes annotated detail below) shows the *common conductor* (red) *includes a* “point A: feed point.” Teng, 23. While Teng calls this a “feed point” (Teng, Fig. 1), in Limitation [1J]’s terminology this portion of Teng’s common conductor element is the “*feeding port*” because it is “the point through which RF signals are fed into and from the antenna” from the adjacent “*feeding point*” on PCB, as I discussed above in §IX.D.1.e ([1D])). Teng, 24 (“The proposed **antenna can then be easily fed at Point A** with the use of a 50-Ω microstripline[.]”).



113. Thus, Teng's feed point A is the *common conductor's feeding port* because it is the point of electrical contact between the antenna's conductor and the communications circuitry. See EX1023, 5:38-41 (discussed above, which discloses that "feed port" was known to "refer[] to the point of electrical contact between the conducting antenna elements and signal processing electronics"). In Tran+Teng, Teng's *feeding port* (feed point A) would have been *coupled to* Tran+Teng's PCB's *feeding point* (discussed above §IX.D.1.d ([1E])) to transmit signals to and/or receive signals from the communications circuitry.

l. Limitation [1K]: wherein at least a portion of the first radiating arm and at least a portion of the second radiating arm are arranged on different planes;

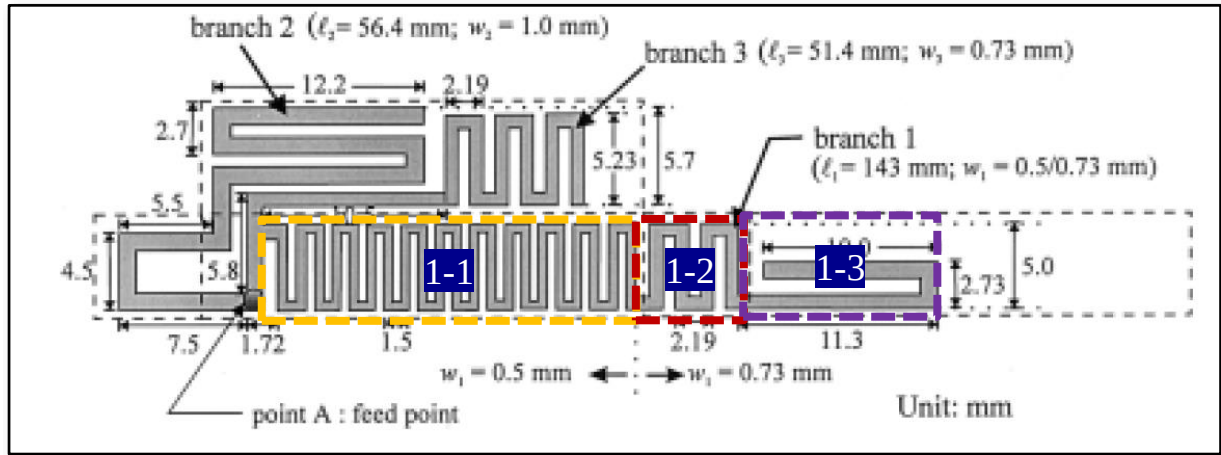
114. Teng's *antenna element* is "folded into a rectangular-box-like compact structure" in which *at least a portion of* Branch 1 (blue: *the first radiating arm*, as I discussed above §IX.D.1.j, [1I]) and *at least a portion of* Branch 2 (green: *the second radiating arm*, as I discussed above §IX.D.1.j, [1I]) are *arranged on different planes* of the rectangular-box-like structure, as illustrated in Teng's Figure 1 (which I have annotated below). Teng, 23.



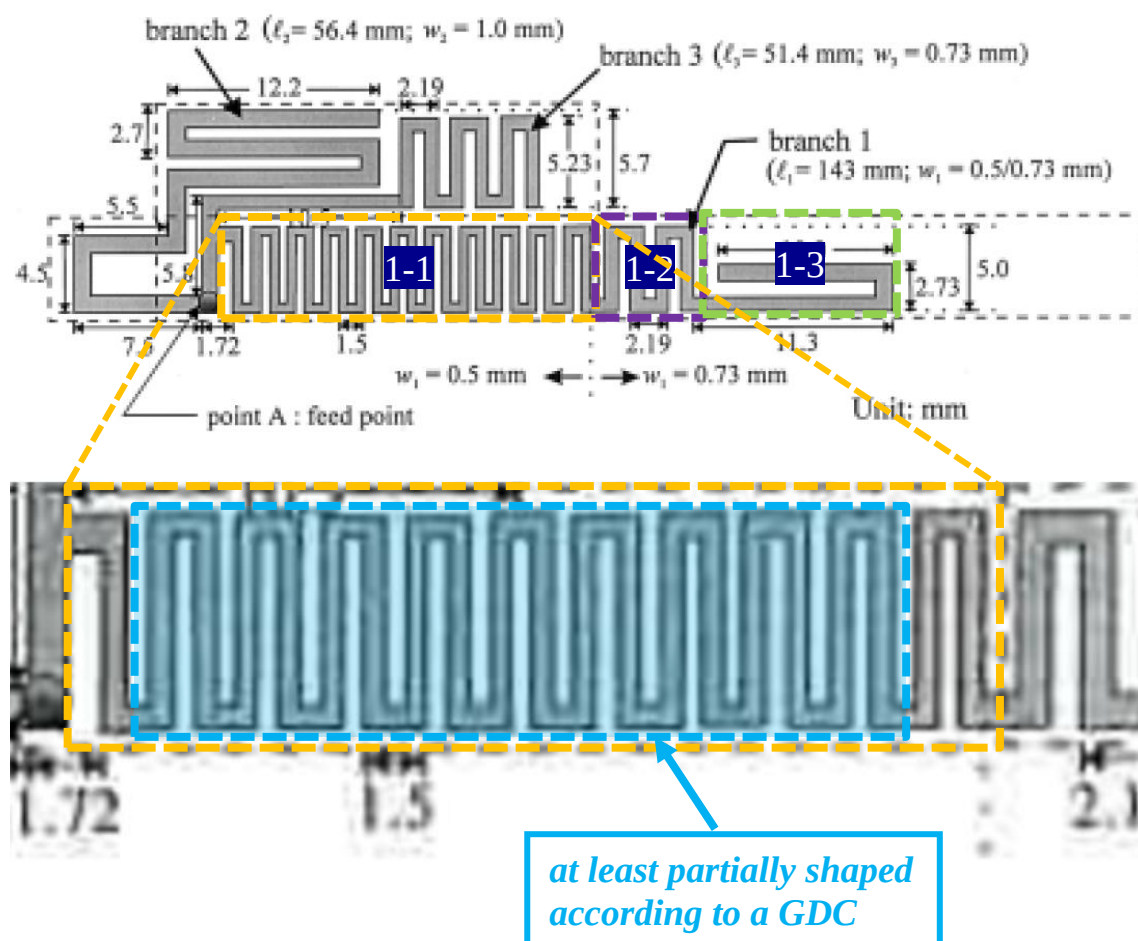
m. **Limitation [1L]:** *wherein the first radiating arm is at least partially shaped according to a grid-dimension curve; and*

115. Under the plain language of Limitation [1L], the *first radiating arm* portion need only *at least partially*, not entirely, be *shaped according to a grid-dimension curve*. See also §VIII.B (above; discussing each party's construction of "grid-dimension curve"). In Teng's antenna (used in Tran+Teng), Teng's Branch 1 (*first radiating arm*) has portions (1-1, 1-2, and 1-3) that, when Branch 1 is

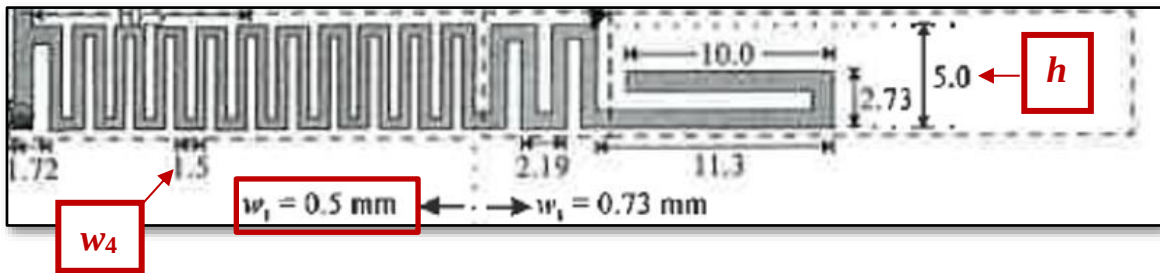
folded, lie on three different planes, which I discuss further below (§IX.D.1.l, [1K]). Teng, Fig. 1 (which I have annotated below).



116. I will refer to the portion of section 1-1 that I have shaded blue below as the “GDC portion” or “First GDC portion.” The GDC portion of Branch 1 (first radiating arm) is “at least partially shaped according to a grid-dimension curve” under each party’s construction, thereby meeting limitation [1L], as I explain below in §§IX.D.1.m.i-ii.



117. Teng's Figure 1 (with annotated detail above) reports dimensions for Branch 1-1, as shown in the figure below from Teng. (In the subsequent figure below, I have prepared a scaled model of the GDC portion of Branch 1-1, which I have labelled Petitioners' Figure P-1.) As indicated in Teng's Figure 1 (and annotated below), the strip containing the GDC portion has a width $w_1 = 0.5$ mm, the meandering pattern has a height $h = 5.0$ mm, and the width $w_4 = 1.5$ mm (where w_4 is a label I have added for convenience). *See also* Teng, 23.



118. Based on Teng's Figure 1 and that Teng discloses only the dimensions above, POSAs would have understood that the GDC portion's pattern is repeating and symmetrical so that the top and bottom horizontal segments have the same 1.5 mm width and thus the spacing between consecutive horizontal segments is uniform, as I have illustrated below in Petitioners' Figure P-1.



Petitioners' Figure P-1

119. But even if the above uniformity were not expressly taught by Teng, that would have been the obvious way to implement what Teng discloses to a POSA because it would have made it easier to layout, simulate, and modify Teng's design, and because a lack of uniformity would have led to an increased level of effort to design, lay out, and modify the antenna pattern, and possibly increased

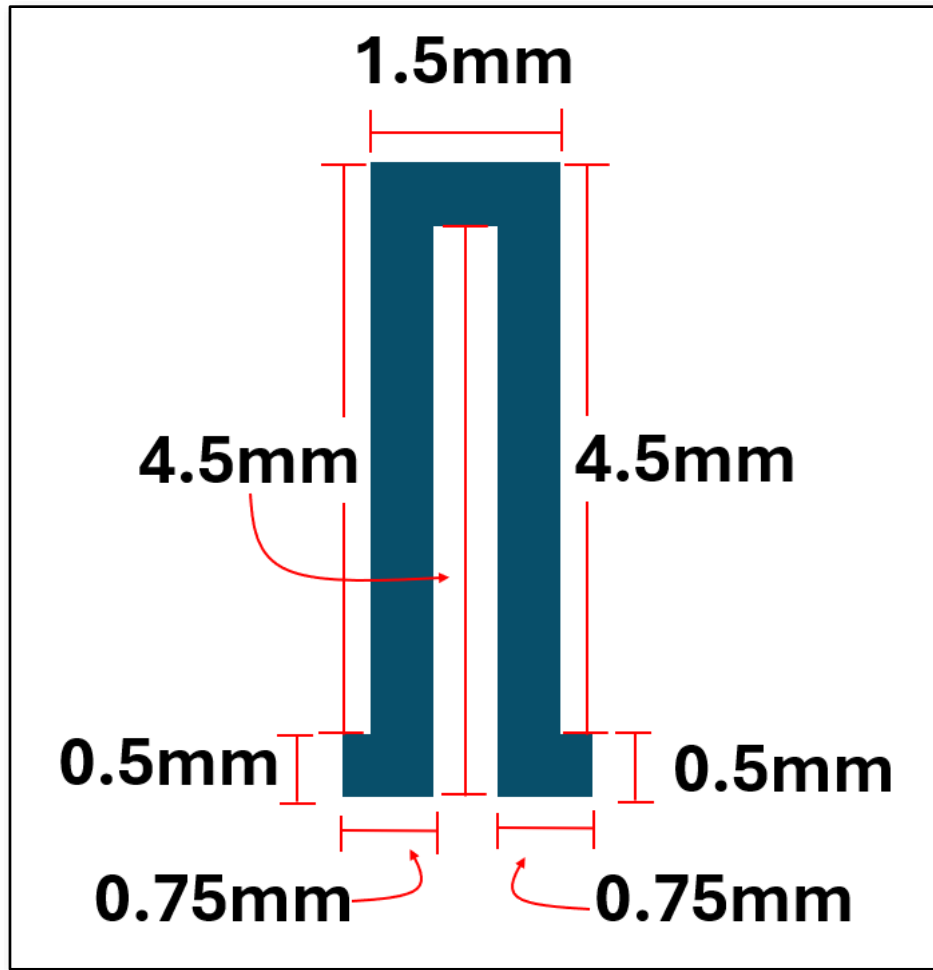
radiation losses. For example, by having a uniform, repeating pattern, a POSA could optimize the layout based on one of the repeating elements and repeat it as many times as needed to obtain the desired radiating characteristics, which was a common design principle for meander-line antennas, like each of Teng's branches. My opinion in this regard is further corroborated by the following references:

- EX1027, which discloses that “[w]ith respect to the periodic slow wave structures of FIGS. 6 [a meanderline-structure] and 7, the effect can [be] explained by recognizing that **the wave traveling in the structure couples (due to inter-element coupling) more easily between periodic sections as the frequency increases.**” EX1027, [0054]. Thus, EX1027 corroborates my opinion that having a periodic structure to a meander-line antenna structure, like Teng's branches, beneficially increases the coupling of the RF travelling wave to the antenna element.
- EX1030, which discloses that when “[i]n a conventional **radiation electrode having a bent portion substantially in a shape of L, rectangular U, meander or crank, its straight portion and its bent portion are different in width, connected in a rectangular manner. This means that impedance changes discontinuously, leading to the partial reflection of a propagating wave.** Accordingly, there is large reflection loss in an input high-frequency signal, resulting in decrease in a gain. It has been found that when the bent portion is rounded to provide a line electrode with substantially the same width, it is possible to avoid the discontinuity of impedance. It has also been found that chamfering the bent portion is effective. **If reflection loss in the bent portion were**

suppressed, transmission loss would be decreased in a resonance current flowing through the radiation electrode of the antenna, resulting in improvement in a gain.” EX1030, [0095]. Thus, EX1030 corroborates my opinion that it would have been beneficial to minimize changes in widths in Teng’s meanderline-branches (i.e., use a uniform, periodic structure) because a non-uniform design would have likely led to undesirable reflections of the wave propagating in the antenna branches and increased signal losses.

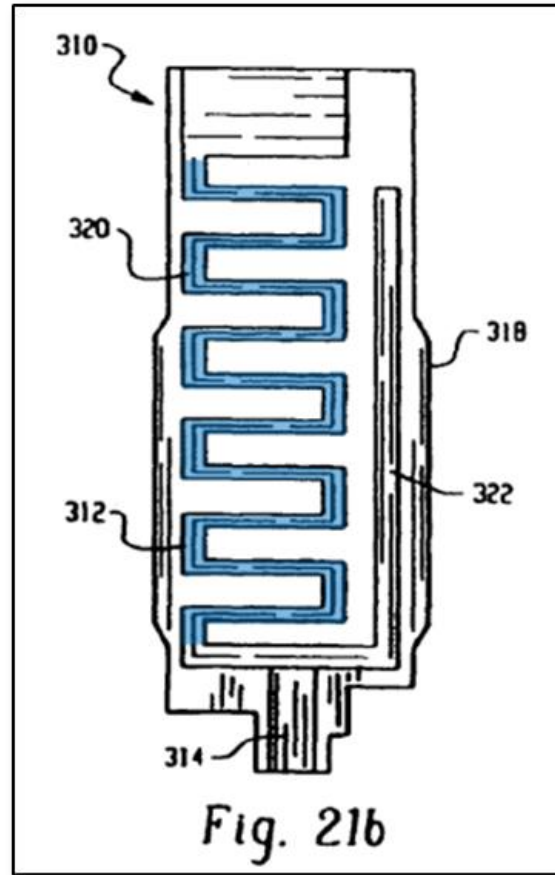
120. Given that Teng’s meandering pattern is (or at least beneficially would have been) uniform, other dimensions in Teng’s Branch 1-1 can be calculated, as shown in what I have labelled as Petitioners’ Figure P-2 below. The 1.5 mm dimension below is based on Teng Figure 1’s disclosure that the length of the horizontal segments at the outermost edge of Branch 1-1’s strip is 1.5 mm; the 0.75 mm dimensions below are calculated by halving the same 1.5 mm dimension in Teng’s Figure 1; and the 4.5 mm dimensions below are calculated by subtracting 0.5 mm (Branch 1-1’s strip width) from the 5.0 mm peak-to-peak height in Branch 1-1, as shown Teng Figure 1.

121. Petitioners’ Figure P-1 above shows the GDC portion is formed by repeating the unit meander shape that I have identified in Figure P-2 (below), specifically by repeating the shape below nine times.



Petitioners' Figure P-2

122. As demonstrated below in §§IX.D.1.m.i-ii, the GDC portion (below left) meets each party's construction of *grid-dimension curve* and also meets the patent's depiction of "grid dimension section 320." In the below right, I have highlighted '365 patent's Figure 21b, which the patent says illustrates a "grid dimension section 320" (highlighted blue). EX1001, Fig. 21b (annotated below), 8:61-64. As shown below, Teng's GDC portion has a similar shape to the '365 patent's alleged grid dimension section 320.



- i. **Tran+Teng's first radiating arm meets Petitioners' (Geotab's) construction of *grid-dimension curve*.**

123. As I discussed above (§VIII.B.2), Petitioners' construction requires the grid-dimension of the grid-dimension portion to be greater than 1, using this formula:

$$Dg = -\frac{\log(N2) - \log(N1)}{\log(L2) - \log(L1)}$$

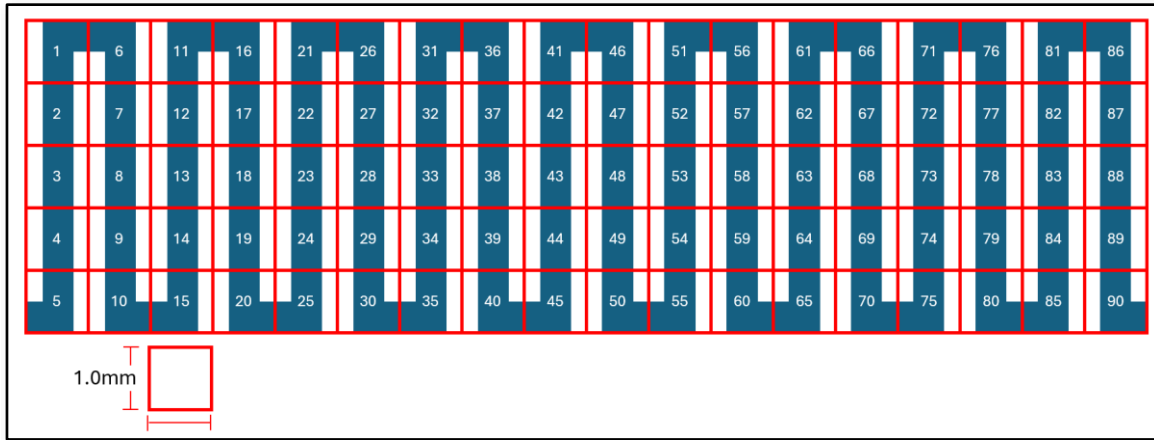
where:

- **(1)-(2):**⁵ L1, L2 are the edge lengths of the square cells that form respective rectangular grids that “completely cover[] the curve”;
- **(1a)-(1c), (2a)-(2c):** N1, N2 are the respective “number of cells” in each grid “that enclose at least a portion of the curve”;
- **(3):** both grids are “positioned within a minimum rectangular area” “such that no entire row or column on the perimeter” of a grid “fails to enclose at least a portion of the curve”;
- **(4):** N1_{Total} is at least 25;
- **(5):** N2_{Total} should be four times N1_{Total}; and
- **(6):** L2 “should be one-half” of L1.

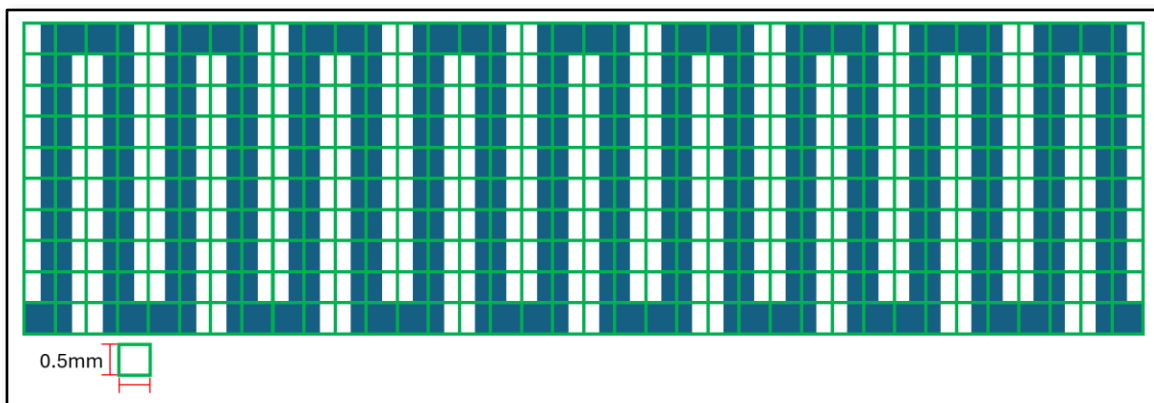
See also EX1001, 6:59-7:15 (cited and discussed in §VIII.B.2 above).

124. Applying Petitioners’ construction results in a first rectangular grid (red squares) below comprising 5 rows and 18 columns, enclosing the GDC portion with 90 square cells (which I have numbered for convenience) of edge length $L1 = 1.0 \text{ mm}$ (i.e., each red square below represents a $1.0 \text{ mm} \times 1.0 \text{ mm}$ square):

⁵ The bolded labels have been added for convenience to identify different portions of Petitioners’ construction, which I also identified and discussed above in §VIII.B.2.



125. A second rectangular grid (green squares) below encloses the GDC portion with 360 square cells of edge length $L2 = 0.5 \text{ mm}$ (*i. e.*, $L2 = 1/2 \times L1$):



126. As shown above, in each grid ***all cells*** “enclose ***at least a portion***” of the GDC portion. See EX1001, 6:63-7:1. Thus, every cell is counted in the grid-dimension calculation, and so $N1 = 90$, $N2 = 360$, and the grid-dimension value is greater than 1, as shown below:

$$\begin{aligned}
D_g &= -\left(\frac{\log(N2) - \log(N1)}{\log(L2) - \log(L1)}\right) = -\left(\frac{\log(360) - \log(90)}{\log(0.5) - \log(2 \times 0.5)}\right) \\
&= -\left(\frac{\log(360/90)}{\log(1/2)}\right) = -\left(\frac{\log(4)}{\log(1/2)}\right) = -\left(\frac{2 \log(2)}{(-1) \log(2)}\right) = 2.0.
\end{aligned}$$

127. The additional requirements in Petitioners’ construction (see §VIII.B.2 above) are also met, as I discuss below.

128. **First**, $N1_{Total} = 90$ (i.e., the total number of red-colored squares in the first grid), which is “at least twenty-five cells,” and $N2_{Total} = 360$, which is “four times the number of cells as the first grid.” See §VIII.B.2 (above; citing EX1001, 7:5-7).

129. **Second**, “the length (L2) of each square cell in the second grid” (0.5 mm) is “one-half” the length (L1) (1.0 mm) of each square cell in the first grid. See §VIII.B.2 (above; citing EX1001, 7:7-9).

130. **Third**, grids 1 (red) and 2 (green) are “positioned within a minimum rectangular area enclosing the curve, such that no entire row or column on the perimeter of” either “grid[] fails to enclose at least a portion of the curve.” See §VIII.B.2 (above; citing EX1001, 7:1-5).

131. Thus, the GDC portion of Teng’s Branch 1 (*first radiating arm*) meets Petitioners’ construction of a *grid-dimension curve*.

**ii. Tran+Teng’s first radiating arm meets
Fractus’s construction of *grid-dimension curve*.**

132. As I discussed above, Fractus’s (like Petitioners’) construction of “*grid-dimension curve*” requires a “grid dimension that is greater than one,” which is met by Tran+Teng’s GDC portion for the reasons I discussed above (§IX.D.1.m.i). *See also* §VIII.B.1 (above; discussing Fractus’s claim construction and quoting EX1008, 27). As discussed above (§VIII.B.1), Fractus’s construction has two additional requirements that are met by the GDC portion, as I discuss below.

133. “*A curve which is not self-similar*”: Fractus’s claim-construction briefing from the ADT litigation does not explain what “*self-similar*” means or how this negative limitation is met. *See generally* EX1008. However, another Fractus-assigned patent (which has been marked as EX1024) says “self-similarity” means “each part of the geometrical object is a replica of the whole object at a different scale” (e.g., a “fractal curve”). EX1024, 2:12-14. Under that definition, the GDC portion I discussed above (§IX.D.1.m.i) is “**not** self-similar” because the repeating part (as shown in Petitioners’ Figure P-2 above) is not a replica of the entire pattern (that is shown in Petitioners’ Figure P-1 above).

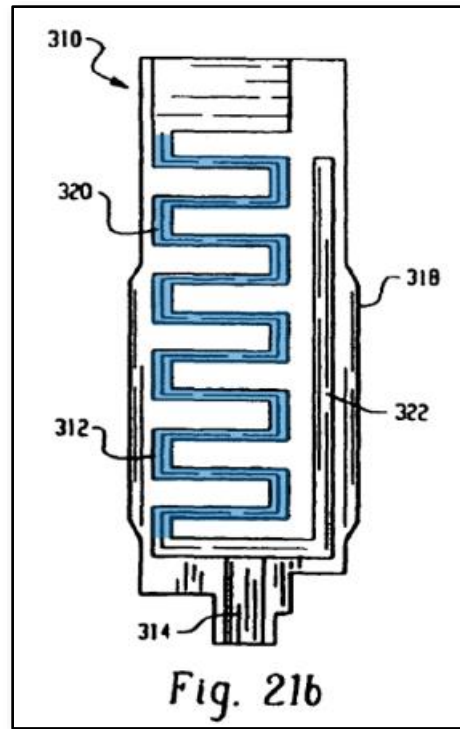
134. Moreover, as I discussed above (§IX.D.1.m), the GDC portion (which is modeled below-left) is shaped like the ’365 patent’s example “**grid dimension section 320**” in Figure 21b (blue-highlighted, below-right), which would have

reinforced to a POSA that if a grid-dimension curve cannot be self-similar, then Tran+Teng's GDC portion and the '365 patent's section 320 are "not self-similar" in the same way. See EX1001, 8:61-64.

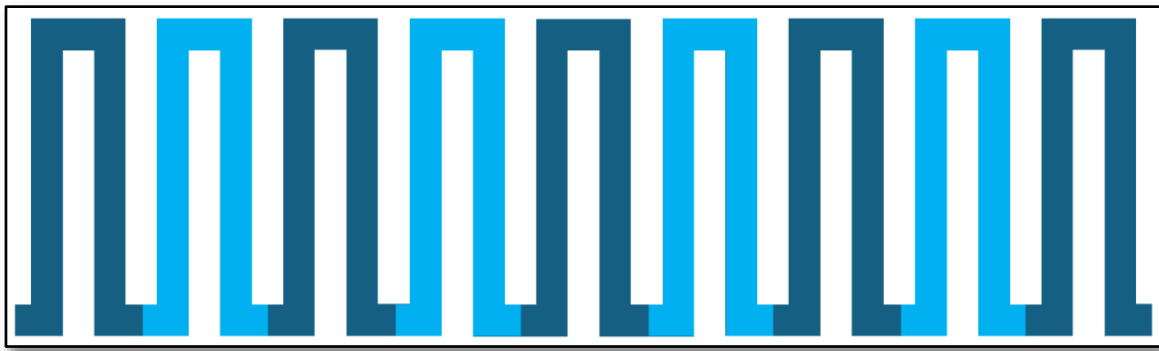
Teng GDC portion



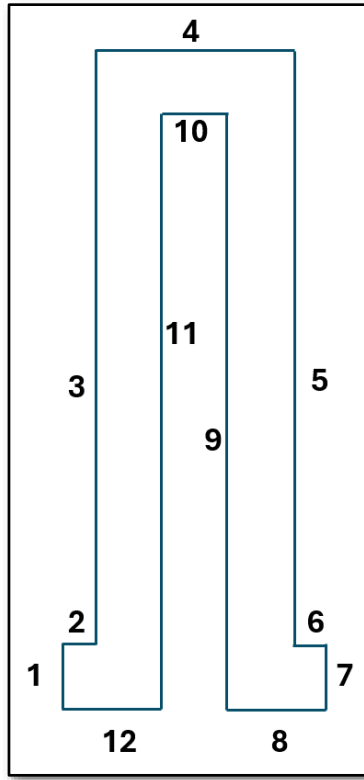
'365 patent "grid dimension section 320"



135. "If the curve has any periodicity, the period is defined by a non-periodic curve that includes at least ten connected segments in which no two adjacent and connected segments define a longer straight segment" (see §VIII.B.1 above (quoting EX1008, 27)): Tran+Teng's GDC portion has a periodicity with a period defined by the non-periodic curve, which I have highlighted in alternating colors below:



136. As I discussed above (§VIII.B.1), Fractus’s proposed construction recites the ’365 patent’s specification’s description of segments in a “space filling curve” (EX1001, 3:10-13), and based on that, a POSA would understand that a “segment” under Fractus’s construction is a straight portion along the outer perimeter of the curve. As I have shown below, the non-periodic unit curve of the GDC portion (which is in alternating colors above) includes twelve (“at least ten”) connected segments—which I have numbered below clockwise around the perimeter of the unit curve. As can be seen below, no two adjacent and connected segments define a longer straight segment because adjacent connected segments form right angles (i.e., 90-degree corners).



137. Thus, for the reasons discussed above, Tran+Teng’s GDC portion also meets Fractus’s construction of *grid-dimension curve* (see §VIII.B.2 (claim construction)).

- n. **Limitation [1M]:** *wherein the printed circuit board, the communication circuitry, and the multi-band antenna are arranged inside the device housing.*

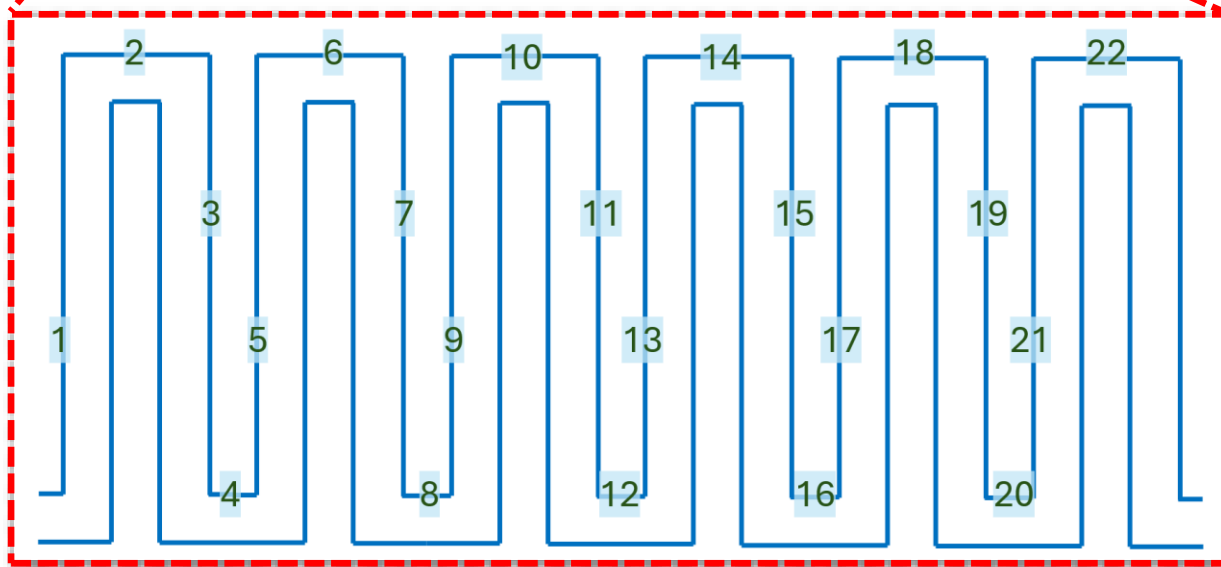
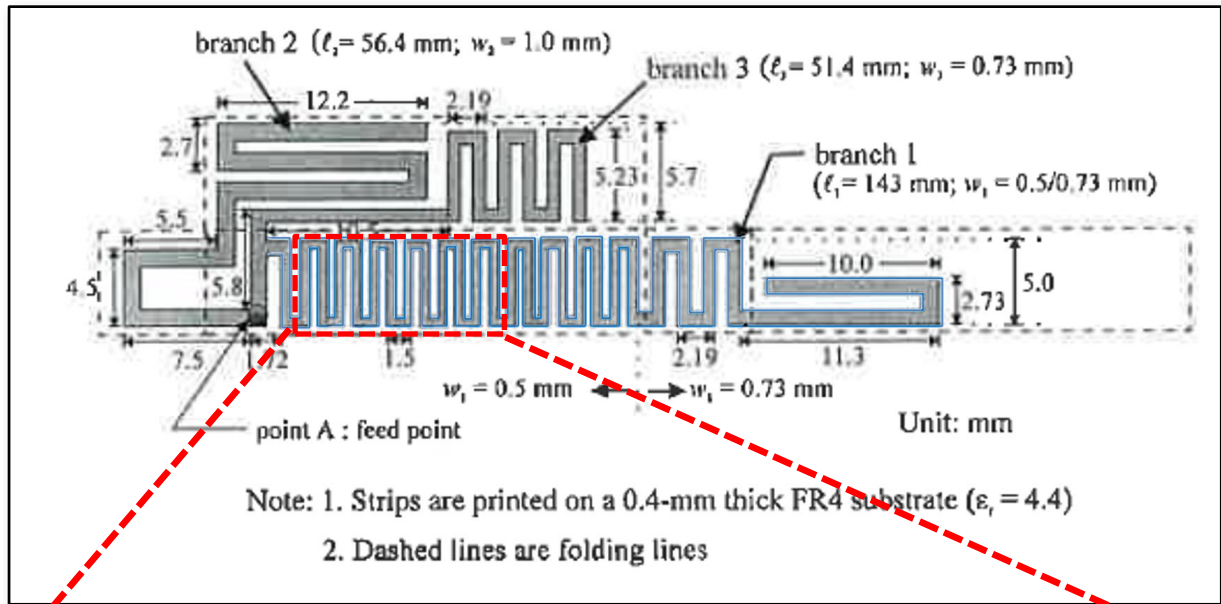
138. Tran+Teng’s “*printed circuit board*,” “*multi-band antenna*,” and “integrated circuits or chips” implementing the *communication circuitry* are all *arranged inside the device housing*, similar to Tran’s Figures 14A-14B. See also §IX.C (discussing the Tran+Teng combination). For example, Tran discloses that Figures 14A and 14B “illustrate” an example of a “phone[] hav[ing] various **internal components** generally supported on one or more **circuit boards** [sic:

board] for performing the various functions needed or desired” (e.g., communication circuitry needed for mobile-telephone functionality). Tran, 13:28-33. As Tran says, “a circuit board 1402 is shown **inside of housing** 102” in Figures 14A-B. Tran, 13:33-37; Tran, 13:37-57 (describing additional, conventional mobile device components inside the housing); *see also* §IX.D.1.b (above; discussing the device housing shown in Figures 14A-14B). As Tran further explains, Tran’s antenna (which is replaced by Teng’s antenna in Teng-Tran), “is shown mounted near an upper portion of the housing adjacent to the circuit board 1402” (i.e., the antenna is also inside the housing): for example, “the antenna can be secured **within portions of the wireless device housing.**” Tran, 13:57-14:13 (describing conventional ways to mount and/or secure an antenna inside a mobile device housing).

2. Claim 2

a. Limitation [2A]: *The mobile communication device according to claim 1, wherein the first radiating arm comprises a first plurality of segments;*

139. Tran+Teng’s Branch 1 (*first radiating arm*) *comprises a first plurality of segments*, which I have outlined in blue in the first image, which is from Teng’s Figure 1 (which is excerpted and annotated in the first image below). In the second image below, I have modeled a portion of Branch 1 that includes the 22 segments that I have numbered below (plus additional segments that I have not numbered). *See* §IX.D.1.j ([1I], where I discuss Tran+Teng’s *first radiating arm*).



b. **Limitation [2B]:** *wherein each segment of the first plurality of segments is smaller than 1/10 of a lowest operating free-space wavelength of the multi-band antenna;*

140. Tran+Teng uses Teng's antenna, which is capable of *operating* over three frequency bands: "GSM (890–960 MHz), DCS (1710–1880 MHz), and PCS (1850–1990 MHz)." Teng, 23; see §IX.C (above; discussing the Tran+Teng

combination); §IX.D.1.h ([1G]) (above; discussing the bands for Tran+Teng’s multi-band antenna). A POSA understood that the *free-space wavelength* (λ , in mm) of an antenna is determined from its operating frequency, as follows:

$$\lambda = \frac{c}{f},$$

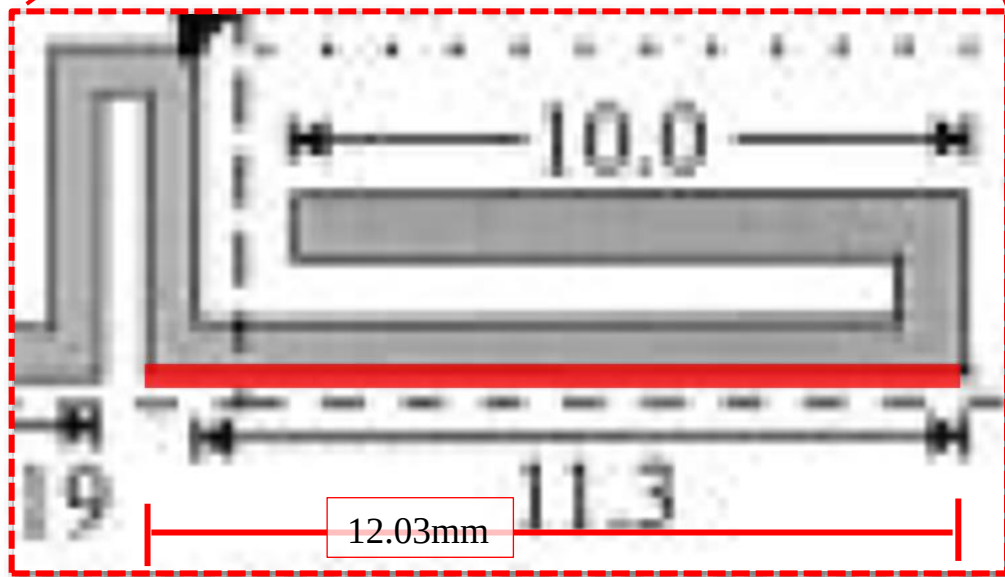
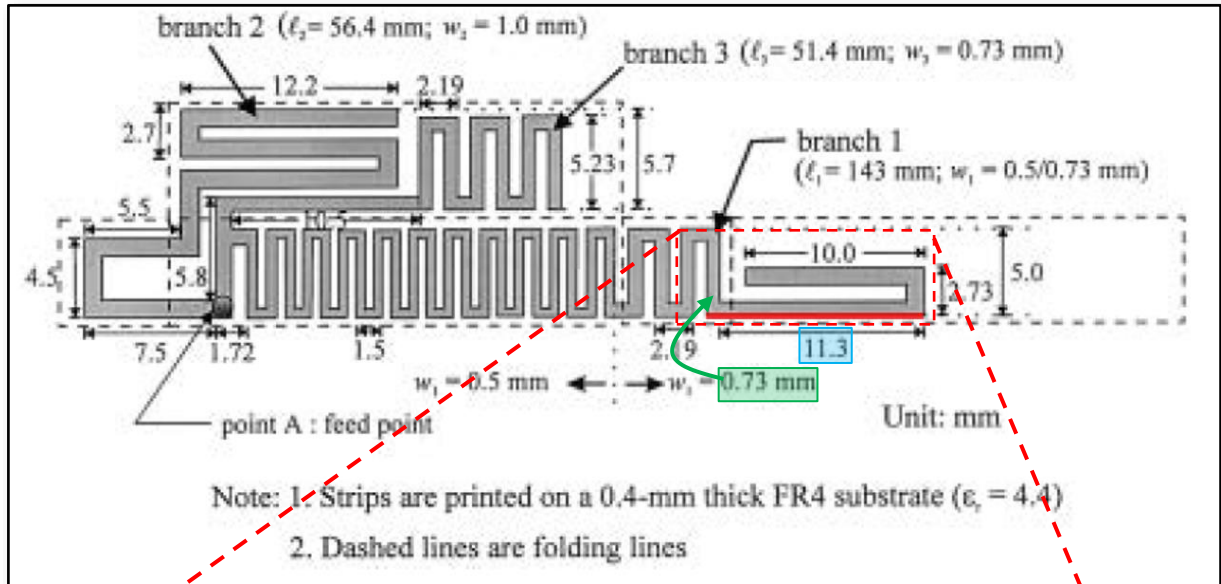
where c = speed of light ($\approx 3 \times 10^{11}$ mm/sec), and f = frequency (Hz). See EX1040, 15-16 (disclosing that wavelength $\lambda = v_p / f$, where “in free space, we have $v_p = \dots = c = 2.998 \times 10^8$ m/sec”); EX1025, 6:26-29 (disclosing that “the speed of light [c] is 3×10^8 m/sec” (which equals 3×10^{11} mm/sec) and that “a wavelength [λ] of 0.532 μm ” (which equals 5.32×10^{-4} mm) “has a frequency [f] of 563 THz” (which equals 5.63×10^{14} Hz): i.e., $5.32 \times 10^{-4} (\lambda) = 3 \times 10^{11} (c) / 5.63 \times 10^{14} (f)$, as I noted above).

141. Thus, 1/10 of the free-space wavelengths of Tran+Teng’s antenna for each frequency band can be determined from the table below. As shown below, the “lowest operating free-space wavelength” in Tran+Teng is 15.1 mm:

Band	Frequency (MHz)	Wavelength (mm)	1/10 Wavelength (mm)
GSM	890–960	313–337	31.3–33.7
DCS	1710–1880	160–175	16.0–17.5
PCS	1850–1990	151–162	15.1–16.2

142. The **longest** segment among *the first plurality of segments* is 12.03 mm (highlighted red below), which can be determined as follows. The red-highlighted segment below includes the 11.3 mm dimension that Teng’s Figure 1 provides (highlighted blue below) **plus** 0.73 mm for the portion of the segment that

is as long as the 0.73 mm strip width that completes the segment (highlighted green below). Teng, 23, Fig. 1.

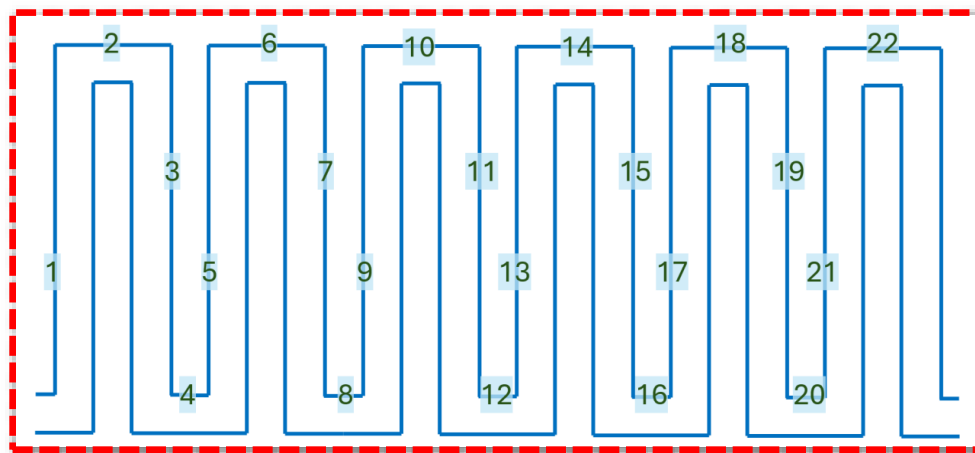
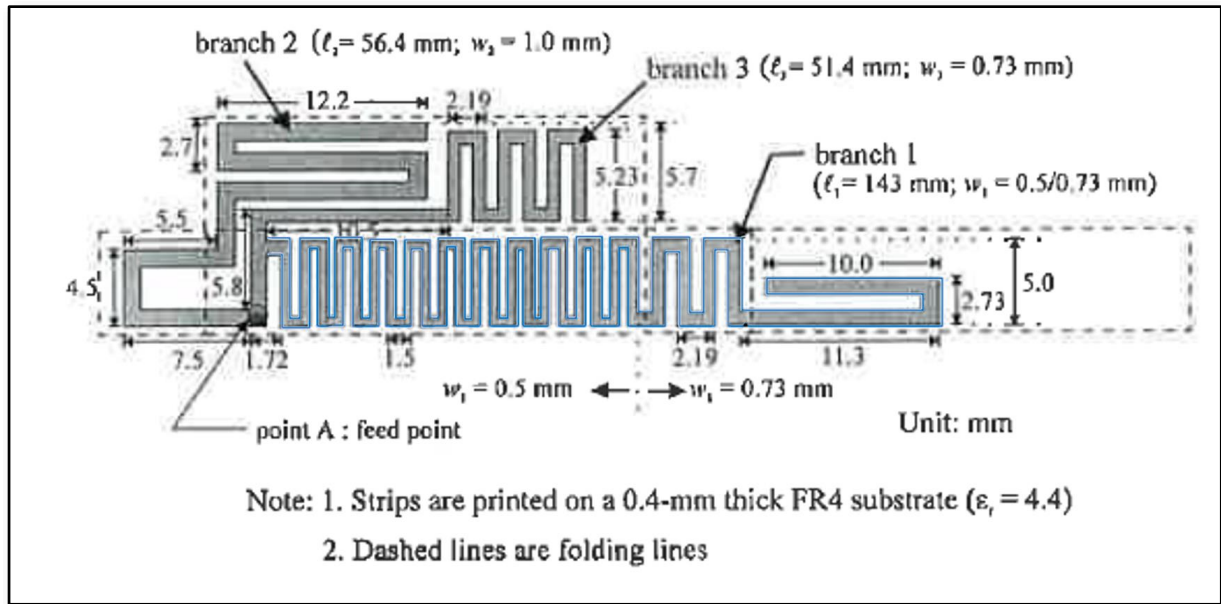


143. Thus, the **longest segment** in the first plurality of segments (12.03 mm) is smaller than 15.1 mm, which is 1/10 of a lowest operating free-space wavelength of Tran+Teng's multi-band antenna. Because each of the other

segments of *the first plurality of segments* is shorter than the longest segment, each of *the first plurality of segments* is smaller than the *1/10 of a lowest operating free-space wavelength* of Tran+Teng's multi-band antenna.

c. Limitation [2C]: *wherein the segments are spatially arranged such that each pair of adjacent segments forms a corner; and*

144. In Tran+Teng's first plurality of segments (which I have highlighted blue below), the segments are spatially arranged such that each pair of adjacent segments forms a 90-degree corner. Teng, Fig. 1 (annotated below).

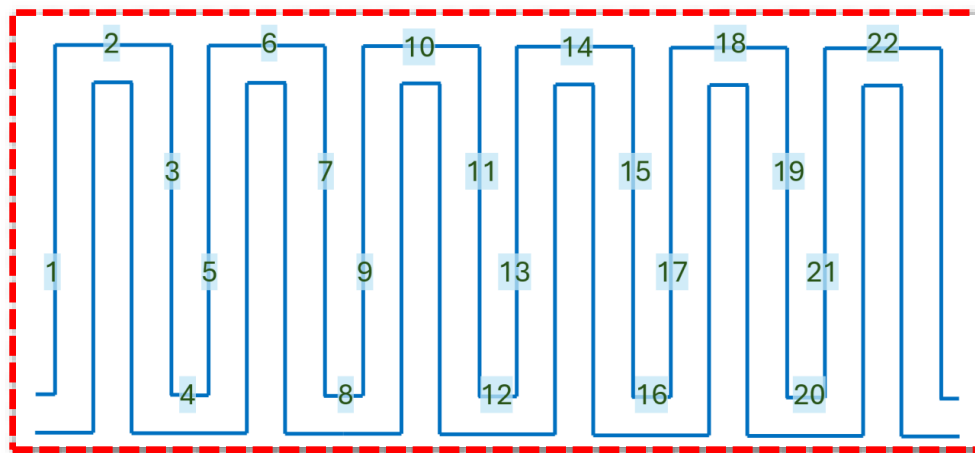
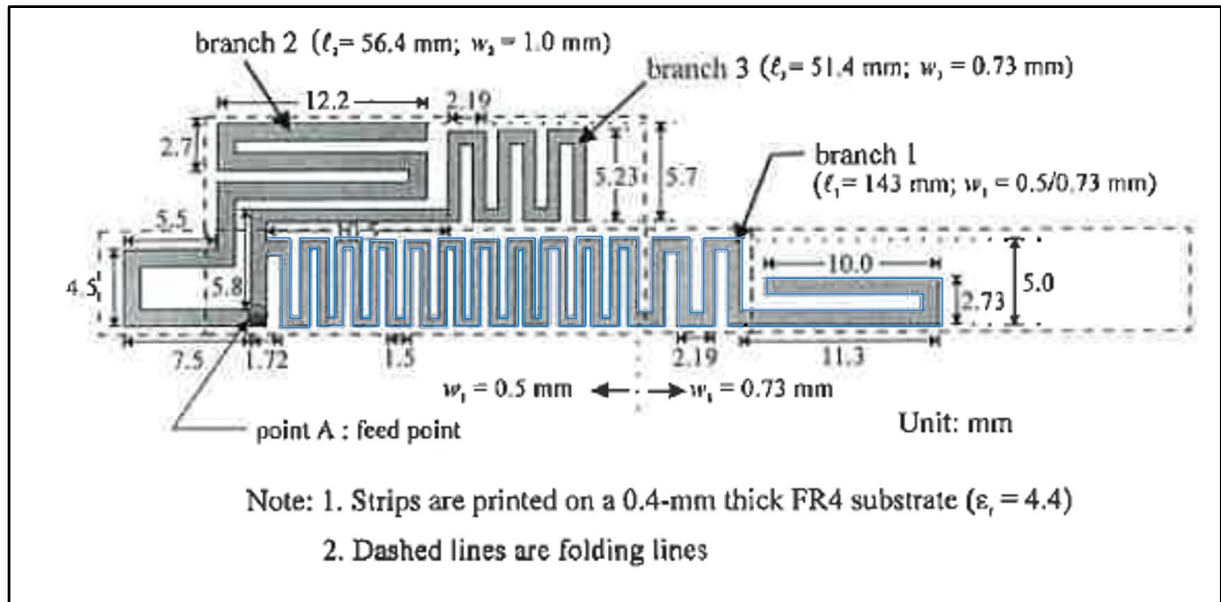


d. **Limitation [2D]:** *wherein no two adjacent and connected segments form another longer straight segment; and*

145. As I discussed above (§IX.D.2.c ([2C])), in Tran+Teng's first plurality of segments (highlighted in blue in the image above) *no two adjacent and connected segments form another longer straight segment* (i.e., there is no 180-degree angle between adjacent segments) because each pair of adjacent segments form a 90-degree corner, as I discussed above (§IX.D.2.c ([2C])). Teng, Fig. 1.

- e. **Limitation [2E]:** *wherein none of said segments intersect with another segment other than to form a closed loop.*

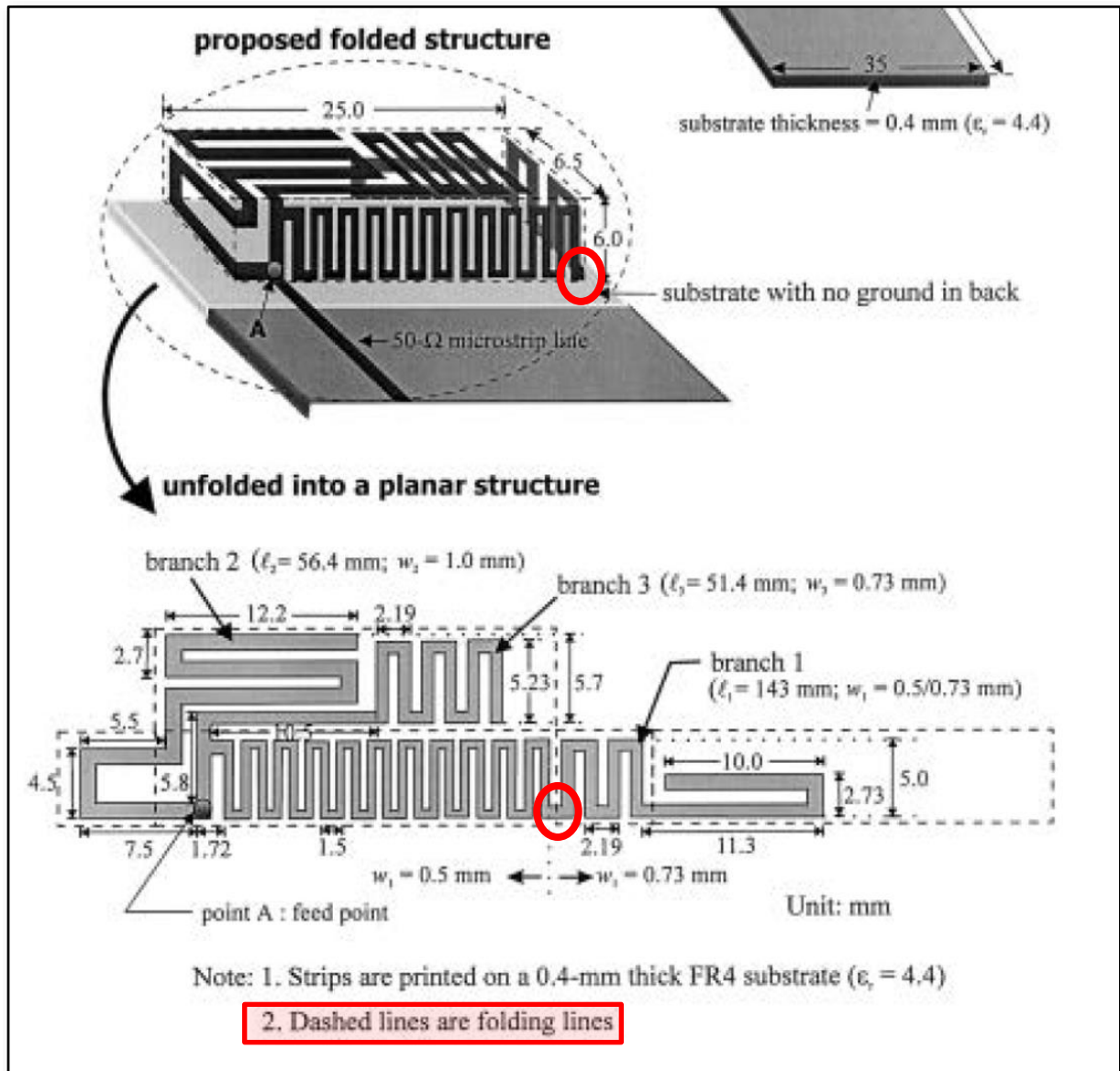
146. In the GDC portion of Tran+Teng's first plurality of segments, *none of said segments intersect with another segment other than to form a closed loop* because each adjacent segment forms a 90-degree corner (as I discussed above §IX.D.2.c ([2C])), and as shown by the blue-outlined segments of *the first plurality of segments* in Teng's annotated Figure 1 below.



3. **Claim 3:** *The mobile communication device according to claim 2, wherein the first plurality of segments comprises at least one curved segment.*

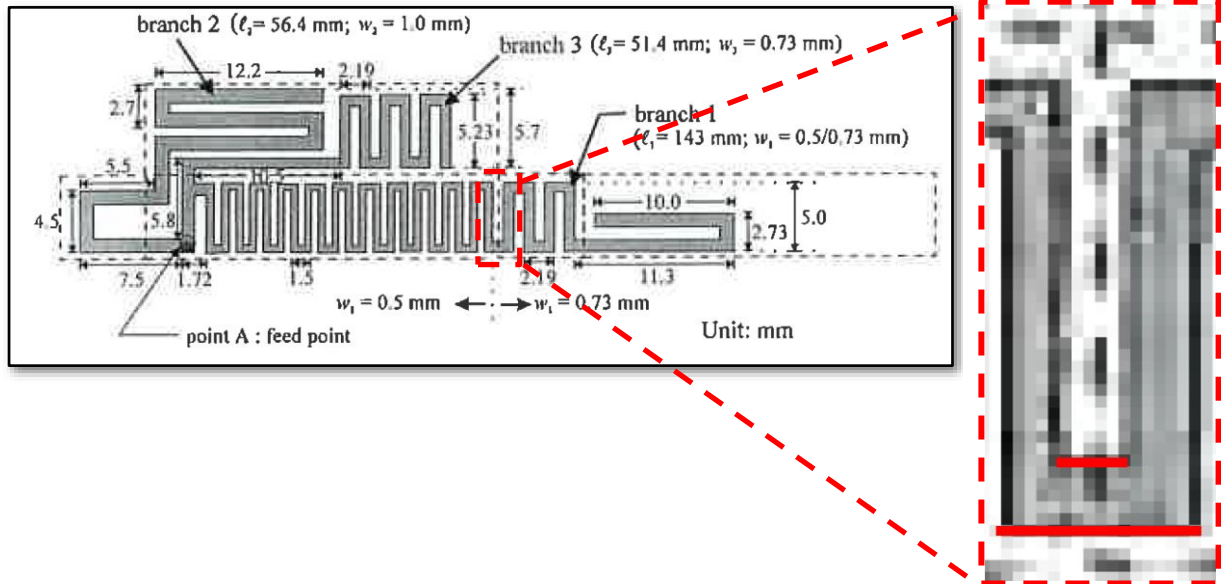
147. Tran+Teng's Branch 1 has segments that are within the circle I have added below to Teng's Figure 1 (excerpted and annotated below) that are bisected by the dashed "folding lines" shown in Teng's Figure 1. That is, the dashed lines

identify where the antenna is folded to achieve its “folded structure” so that different portions of the antenna lie in different planes.



148. POSAs understood that Teng teaches that the two segments (red-highlighted below-right) bisected by the folding line are *curved* when a real-world antenna is in its folded structure, rather than have a perfect 90° angle fold, because a POSA would understand that without a curvature there would be a discontinuity

in conducting metal that forms Branch 1, rather than the contiguous metal strips that Teng illustrates in all images in Teng Figure 1.



149. Additionally, if Teng were considered to not expressly teach this, that would have been the conventional and obvious way to implement the folded antenna structure Teng describes. As demonstrated by multiple pieces of corroborating evidence cited below, *curving* the segments where the Tran+Teng antenna is folded would have beneficially reduced the risk of fracturing at a corner and could reduce “reflections and attendant losses” in RF energy if the antenna were to be bent at a sharp 90° angle. EX1022, [0056]. In addition to EX1022, my opinion in this regard is corroborated by the following reference:

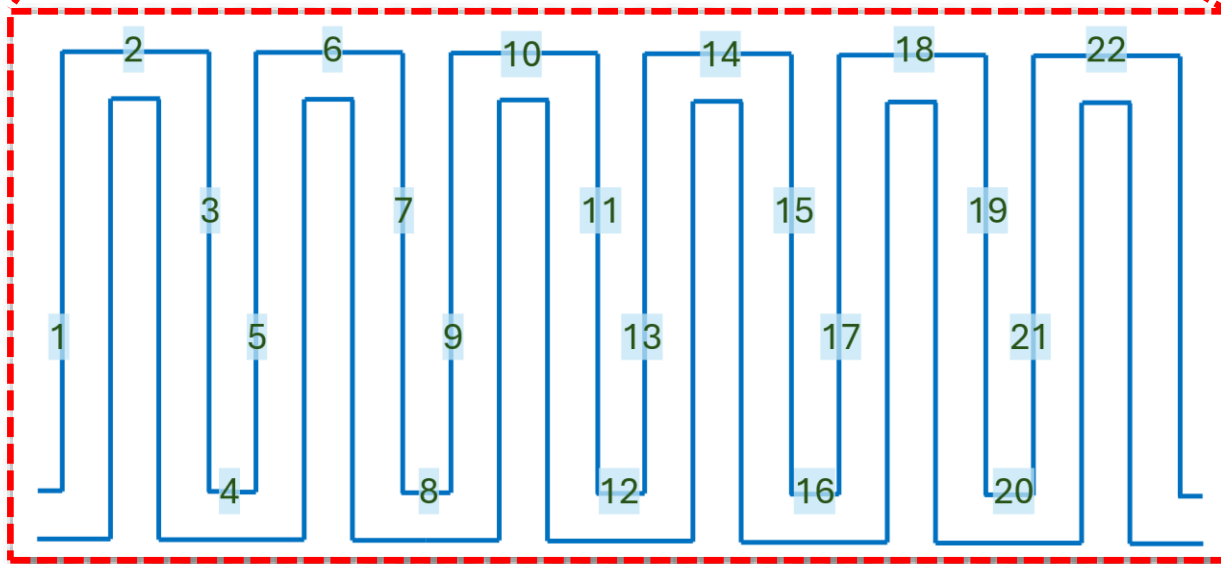
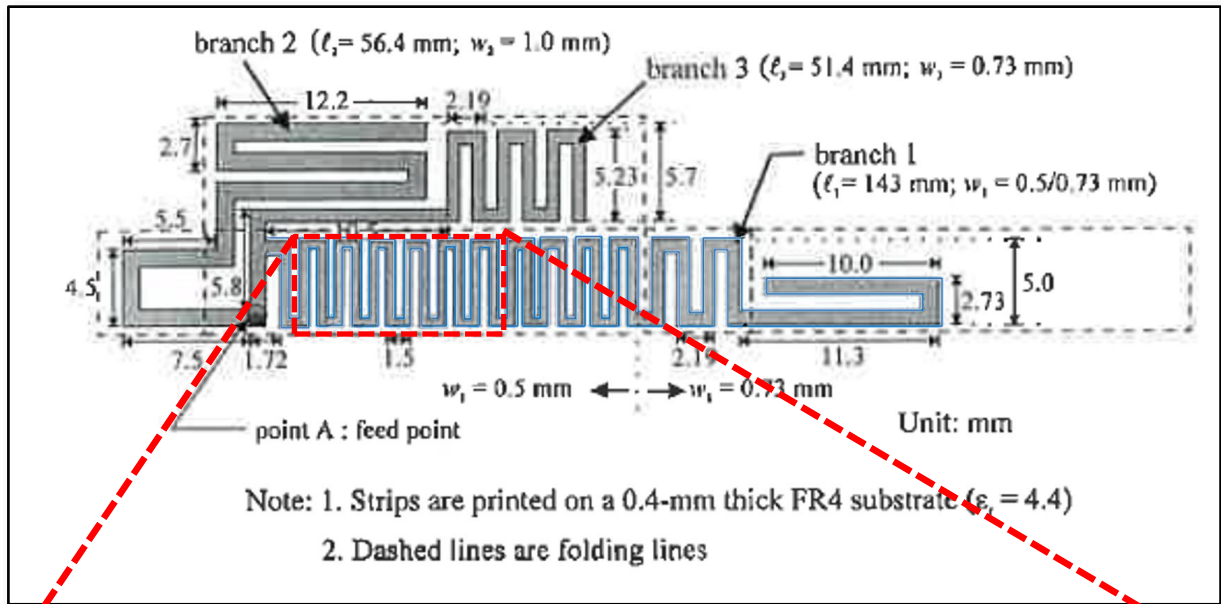
- EX1026, which discloses an antenna with meander segments, like Tran+Teng’s antenna, that are “joined by smooth interconnections so as to form of [sic] a sinusoidal curve ... **have the advantage of reducing**

radio wave radiation loss because these patterns do not include [] acutely bent portions.” EX1026, [0069].

- EX1027, which says that its “FIG. 9 illustrates a serpentine meanderline periodic slow wave structure 42,” having curved segments. EX1027, FIG. 9, [0057];
- EX1028, which discloses in its Figure 2 an antenna with “**meanders ... located** not in flat planes but **on curved surfaces.**” EX1028, FIG. 2, [0019];
- EX1029, which discloses antenna radiating elements with “a sinu[o]id pattern” (FIG. 7c: curved segments) and “a combination of” “a square-wave pattern ... and a sinus[o]id pattern.” EX1029, 4:46-59, FIG. 7f;
- EX1030, which discloses when an electrode (“has a rounded bent portion ... radiation gain is improved” because “[i]t has been found that when the **bent portion is rounded** to provide a line electrode with substantially the same width, **it is possible to avoid the discontinuity of impedance.**” EX1030, FIGs. 11(a)-11(b), [0095].

4. Claim 4: *The mobile communication device according to claim 2, wherein the first plurality of segments comprises at least ten segments.*

150. As I discussed above (§IX.D.2.a, [2A]), Tran+Teng’s Branch 1 comprises the *first plurality of segments* (which I have highlighted blue in the first image below), which *comprises at least ten segments* (more than the 22 segments annotated in the second image below, which I discussed above §IX.D.2.a ([2A])).

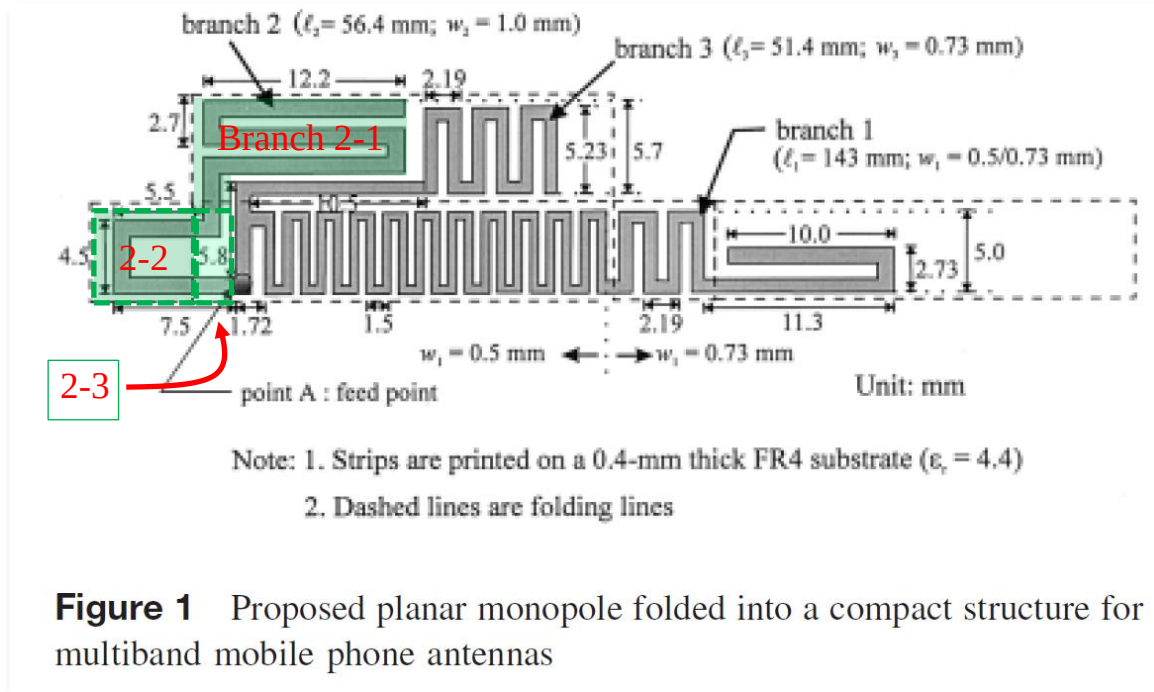


5. Claim 5

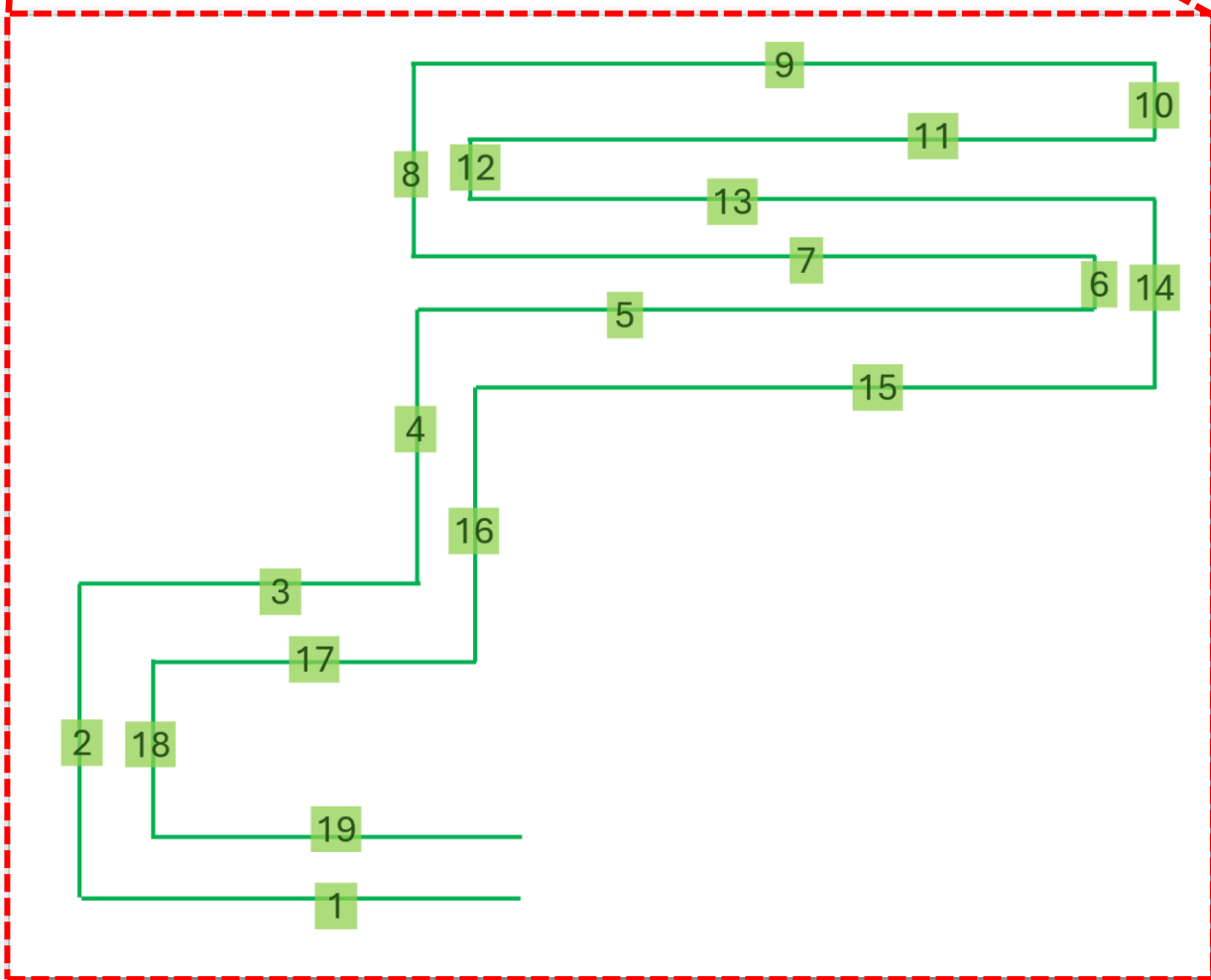
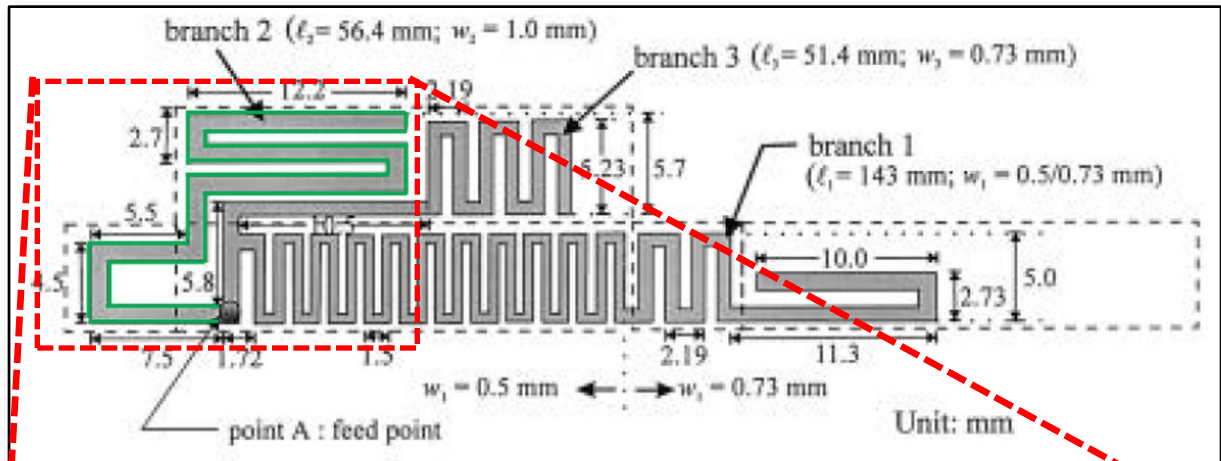
- a. **Limitation [5A]:** *The mobile communication device according to claim 2, wherein the second radiating arm comprises a second plurality of segments;*

151. Tran+Teng's antenna Branch 2 (second radiating arm, which I discussed above §IX.D.1.j ([1I])) has three sections, which are separated by dashed

fold lines that I have labelled Branch 2-1, 2-2, and 2-3 in Teng's Figure 1 annotated below:

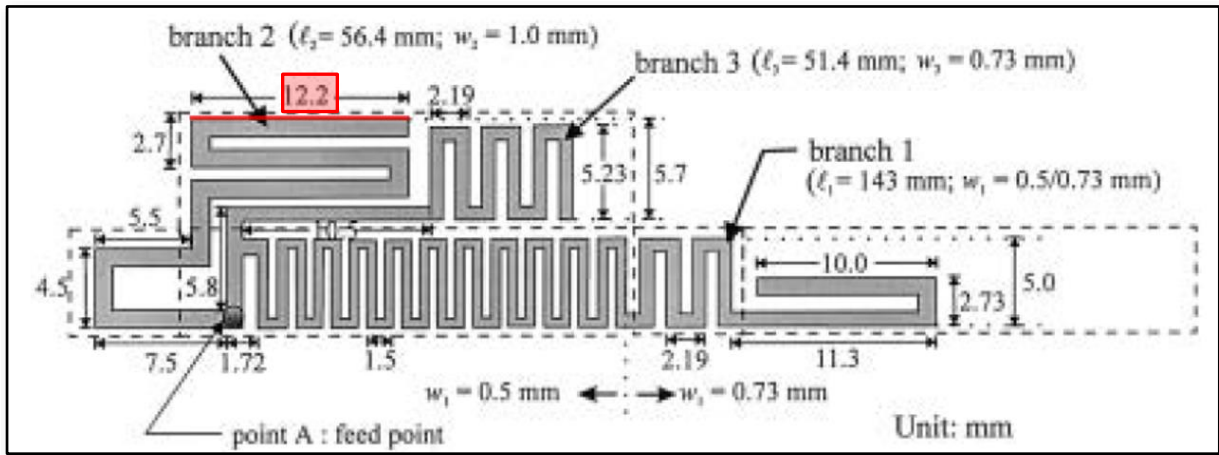


152. Branch 2 comprises a second plurality of segments: the 19 segments that I have numbered in the second image below, in a model based on Teng's Figure 1.



- b. **Limitation [5B]:** *wherein each segment of the second plurality of segments is smaller than 1/10 of a lowest operating free-space wavelength of the multi-band antenna;*

153. As I discussed above (§IX.D.2.b ([2B])), *1/10 of a lowest operating free-space wavelength of Tran+Teng's multi-band antenna is 15.1 mm. As shown in Teng's Figure 1 (which I have annotated below), Tran+Teng Branch 2's longest segment (red) is 12.2 mm.*



154. Thus, Branch 2's **longest** segment *in the second plurality of segments* is smaller than 1/10 of a lowest operating free-space wavelength of Tran+Teng's multi-band antenna (15.1 mm). Because each of the other segments of *the second plurality of segments* is shorter than the longest segment, each of *the second plurality of segments* is smaller than 1/10 of a lowest operating free-space wavelength of Tran+Teng's multi-band antenna.

- c. **Limitation [5C]:** *wherein the segments are spatially arranged such that each pair of adjacent segments forms a corner; and*

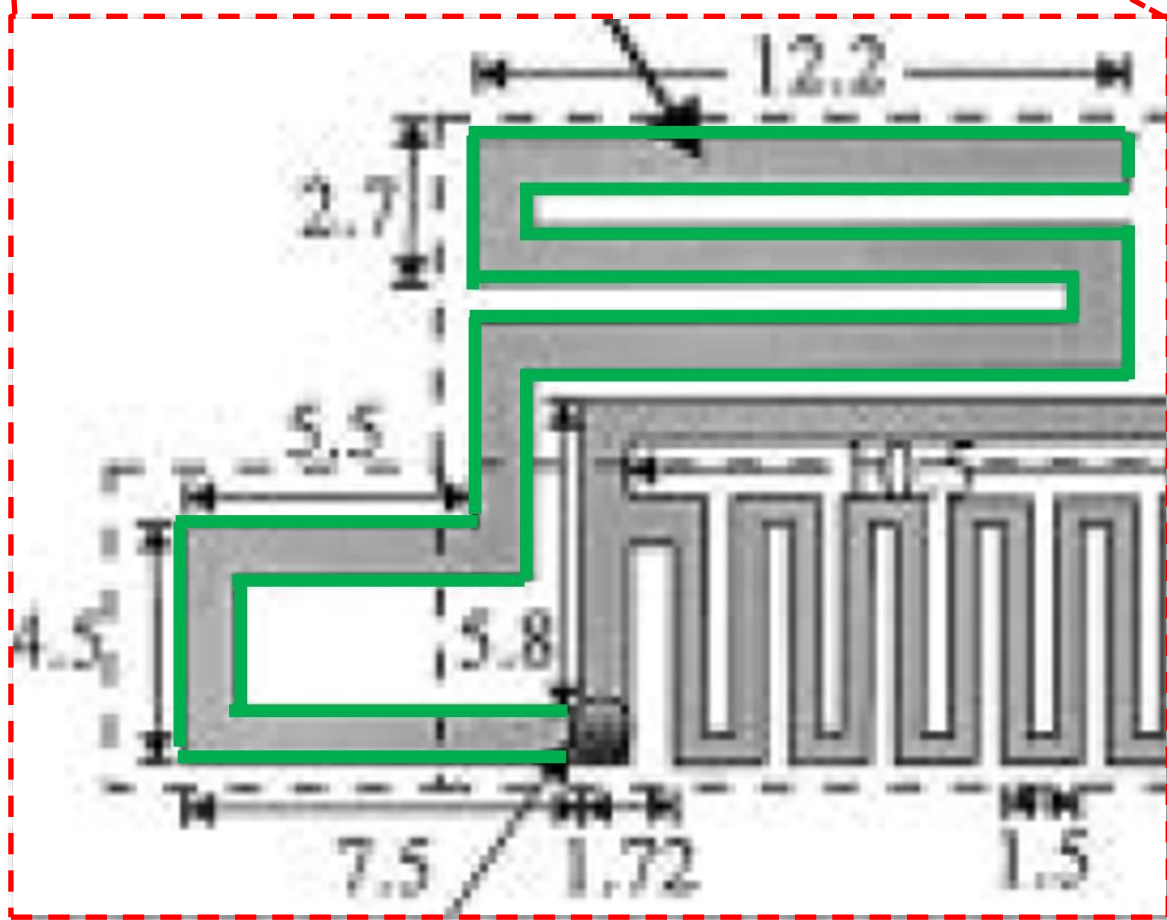
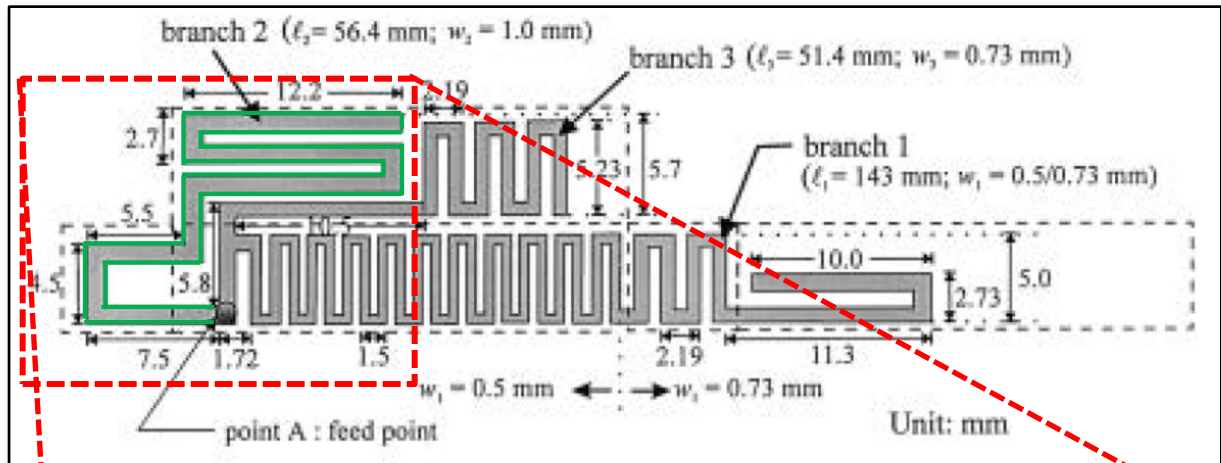
155. As shown in the figure discussed above in §IX.D.5.a ([5A]), Branch 2's second plurality of segments are spatially arranged such that each pair of adjacent segments forms a 90-degree corner.

- d. **Limitation [5D]:** *wherein no two adjacent and connected segments form another longer straight segment; and*

156. As illustrated in the figure discussed above in §IX.D.5.a ([5A]), no two adjacent and connected segments form another longer straight segment (i.e., there is no 180-degree angle between adjacent segments) because each pair of adjacent segments forms a 90-degree corner, as I discussed above in §IX.D.5.c ([5C]).

- e. **Limitation [5E]:** *wherein none of said segments intersect with another segment other than to form a closed loop.*

157. In Tran+Teng's Branch 2 (*second radiating arm*), *none of said segments intersect with another segment other than to form a closed loop* because each adjacent segment forms a 90-degree corner, as I discussed above §IX.D.5.c ([5C]), and shown by the green-outlined segments below that comprise *the second plurality of segments* in Teng's annotated Figure 1 below.



6. **Claim 6: *The mobile communication device according to claim 5, wherein the first plurality of segments comprises more segments than the second plurality of segments.***

158. As I discussed above in §IX.D.4 (claim 4), *the first plurality of segments comprises over 22 segments, which is more segments than the (19) second plurality of segments* that I discussed above in §IX.D.5.a ([5A]).

7. **Claims 7-8**

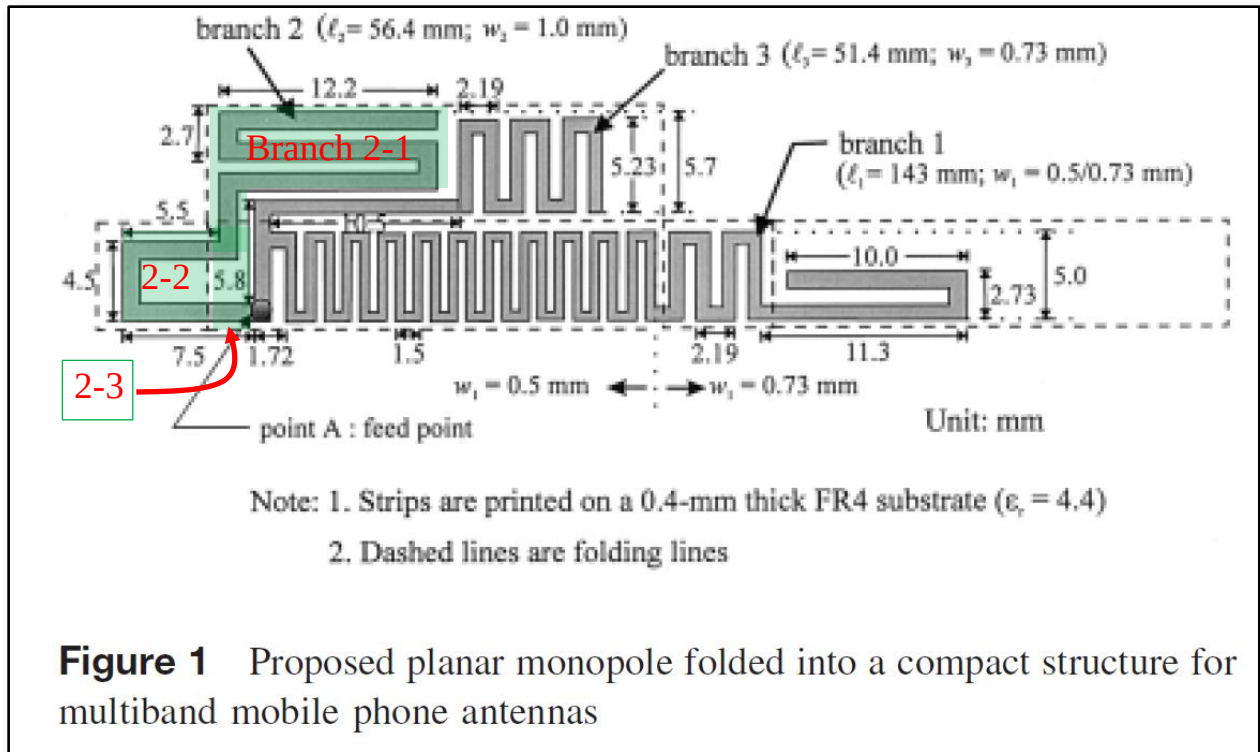
Claim 7: *The mobile communication device according to claim 1, wherein the grid-dimension curve has a grid dimension larger than 1.3.*

Claim 8: *The mobile communication device according to claim 1, wherein the grid-dimension curve has a grid dimension larger than 1.5.*

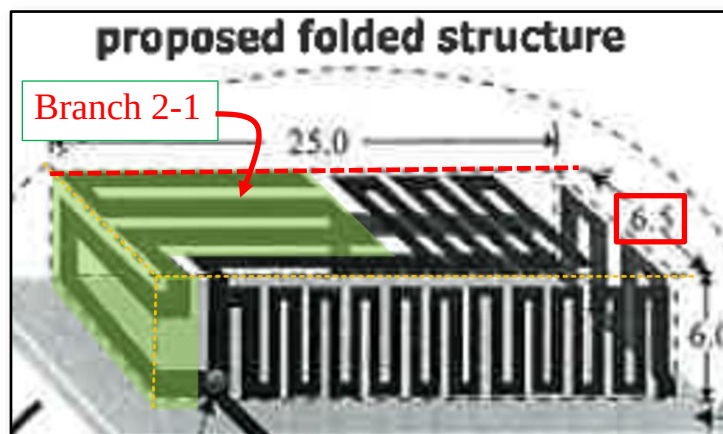
159. As I discussed above in §IX.D.1.m ([1L]), Tran+Teng's Branch 1-1's (*grid-dimension curve*) *has a grid dimension of 2, which is larger than 1.3 (and thus meets claim 7) and 1.5 (and thus meets claim 8).*

8. **Claim 9: *The mobile communication device according to claim 1, wherein the second radiating arm is at least partially shaped according to a second grid-dimension curve.***

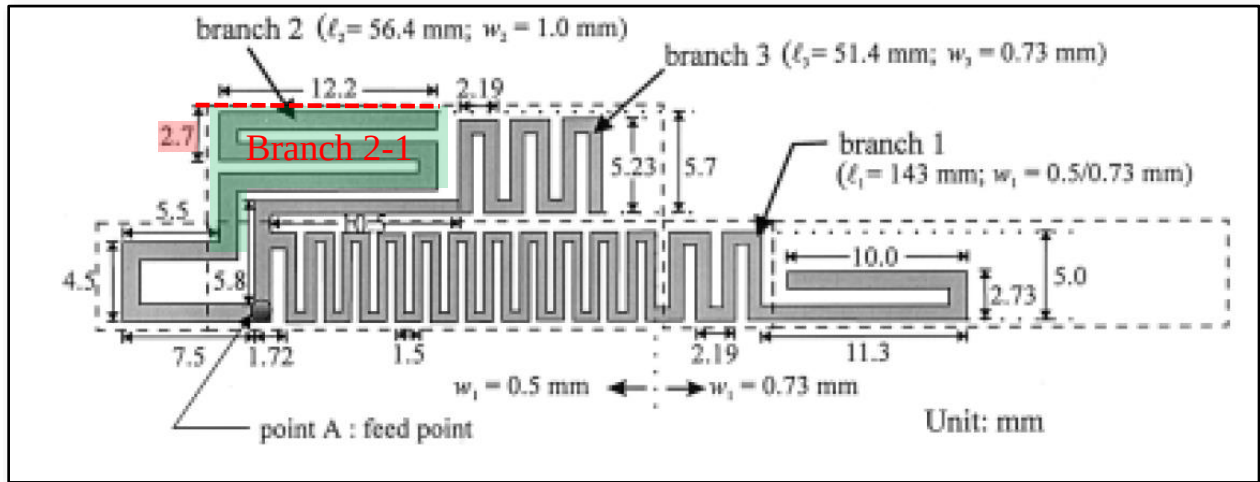
160. As I discussed above in §IX.D.5.a ([5A]), Tran+Teng's Branch 2 has three sections 2-1, 2-2, and 2-3, which I have highlighted below in Teng's Figure 1 (excepted and annotated below):



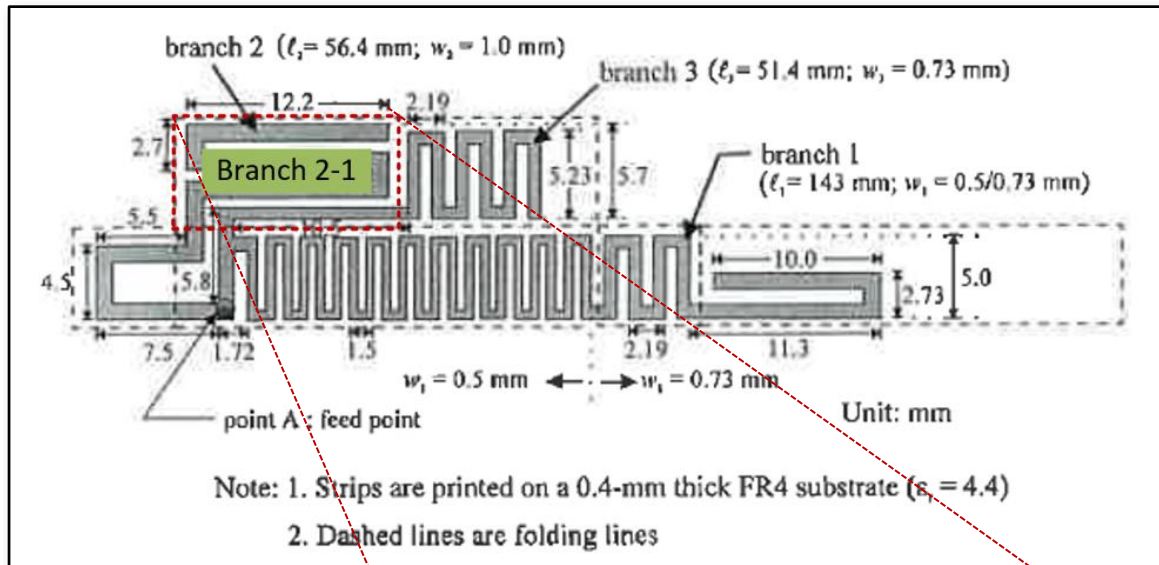
161. The annotated image above from Teng Figure 1 (the bottom-most image) provides the dimensions for portions of Teng's antenna trace, whereas the image below from Teng Figure 1 (the middle image; with annotated detail below) provides dimensions for the surfaces of the rectangular folded mounting structure.



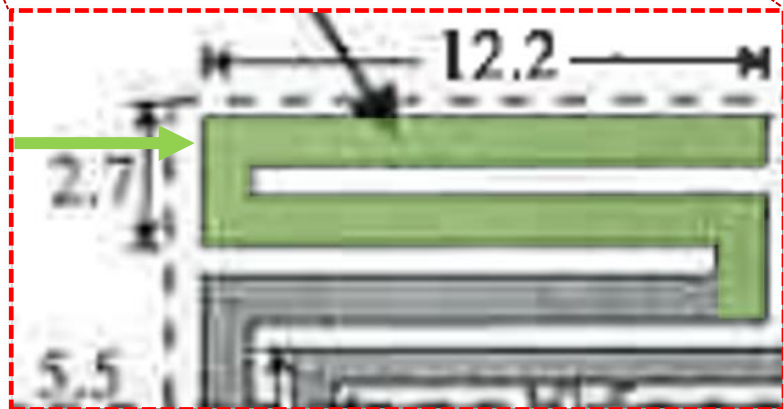
162. As shown above, Branch 2-1 extends to the lateral edge of the top-surface (red-dashed line) having a 6.5 mm width. Thus, the top-arrow for the 2.7 mm dimension in Teng Figure 1 (red-box below) coincides with the upper lateral edge of Branch 2-1 (red-dashed line).



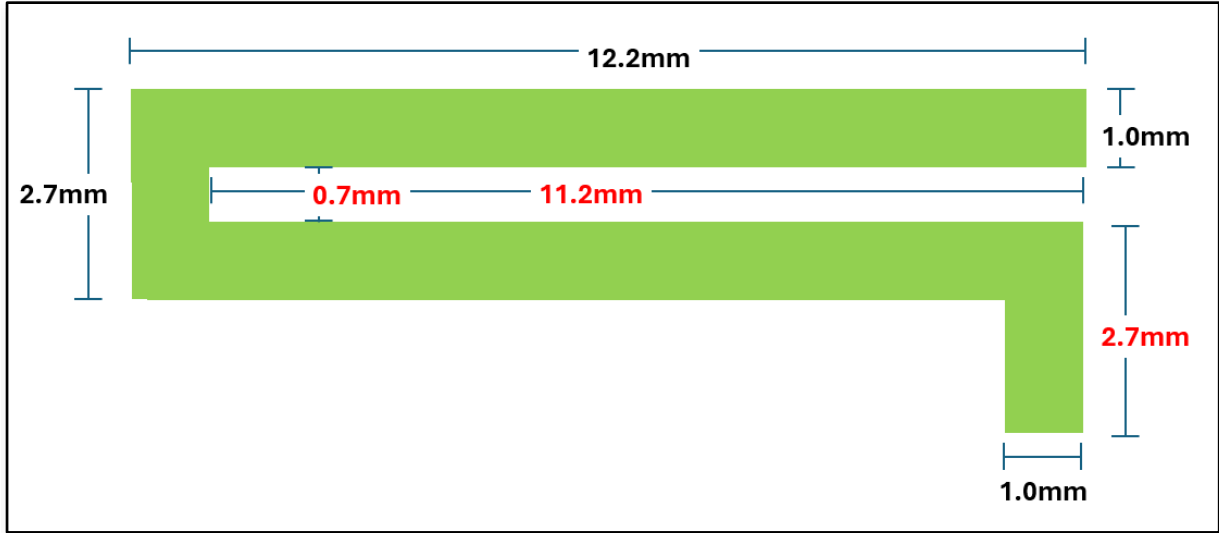
163. The portion of Tran+Teng’s Branch 2-1, which I have shaded green below and will refer to as the “Second GDC portion,” meets each party’s construction of *grid-dimension curve*, as I demonstrate below in §§V.B.8.i-ii.



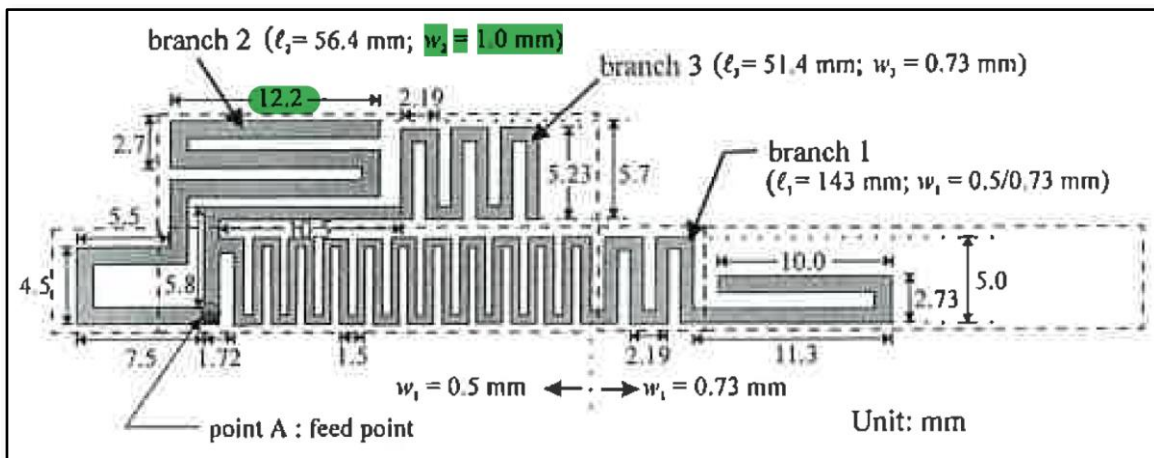
Second GDC portion



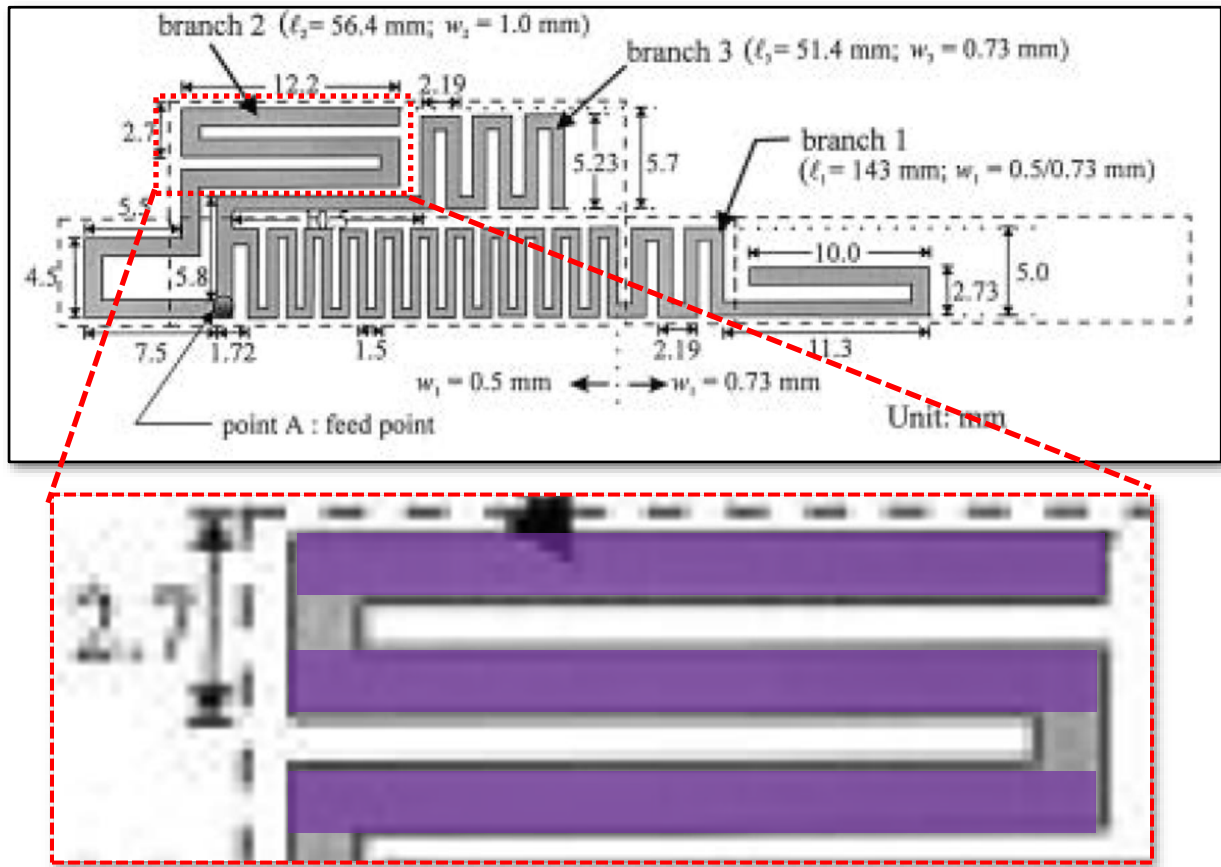
164. The dimensions of the Second GDC portion's segments are shown below, with black dimensions taken directly from Teng Figure 1 and the other dimensions (red), which a POSA would have calculated from Teng's Figure 1, as I discuss below.



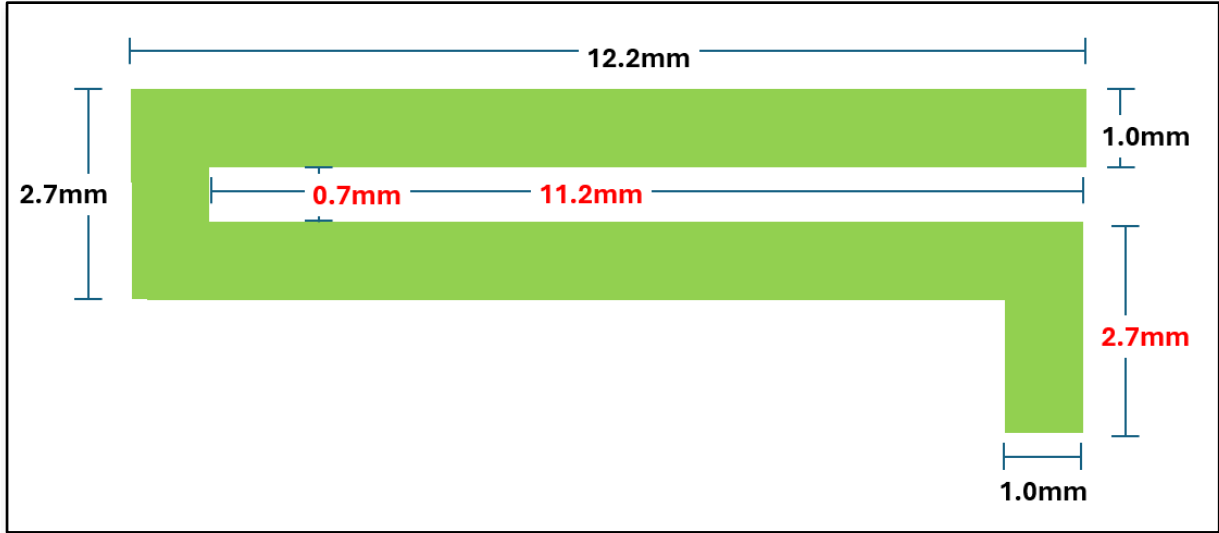
165. The 0.7 mm dimension for the gap between the above-two horizontal strips is calculated by subtracting from the left-hand 2.7 mm dimension (provided by Teng Figure 1) two of the 1.0 mm widths of the antenna trace that are above and below the gap. The 11.2 mm horizontal dimension in the gap between two horizontal strips is calculated by subtracting one 1.0 mm wide antenna trace on one right-hand side of the horizontal gap from the 12.2 mm dimension that Teng discloses in Figure 1 (as highlighted and excerpted below).



166. The red 2.7 mm dimension is calculated based on a POSA's understanding that the gap between the three horizontal strips highlighted purple below is the same 0.7 mm dimension that I discussed above.

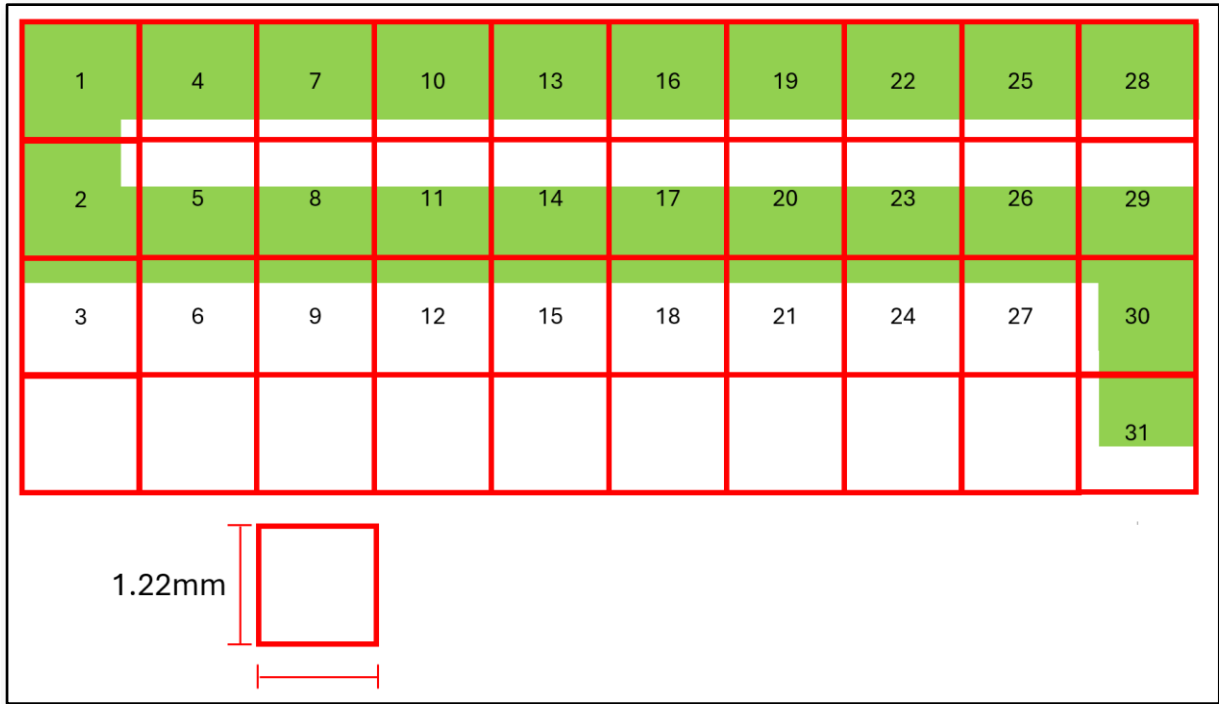


167. Based on the dimensions of Branch 2-1's segments that I discussed above, the dimensions of the Second GDC portion within a 4.4 mm x 12.2 mm area is modeled as follows:

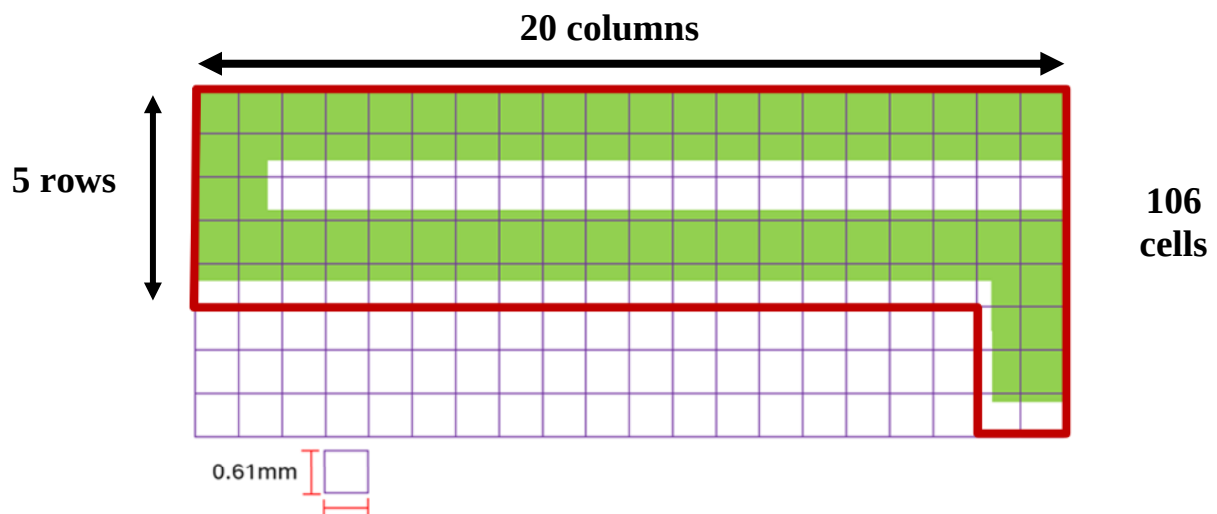


i. Tran+Teng’s second radiating arm meets Petitioners’ (Geotab’s) construction of *grid-dimension curve*.

168. In the image below, the Second GDC portion (discussed above §IX.D.8) is enclosed with $N1_{Total} = 40$ square cells (four rows by ten columns) of edge length $L1 = 1.22\text{ mm}$, where 31 cells (which I have numbered below for convenience) contain at least a portion of the curve (i.e., $N1 = 31$):



169. In the image below, the Second GDC portion is enclosed with $N2_{Total} = 160$ square cells of length $L2 = 0.61 \text{ mm}$ (i.e., $L2 = 1/2 \cdot L1$), where 106 cells enclose at least a portion of the curve (i.e., $N2 = 106$). (The 106 cells are the 100 cells in the top 5 rows and 20 columns, and the 6 cells at the bottom right, as illustrated in the second image below.)



170. Thus, the Second GDC portion grid-dimension value is greater than 1, based on the formula I discussed above (§VIII.B; claim constructions of “*grid-dimension curve*”):

$$\begin{aligned}
D_g &= -\left(\frac{\log(N2) - \log(N1)}{\log(L2) - \log(L1)}\right) = -\left(\frac{\log(106) - \log(31)}{\log(0.61) - \log(2 \times 0.61)}\right) \\
&= -\left(\frac{\log(106/31)}{\log(1/2)}\right) = -\left(\frac{0.534}{-0.301}\right) \approx 1.77.
\end{aligned}$$

171. The additional requirements in Petitioners’ construction that I discussed above (§VIII.B.2) are also met, as I discuss below.

172. **First**, $N1_{Total} = 40$ (i.e., the total number of red-colored squares in the first grid), which is “at least twenty-five cells,” and $N2_{Total} = 160$, which is “four times the number of cells as the first grid.” See §VIII.B.2 (above; citing EX1001, 7:5-7).

173. **Second**, “the length (L2) of each square cell in the second grid” (0.61 mm) is “one-half” the length (L1) (1.22 mm) of each square cell in the first grid. See §VIII.B.2 (above; citing EX1001, 7:7-9).

174. **Third**, grids 1 (red) and 2 (purple) above are “positioned within a minimum rectangular area enclosing the curve, such that no entire row or column on the perimeter of” either “grid[] fails to enclose at least a portion of the curve.” See §VIII.B.2 (above; citing EX1001, 7:1-5).

175. Thus, the Second GDC portion in Branch 2-1 (*second radiating arm*) meets Petitioners’ construction of a *grid-dimension curve*.

**ii. Tran+Teng's second radiating arm meets
Fractus's construction of *grid-dimension curve*.**

176. The Second GDC portion of Tran+Teng's Branch 2-1 meets the requirements of Fractus's construction, as demonstrated below. See §VIII.B.1 (above; discussing Fractus's construction of "*grid-dimension curve*" (quoting EX1008, 27)).

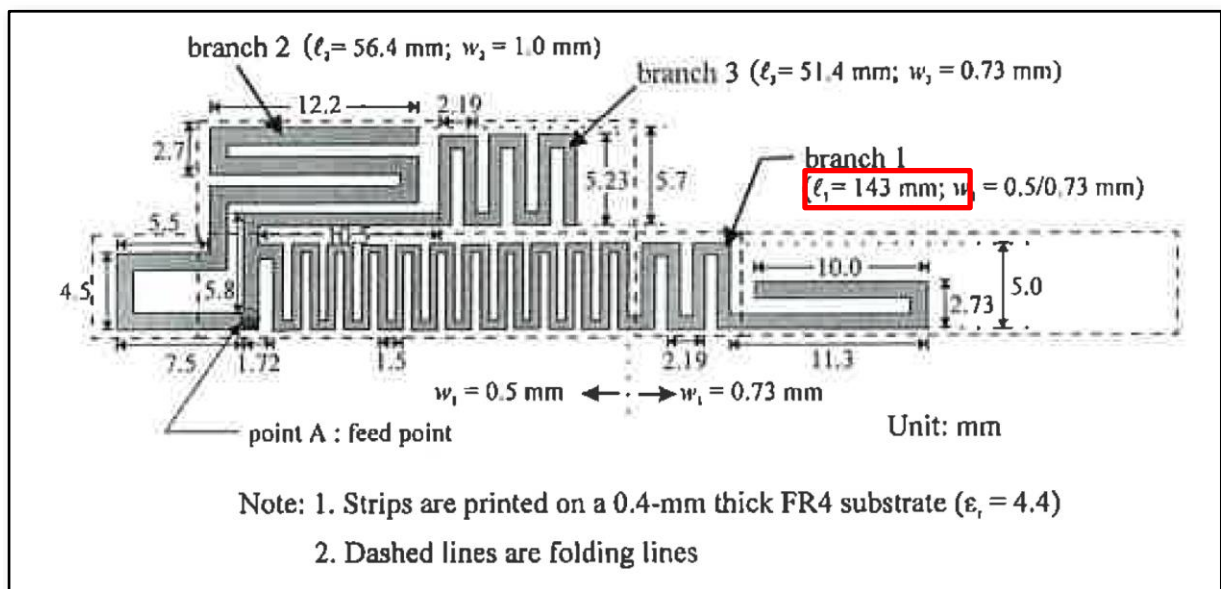
177. **Fractus's "*not self-similar*" limitation:** Under the description of "self-similar" that Fractus provided in an alternative patent that I discussed above (§IX.D.1.m.ii, [1L] (citing EX1024, 2:12-14)), Tran+Teng's Second GDC portion (comprised in Branch 2-1) is **not** self-similar because there is no part of the Second GDC portion that is a replica of the **entirety** thereof (e.g., the Second GDC portion is not fractal-like). Moreover, Tran+Teng's Second GDC is shaped similar to the '365 patent's "**grid dimension section 320**" (see EX1001, FIG. 21b, 8:61-64), which would have reinforced to a POSA that if a grid-dimension curve cannot be self-similar, then Tran+Teng's Second GDC portion and the '365 patent's section 320 are "not self-similar" in the same way.

178. **Fractus's "*If the curve has any periodicity ...*" limitation:** Tran+Teng's Second GDC portion *has no periodicity* and thus meets this limitation of Fractus's construction.

179. Thus, Tran+Teng's Branch 2, which comprises the Second GDC portion, meets Fractus's construction of *grid-dimension curve*.

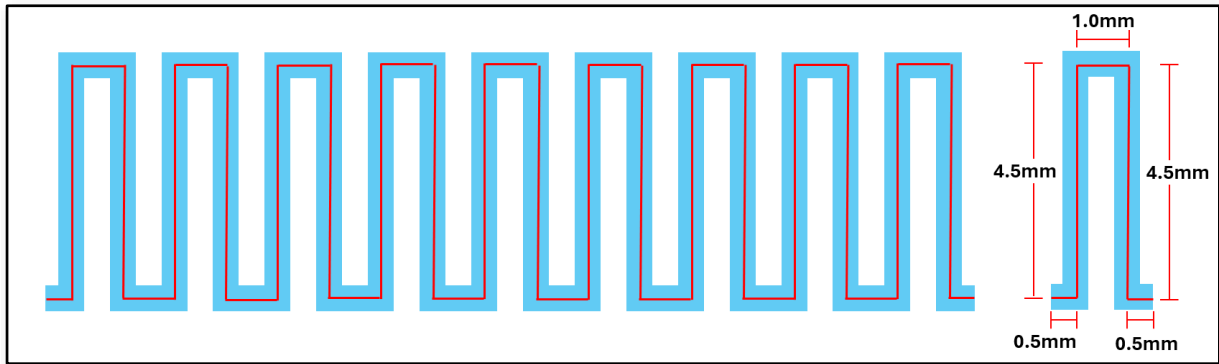
9. **Claim 10: The mobile communication device according to claim 9, wherein the grid-dimension curve and the second grid-dimension curve have different lengths.**

180. The only “length” the ’365 patent specification describes for Figure 1’s “radiating arms 12, 14” is “the total conductor **length**.” EX1001, 3:35-46. Teng says Branch 1’s “strip **length** (ℓ_1) ... is 143 mm.” Teng, 23. POSAs understood that Teng’s strip length is the same as the ’365 patent’s “total conductor length” and is the total linear length of a line (red) running through the center of a branch.



181. As I discussed above (§IX.D.1.m ([1L])), Tran+Teng’s Branch 1-1 is at least partially shaped according to a *grid-dimension curve*, with a portion shaped according to a grid-dimension curve (below-left) that is comprised of a unit cell (below right) that is repeated nine times. As shown in the figure below, which I have labelled Petitioners’ Figure P-3, a line through the center of one unit cell has

two 0.5 mm portions, two 4.5 mm portions, and one 1.0 mm portion. Thus, a line through the center of one unit cell has a total length of 11.0 mm. Thus, the total length of Branch 1-1's grid-dimension portion (which has nine of these unit cells) is $9 \times 11.0 \text{ mm} = 99.0 \text{ mm}$.

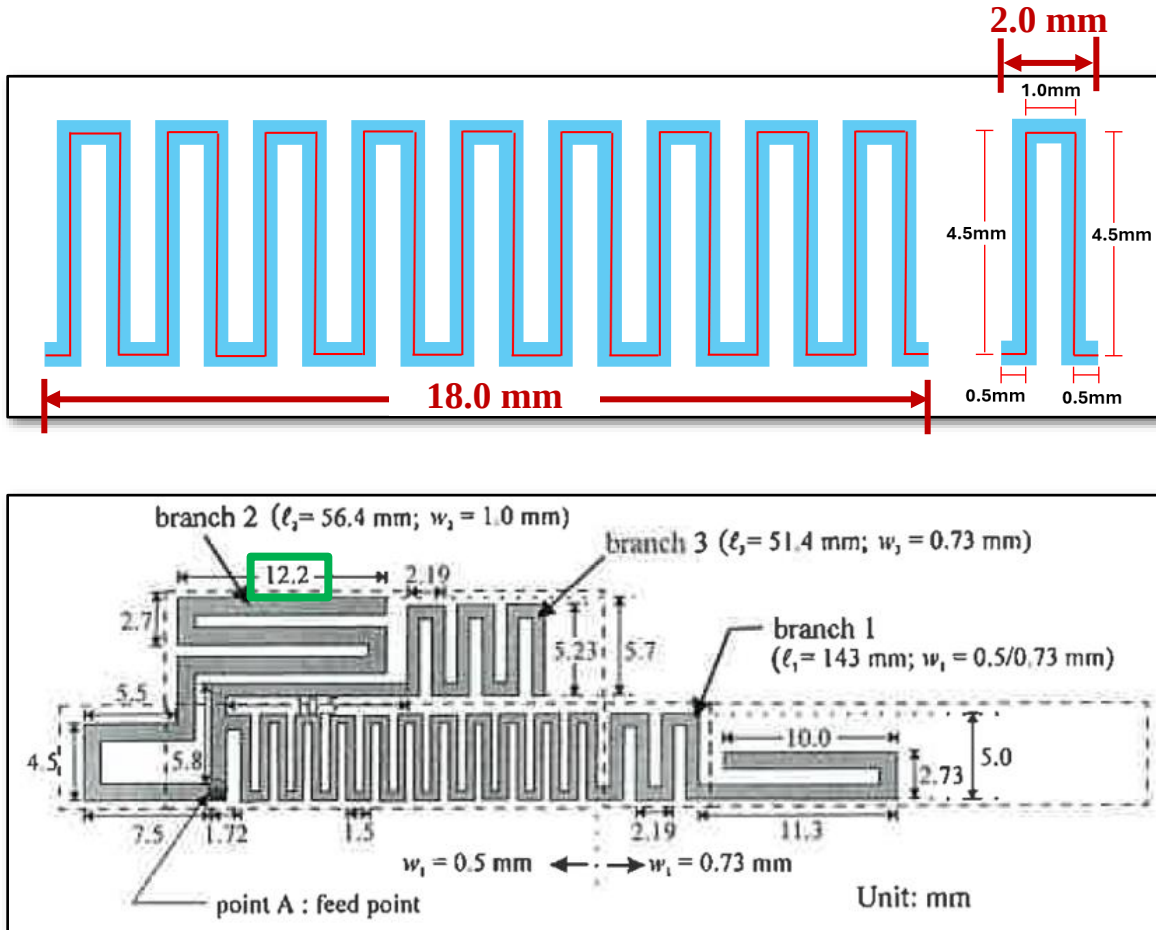


Petitioners' Figure P-3

182. Teng says Branch 2's "strip **length** (ℓ_2) is 56.4 mm." Teng, 23. As I identified above, *the second grid-dimension curve* is a portion of Tran+Teng's Branch 2 (*second radiating arm*). Thus, *the second grid-dimension curve's* strip length is necessarily less than 56.4 mm and therefore is *different from* the *grid-dimension curve's* strip length that I calculated above (90.0 mm). Thus, Tran+Teng's antenna element meets claim 10.

183. Alternatively, if claim 10's "*length*" were considered to be the lateral distance from one edge of a curve to the other edge of the curve, then the GDC portion's lateral length is $9 \times 2.0 = 18.0 \text{ mm}$, which is different from the 12.2 mm

lateral distance for Branch 2-1. See §IX.D.1.m (above; [1L]); Teng, Fig. 1 (annotated detail below).

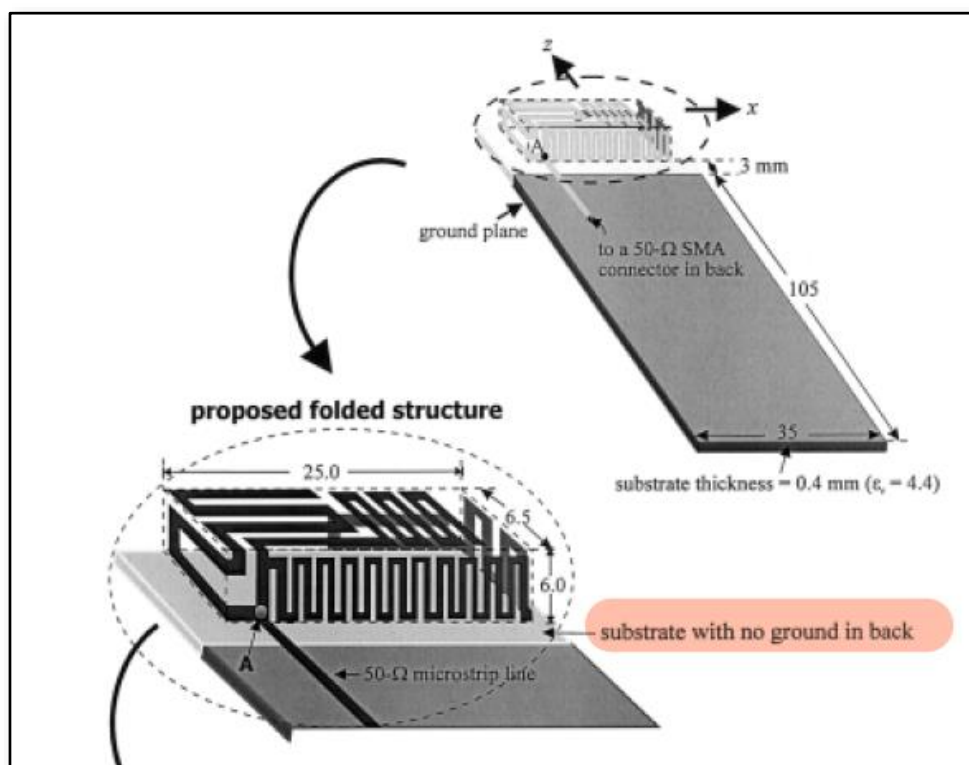


10. **Claim 11:** *The mobile communication device according to claim 9, wherein the grid-dimension curve and the second grid-dimension curve have different grid dimensions*

184. As I discussed above, Tran+Teng's Branch 1's (grid-dimension curve) grid dimension is 2 (§IX.D.1.m.i above), which is different from the second grid-dimension curve's grid dimension (≈ 1.77 , §IX.D.8.i above).

11. **Claim 12:** *The mobile communication device according to claim 1, wherein an orthogonal projection of a footprint of the antenna element on a plane of the printed circuit board overlaps the ground plane layer in less than 50% of an area of said footprint.*

185. As I discussed above in discussing the Tran+Teng combination (§IX.C), Tran+Teng's *antenna element* would have been mounted to the portion of the PCB "substrate with **no ground** in back," as taught by Teng. *See also* §IX.D.1.d ([1C]) (discussing Tran+Teng's PCB); Teng, Figure 1 (which I have annotated below), 24 ("FR4 substrate ... can be considered as the circuit board of a practical mobile handset"). Thus, *an orthogonal projection of a footprint of the antenna element on a plane of the PCB has **zero overlap** with the ground plane and thus overlaps the ground plane layer in less than 50% of an area of said footprint.*



186. I note that the mapping I discussed above is consistent with the '365 patent's discussion of Figure 10, which allegedly shows "50% or less of the projection of the antenna footprint on the plane of the circuit board 102" because "antenna 10 is **laterally offset from an edge of the circuit board 102**, such that" "the projection of the antenna footprint on the plane of the circuit board 102 **does not intersect any** of the metalization [sic: metallization] of the ground plane 106." EX1001, 4:63-5:9.

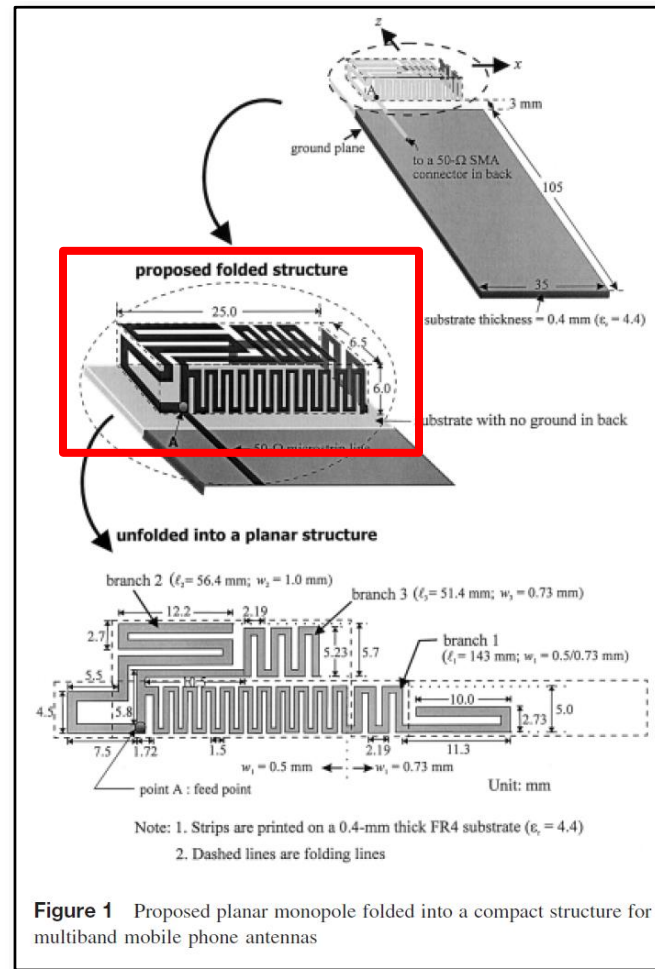
12. Claim 13

- a. **Limitation [13A]: *The mobile communication device according to claim 1, comprising: a dielectric mounting structure having a plurality of surfaces;***

187. In Tran+Teng's mobile communications device (which I discussed above in §§IX.C-IX.D.1.a), the antenna branches are "printed on a thin (0.4 mm) FR4 substrate," which is a *dielectric* substrate, as taught by Teng. Teng, 23, FIG. 1; EX1001, 8:39-41 (disclosing that "[s]uitable antenna substrate materials ... include ... FR4"). My opinion in this regard is corroborated by EX1042, which refers to an "**FR4 dielectric** substrate material." EX1042, [0035].

188. In manufacturing the Tran+Teng mobile communications device, the FR4 substrate with the antenna printed upon is "folded into a compact structure like a rectangular box" (Teng, 23), as shown in Teng Figure 1 (which I have annotated below), and the compact structure (the dielectric with the antenna

mounted thereon) is then mounted to Tran+Teng mobile device’s PCB, which I discussed above. See §IX.C (above; discussing the Tran+Teng combination); §§IX.D.1.d-f ([1C]-[1E]) (above; discussing Tran+Teng’s PCB).



189. In the manufactured mobile communications device, the FR4 dielectric material folded into a “rectangular box” is *a dielectric mounting structure having a plurality of surfaces* because the rectangular dielectric structure has at least five surfaces having portions of the antenna element mounted thereon,

as shown in the middle and top images of Teng's Figure 1 above. *See also* Teng, 23.

190. Furthermore, it would have also been obvious to include an additional mounting structure to support Tran+Teng's antenna. For example, Teng's authors elsewhere describe similar, folded-planar antennas where the folded dielectric substrate is "attached to and **supported by a foam base.**" EX1031, 108; EX1032, 1 (disclosing an antenna "constructed from folding a planar stamped copper plate... onto a **foam base,**" which "can be surface mounted on the system circuit board using surface mounting technology"). A POSA would have had reasons to use such a dielectric foam base in Tran+Teng to beneficially provide additional rigidity to Tran+Teng's antenna with a reasonable expectation of success, based (in part) on EX1031's and EX1032's similar antenna structures being mounted to a foam base on a PCB.

191. My opinion in this regard is further corroborated by EX1035, which discloses that the "dielectric constant for" "low density foams is 1.02 to 1.04 and is **nearly the dielectric constant of air.**" EX1035, [0053]. EX1035 further discloses that "Rohacell™ foam has" several beneficial aspects," such as "excellent mechanical properties, high dimensional stability under heat, solvent resistance, and particularly a low coefficient of heat conductivity." EX1035, [0054]. Because, the dielectric constant of foam is nearly the same as air, as

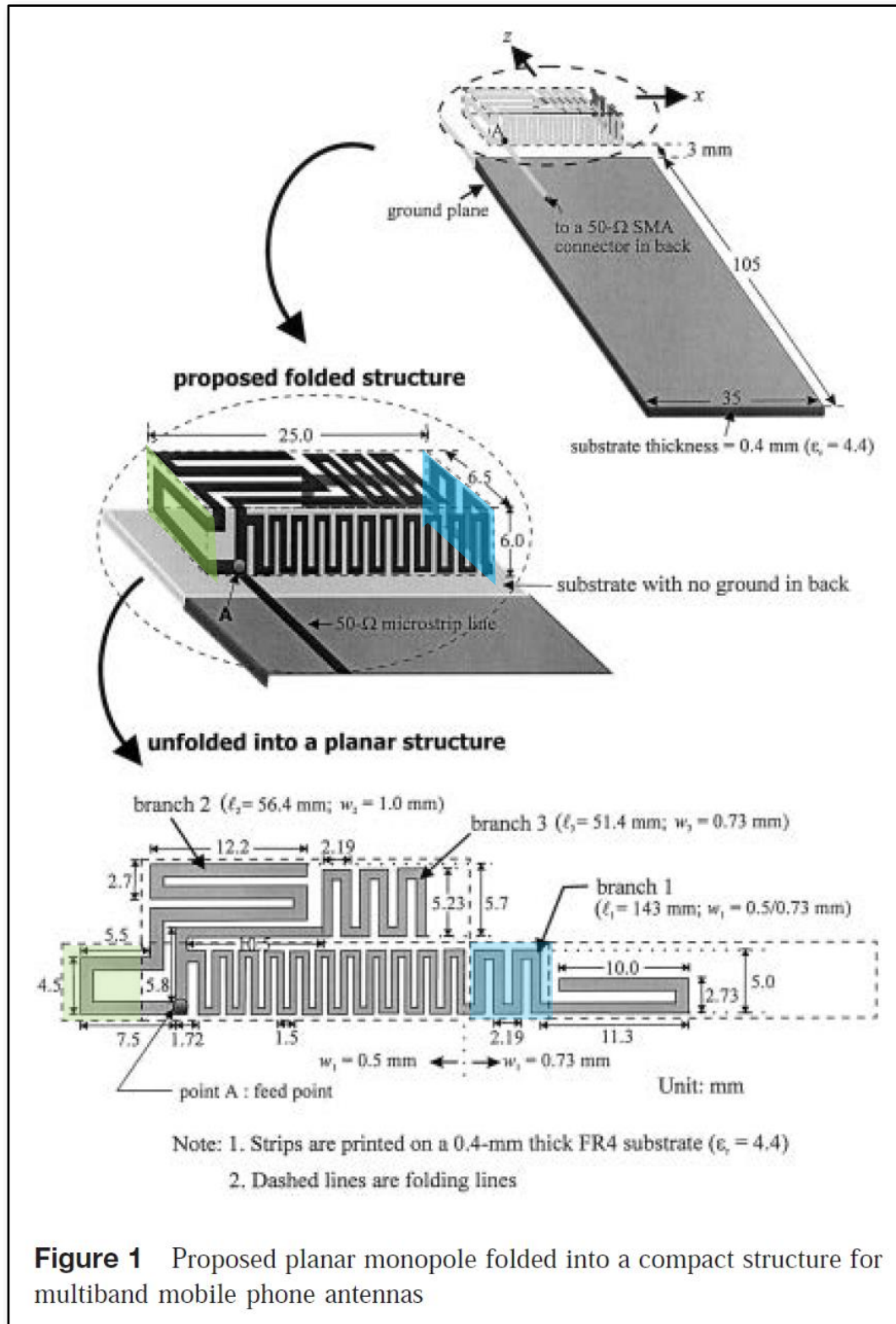
EX1035, a POSA would have understood that the addition of a foam core would have made an imperceptible difference to the radiation characteristics of Teng's antenna structure which has air between the surfaces of its FR4 mounting structure.

192. Similarly, Tran's "dual strip antenna" has two strips "spaced apart from each other by a dielectric material or substrate, such as air or a foam ... known for such uses." Tran, 7:63-8:6. For example, Tran uses "Rohacell foam ($\epsilon_r=1.05$ [relative permittivity]) ... to manufacture [Tran's] dielectric substrate." Tran, 13:9-14. The relative permittivity of Rohacell's foam is only 5% different from air's relative permittivity ($\epsilon_r=1.00$). Moreover, a POSA would have known that there is a square root effect of ϵ_r on antenna characteristics that is proportional to $1/\sqrt{\epsilon_r}$ —in this example, $1/\sqrt{1.05} = 0.975$ —and so the relevant distinction is even less pronounced (only 2.5%). Furthermore, Teng discloses that its "FR4 substrate" has an " $(\epsilon_r = 4.4)$." The difference between Rohacell's relative permittivity ($\epsilon_r=1.05$) and air's relative permittivity ($\epsilon_r=1.00$), which is already negligible, is further insignificant in comparison to the relative permittivity of Teng's FR4 substrate ($\epsilon_r=4.4$), which would have further reinforced a POSA's reasonable expectation of success in adding a foam core mounting structure to the center of Teng's rectangular-box mounting structure. *See also* EX1035, [0053]-[0054] (discussed above in this section).

193. In this obvious implementation of Tran+Teng, a rectangular dielectric foam base to support the “rectangular box” formed by the folded FR4 substrate with the antenna printed thereon (Teng, 23 and Figure 1) is also *a dielectric mounting structure having a plurality of surfaces* that meets [13A].

- b. Limitation [13B]:** *wherein at least a portion of the first radiating arm is arranged on a first surface of said plurality of surfaces; and wherein at least a portion of the second radiating arm is arranged on a second surface of said plurality of surfaces, the second surface being different from the first surface.*

194. When the *dielectric mounting structure* is mapped to the FR4 substrate folded into a rectangular box (for the reasons I discussed above §IX.D.12.a ([13A])), *at least a portion of Tran+Teng’s Branch 1 (first radiating arm, see §IX.D.1.j ([1I])) is arranged on a first surface* (supporting the blue-highlight strip trace) *of said plurality of surfaces of the dielectric mounting structure* (rectangular box of FR4 substrate), and *at least a portion of Branch 2 (second radiating arm, see §IX.D.1.j ([1I])) is arranged on a second (different) surface of said plurality of surfaces* (supporting the green-highlight strip trace) *of the dielectric mounting structure* (rectangular box of FR4 substrate), as shown in Teng’s Figure 1 (which I have highlighted below).

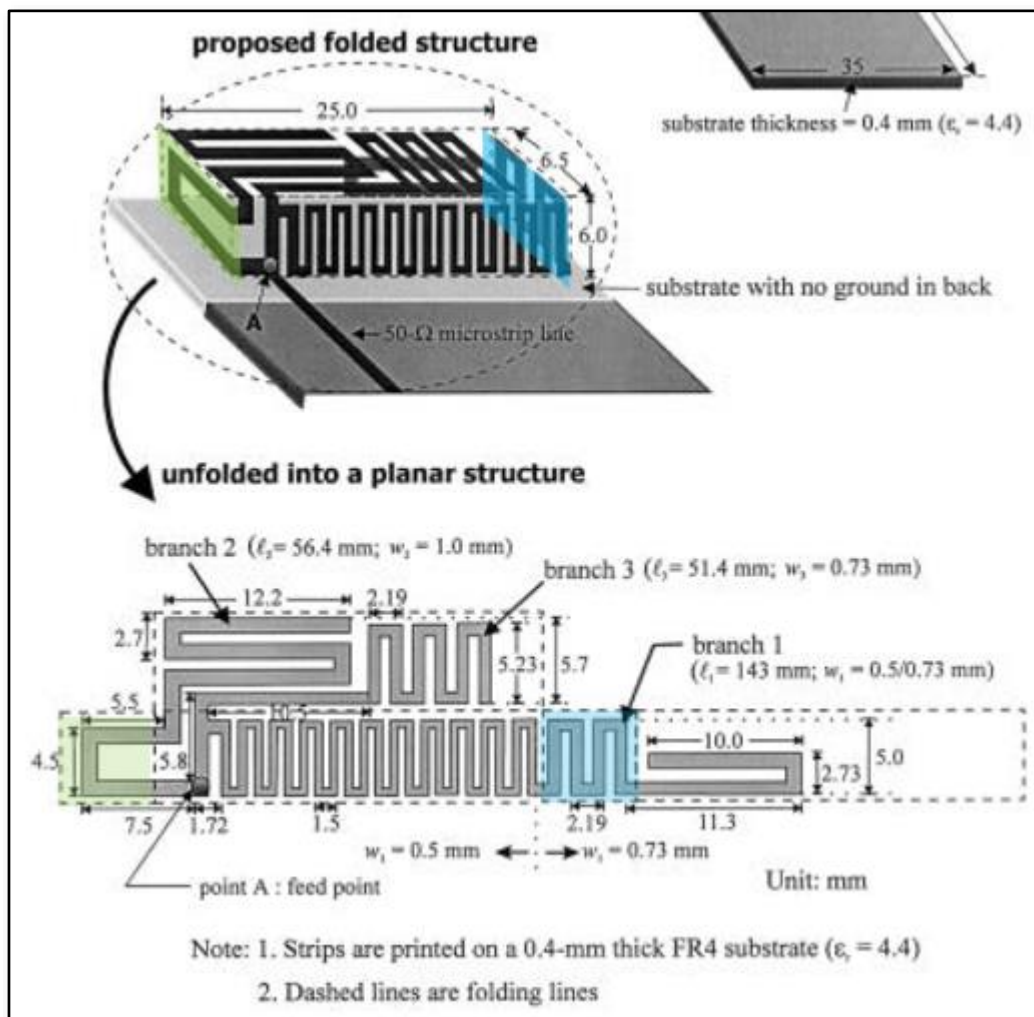


195. When the *dielectric mounting structure* is mapped to a rectangular dielectric foam base that supports the “rectangular box” formed by the folded FR4 substrate with the antenna printed thereon (an obvious alternative for the reasons I discuss above §IX.D.12.a ([13A])), *at least a portion of* Tran+Teng’s Branch 1 (*first radiating arm*) *is arranged on a first surface of said plurality of surfaces of the dielectric mounting structure* (a surface of the dielectric foam base supporting the blue-highlighted surface above), and *at least a portion of* Branch 2 (*second radiating arm*), see §IX.D.1.j ([11])) *is arranged on a second (different) surface of said plurality of surfaces of the dielectric mounting structure* (a surface of the dielectric foam base supporting the green-highlighted surface above), based on Teng’s Figure 1 (which I have highlighted above).

196. Because the claim term “*arranged on*” one of the surfaces of the *dielectric mounting structure* does not require that *at least a portion of the radiating arm* be in direct contact with the surface of the *dielectric mounting structure*, a POSA would understand that the portions of the antenna arranged on different surfaces of the rectangular box are “*arranged on*” the corresponding surface of the rectangular foam base, and thus also meets Limitation [13B].

13. Claim 14: The mobile communication device according to claim 13, wherein the first surface and the second surface are opposite surfaces of the dielectric mounting structure.

197. As shown below from Teng's Figure 1 (highlighted below), the first surface (green) and the second surface (blue) are opposite surfaces of the dielectric mounting structure because they are opposite surfaces of the folded rectangular-box structure.



14. Claim 15

198. Claim 15 is an independent claim that has many limitations that are identical, or substantially similar, to limitations in claim 1. *See* Appendix B (Claim List). In the first section below (§IX.D.14.a), I rely on the opinions I offered above for claim 1 to meet the identical or substantially similar limitations in claim 15, and then in the subsequent sections below (§§IX.D.14.b-d) I address any limitations of claim 15 that are not in claims 1-14.

a. Limitations [15PRE]-[15I], [15L]

199. Tran+Teng meets the following limitations of claim 15 for the same reasons Tran+Teng meets the corresponding limitations below. EX1034 is a chart that compares the claim language for the limitations listed below, which supports my opinion regarding the corresponding limitations and discussions identified in the table below. *See* EX1034, 1-2.

Limitation of Claim 15	Corresponding Limitation of Claim 1	Discussed in the above section(s)
[15PRE]	[1PRE]	§IX.D.1.a
[15A]	[1A]	§IX.D.1.b
[15B]	[1B]	§IX.D.1.c
[15C]	[1C]	§IX.D.1.d
[15D]	[1D]	§IX.D.1.e
[15E]	[1E]	§IX.D.1.f
[15F]	[1F]	§IX.D.1.g
[15G]	[1G]	§IX.D.1.h
[15H]	[1H]	§IX.D.1.i
[15I]	[1I], [1L]	§§IX.D.1.j ([1I]), IX.D.1.m ([1L])
[15L]	[1M]	§IX.D.1.n

200. In Limitation [15I], the “*first conductor*” is Teng’s Branch 1 (the “*first radiating arm*” that I identified in Limitation [1I], above §IX.D.1.j), while the “*grid-dimension section*” is the GDC portion of Teng’s Branch 1, that I discussed above in §IX.D.1.m ([1L]). *See also* §IX.D.14.c.i (below; Limitation [15J], where I discuss the *conducting* material in Tran+Teng’s radiating arms).

b. Limitation [15H]: wherein the antenna element is coupled to the feeding point and operates in cooperation with the ground plane layer;

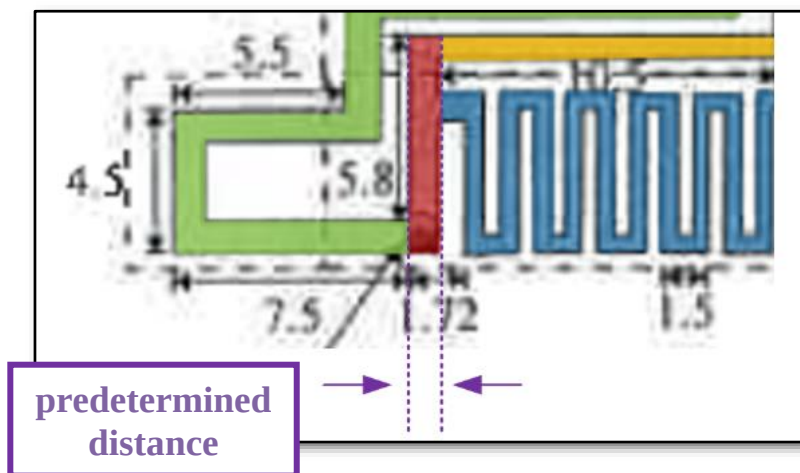
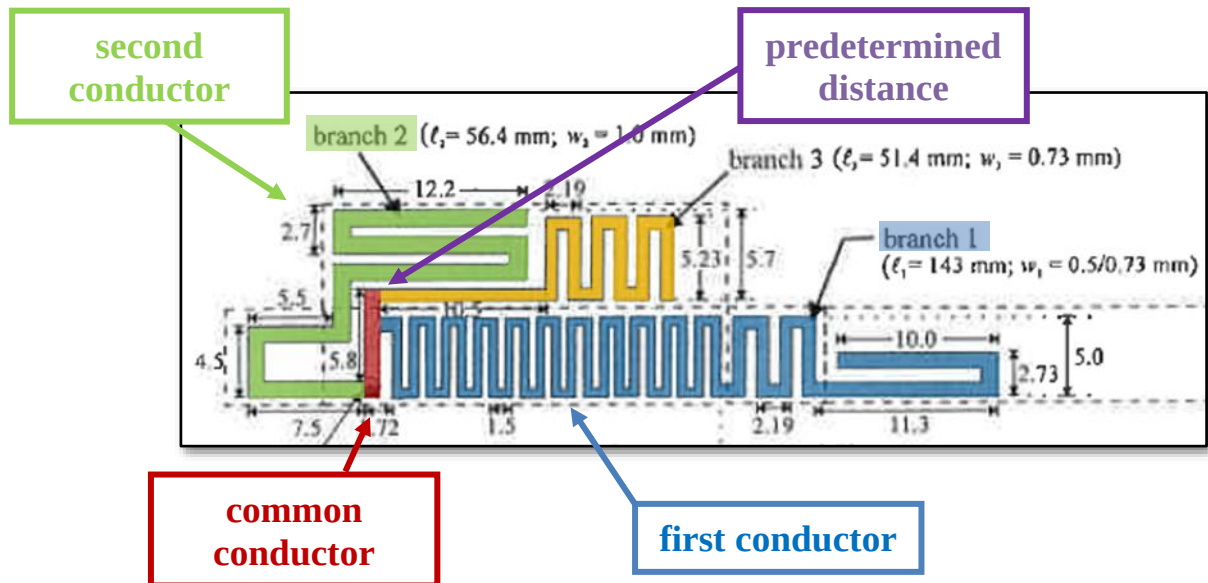
201. Tran+Teng meets Limitation [15H] because Tran+Teng’s *feeding point* provides a pathway (e.g., *is coupled*) for RF signals to travel between Tran+Teng’s antenna assembly (comprising the *antenna element*) and Tran+Teng’s communications circuitry (which I discussed above, §IX.D.1.j ([1I])), as illustrated in Teng Figure 1. *See also* §IX.D.1.e ([1D]), §IX.D.14.a [15D]). Tran+Teng meets the remaining limitations in [15H] for the reasons Tran+Teng meets Limitation [1H], as discussed above (§IX.D.1.i).

c. Limitation [15J]: a second conductor arranged at a predetermined distance from the first conductor and electromagnetically coupled to the first conductor,
i. predetermined distance

202. Tran+Teng’s first and second radiating arms are *first* and *second conductors*, respectively, because Teng discloses (or at least suggests and renders obvious) “print[ing]” the antenna branches as *conducting* material (e.g., metal). *See* §IX.D.1.j ([1I]) (above; citing as corroboration EX1017, 4:12-24; EX1022,

[0006]; Teng, 23; Tran, 11:35-39 (forming antenna using a “**metallic** [conductive] strip” of material)).

203. In addition, Tran+Teng’s *second conductor* (green-highlighted below) is *arranged at a predetermined distance from* Branch 1 (blue-highlighted below: *first conductor comprising a first radiating arm*), where that distance is defined by the width of the common conductor strip and the points where the first and second conductors connect to the common conductor, as shown in Teng’s Figure 1 (annotated below).

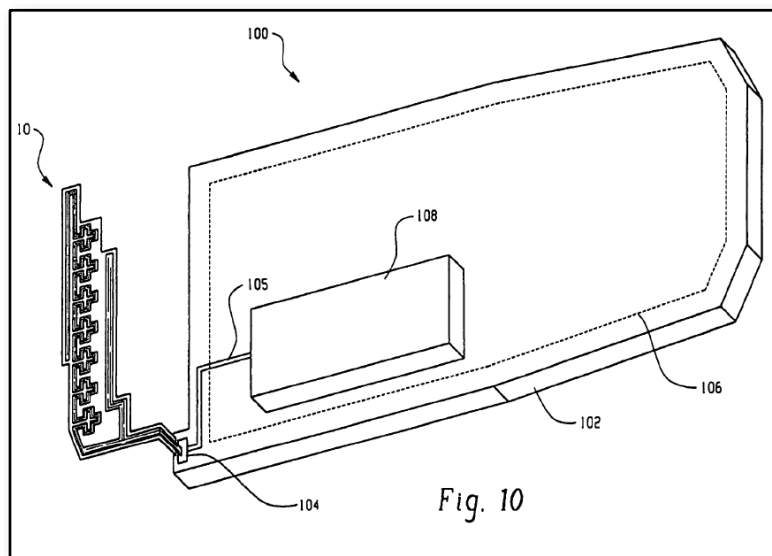


ii. electromagnetic coupling

204. The '365 patent refers to positioning antenna 10 and feeding point 104 in Figure 10 (copied below) to reduce “*electromagnetic coupling* from the ground plane 106.” EX1001, 4:63-64, 5:10-13. POSAs understood that electromagnetic coupling means an interaction between circuit components through

electromagnetic fields. My opinion in this regard is corroborated by the following references:

- EX1038 (a dictionary of electronics), which defines “electromagnetic coupling” as “The mutual relationship between two separate but adjacent wires when the magnetic field of one induces a voltage in the other.” EX1038, 242;
- EX1039 (a dictionary of electronics), which defines “electromagnetic coupling” based on the definition of “INDUCTIVE COUPLING” (EX1039, 240), which is defined as “The transfer of energy between two inductors (or inductive devices) by a linking electromagnetic field.” (EX1039, 362).

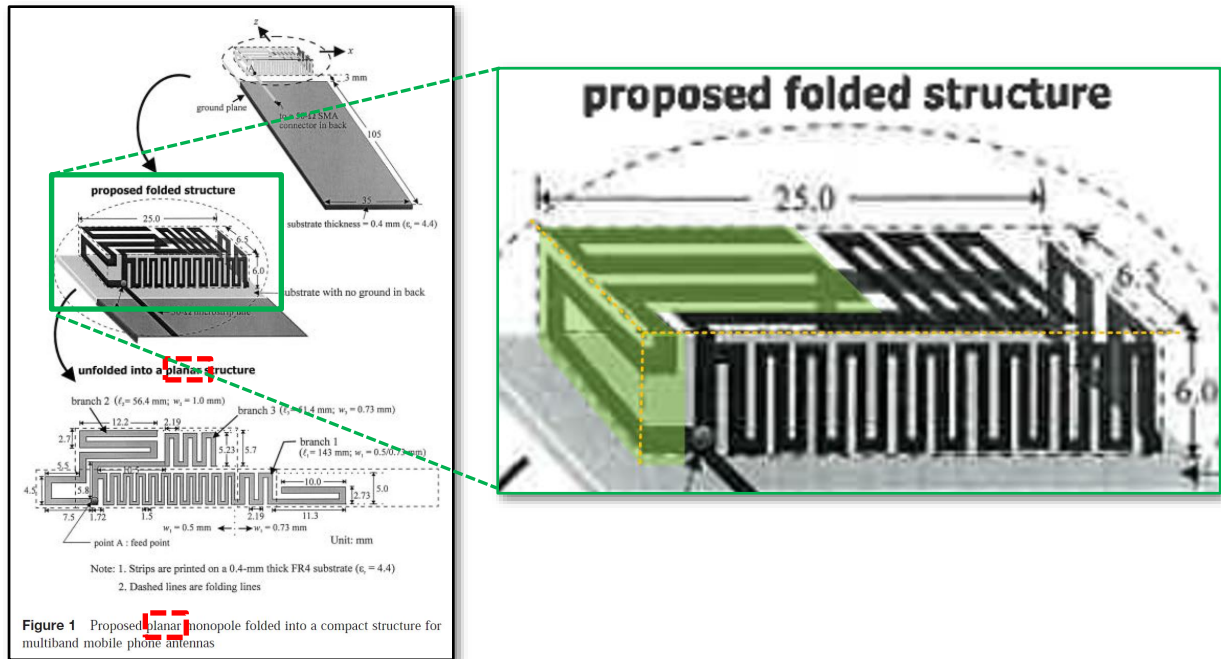


205. As discussed above, Tran+Teng’s Branch 1 and Branch 2 are *first and second conductors*, respectively. In a manufactured mobile device that feeds RF signals into Tran+Teng’s antenna branches, POSAs understood that Branch 1 and

Branch 2 are *electromagnetically coupled* because, as Teng discloses, there will be a “***coupling*** effect between two adjacent or nearby meandered sections”—including between Teng’s Branch 1 and Branch 2. Teng, 23. POSAs understood that Teng’s *coupling* between proximate meandered sections is a type of *electromagnetic coupling*, meeting [15J]. My opinion in this regard is corroborated by EX1022, which discloses two radiating elements and a metallic top plate that are “electromagnetically ***coupled*** due to their proximate disposition.” EX1022, [0040]; *see also* EX1022, [0041] (noting the “conductive element” is “electromagnetically ***coupled*** to the spiral conductor [] due to the proximate physical relationship therebetween”); EX1038, 242 (discussed above); EX1039, 240, 362 (discussed above).

d. Limitation [15K]: the second conductor comprising a planar section; and

206. Tran+Teng’s Branch 2 (the *second conductor*) comprises multiple *planar* sections (highlighted green below-right) because Branch 2 is first formed on a “***planar*** structure” substrate, and then that substrate is folded into a rectangular structure, which results in each section of Branch 2 being located entirely on one *plane* of the rectangular folded structure.

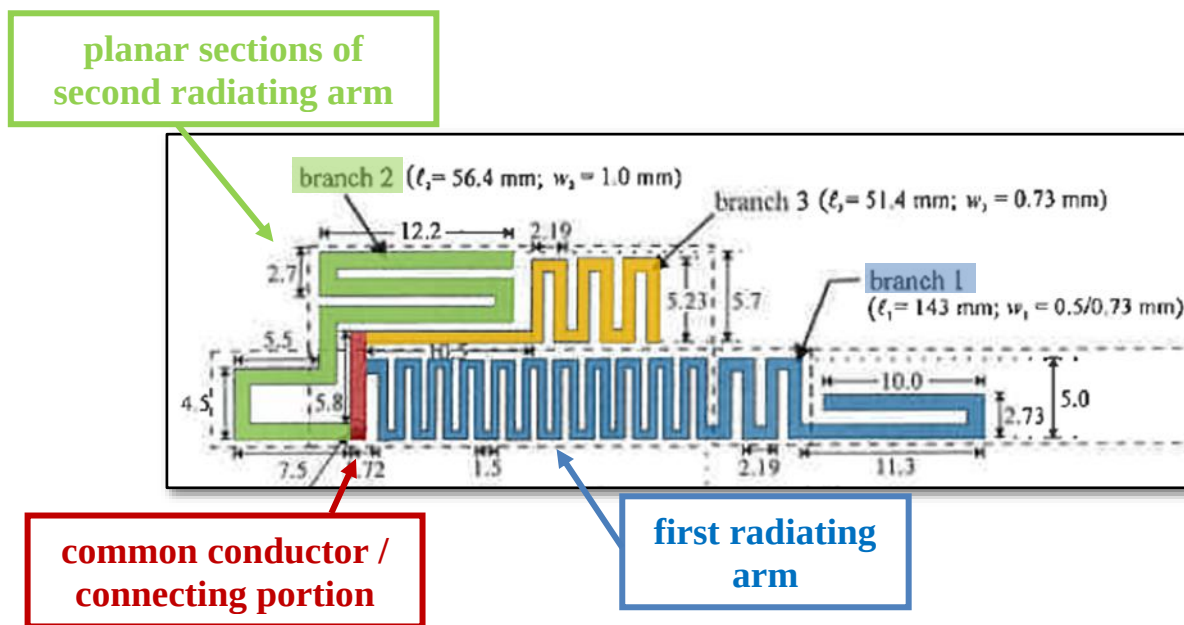


15. **Claim 16:** *The mobile communication device according to claim 15, wherein the first conductor and the second conductor are electrically connected.*

207. Tran+Teng's Branch 1 and Branch 2 (see §IX.D.14.c above) are the *first and second conductors* that are both *connected to the common conductor* that feeds RF (electrical) signals to the branches, as I explained above in §IX.D.1.j ([1I]). That connection is an *electrical connection* because the branches and common conductor are all formed from one piece of conducting metal material, as shown, for example, in Teng Figure 1.

16. **Claim 17: The mobile communication device according to claim 16, wherein the antenna element comprises a connecting portion that connects the first radiating arm and the planar section.**

208. The '365 patent's written description does not use the term "connecting portion." The closest written description is (at most) the patent's disclosure of a "conducting portion." See, e.g., EX1001, 4:4-30 (disclosing that "FIGS. 3-9" illustrate "a common conductor 52 coupled to a first radiating arm 54 and a second radiating arm 56," which is illustrated as a planar, linear conductor). As I discussed above in §IX.D.1.j ([11]), Tran+Teng has a *common conductor* (red), as shown in Teng's Figure 1 (which I have annotated below).



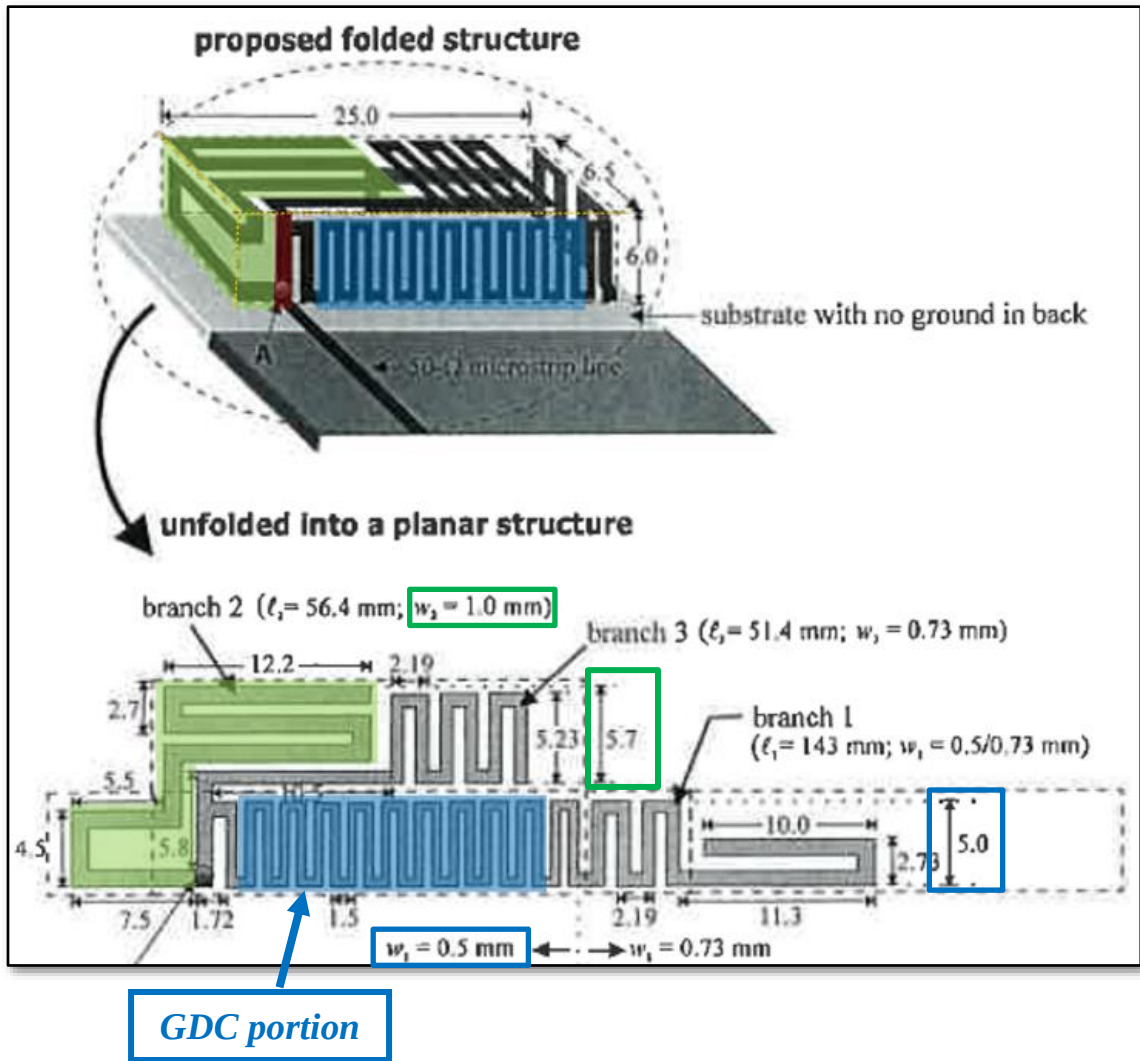
209. Tran+Teng's common conductor (red) connects Branch 1 (blue, *first radiating arm*) to Branch 2 (green, with multiple *planar sections*). See §IX.D.14.c (above; [15J]). Thus, Tran+Teng's common conductor also meets claim 17's

connecting portion that connects the first radiating arm (blue) and each planar section in Branch 2 (green).

17. Claim 18: *The mobile communication device according to claim 17, wherein a width of the grid-dimension section is smaller than a width of the planar section.*

210. In the claims “a width” is the antenna element width. For example, the ’365 patent’s claim 40 recites, in part, that the “second radiating arm has a *uniform width*,” which informs a POSA that the “width” is referring to the trace / strip width. That is also consistent with the ’365 patent’s disclosure referring to the antenna’s “conductor plates ... can be decreased in width.” EX1001, 9:59-61. In Tran+Teng’s Branch 1-1, which comprises the first GDC portion (see §IX.D.1.m (above; [1L])), the 0.5 mm antenna element width *is smaller than* the 1.0 mm antenna element width in Branch 2, which comprises *the planar section* (see §IX.D.14.d (above; [15K])). *See also* Teng, Fig. 1 (detail annotated below).

211. Alternatively, the GDC portion height (e.g., *a width*) is 5.0 mm (as shown in Teng’s Fig. 1 below), which is less than the 5.7mm top planar section height (e.g., *a width*) (as also shown in Fig. 1 below).



18. Claims 19-21, 23, 25, 27

212. Claims 19-21, 23, 25 and 27 add limitations substantially similar to limitations that have already been addressed. Tran+Teng meets the additional limitations for the reasons it meets the corresponding limitations below. EX1034 is a chart that compares the claim language for the limitations listed below, which supports my opinion regarding the corresponding limitations and discussions identified in the table below. See EX1034, 3-5.

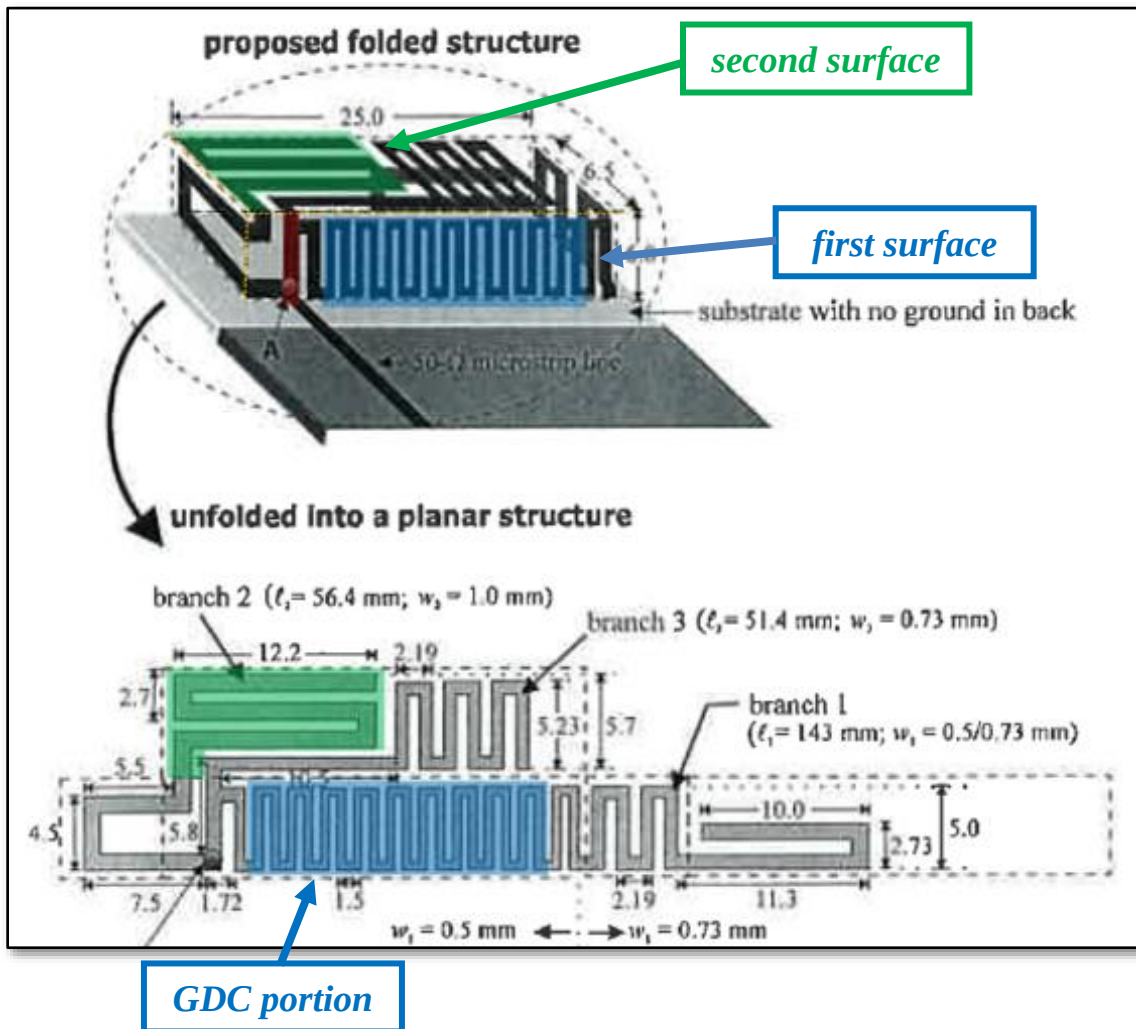
Limitation	Corresponding Claim Limitation	Discussed in the above section
19	7	§IX.D.7
[20A]	4	§IX.D.4
[20B]	[2B]	§IX.D.2.b
[20C]	[2D]	§IX.D.2.d
[20D]	[2E]	§IX.D.2.e
[20E]	[2C]	§IX.D.2.c
[20F]	[1L]	§IX.D.1.m.ii
21	13	§IX.D.12
23	14	§IX.D.13
25	[1I]	§IX.D.1.j
27	9	§IX.D.8

213. Limitation [20F] recites language that Fractus incorporates in its *grid-dimension curve* construction and Tran+Teng meets it for the reasons it meets Fractus’s construction (§IX.D.1.m.ii (above; [1L])) and because the grid-dimension curve’s periodic portion *is periodic along a fixed straight direction*—e.g., the front surface of Tran+Teng’s rectangular mounting structure, as shown in Teng’s Figure 1 (see §IX.D.1.m.ii (above; [1L])).

19. Claim 22: *The mobile communication device according to claim 21, wherein the grid-dimension section is arranged on the first surface; and wherein the planar section is arranged on the second surface.*

214. Tran+Teng meets claim 22 under an alternative *first/second surface* mapping from the one I discussed above for claim 14 (see §IX.D.13). See also §IX.D.14.d (above; [15k], where I identify the multiple *planar sections* in Branch 2). Tran+Teng meets claim 22 because Branch 1’s first GDC portion (*grid-dimension section*; blue below) is disposed on a *first surface* (the foreground

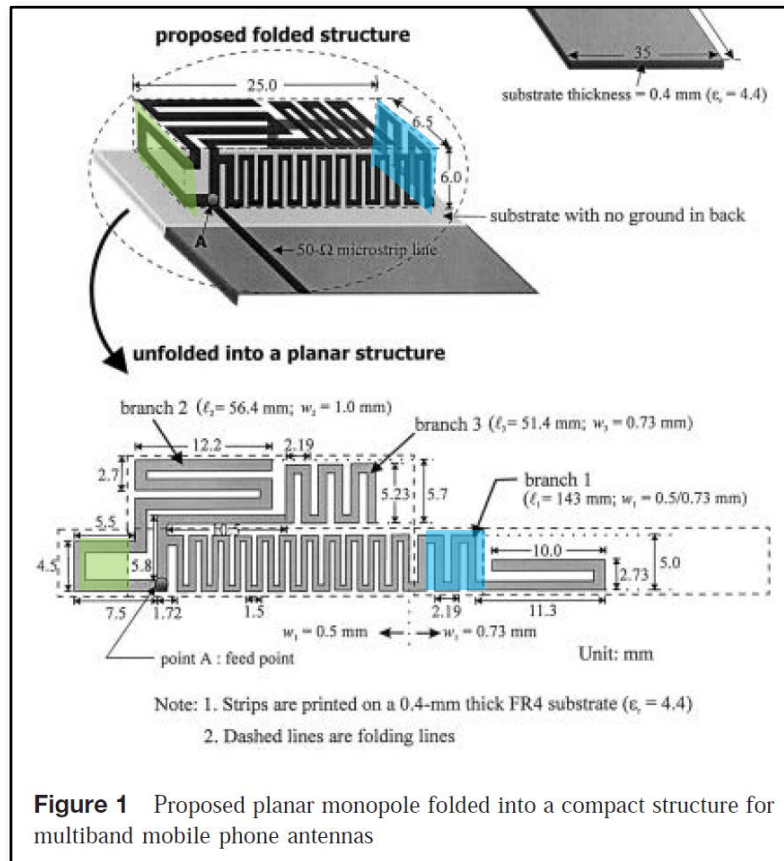
surface of the rectangular box mounting structure), while Branch 2-1 (*planar section*; green below) is disposed on a *second surface* (the top surface of the rectangular box mounting structure), as shown in Teng's Figure 1 (which I have annotated below). See also §IX.D.12 (claim 13), §IX.D.14.d ([15K]).



20. **Claim 24:** *The mobile communication device according to claim 21, wherein the first surface and the second surface are substantially parallel.*

215. For purposes of claim 24, I refer back to the mapping of the *first* and *second surfaces* that I discussed above for claim 13 (§IX.D.12), wherein the *first*

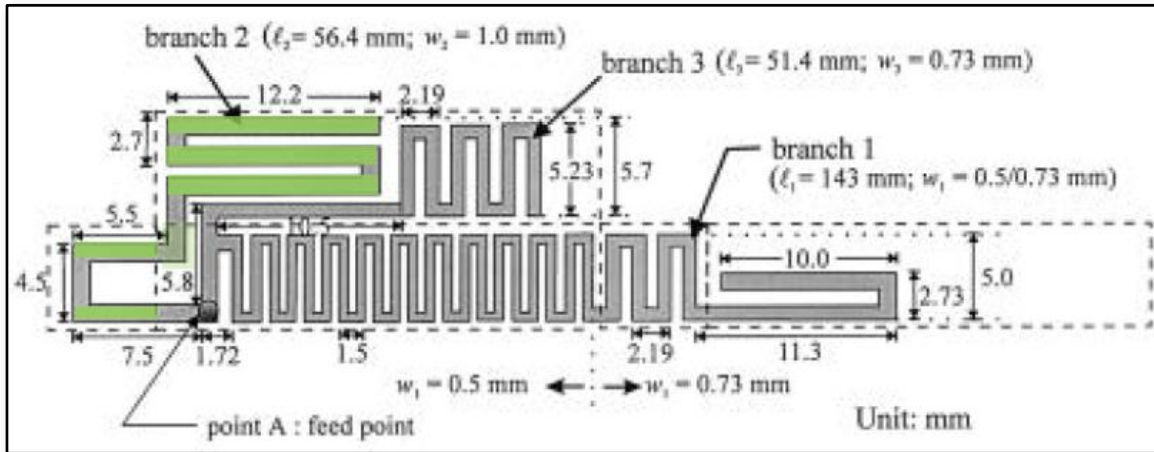
(blue-highlight below) and *second* (green-highlighted below) surfaces are *substantially parallel* because they form opposite sides of the rectangular box mounting structure, as shown in Teng Figure 1 (highlighted below).



21. **Claim 26: The mobile communication device according to claim 25, wherein the second radiating arm comprises a substantially straight section.**

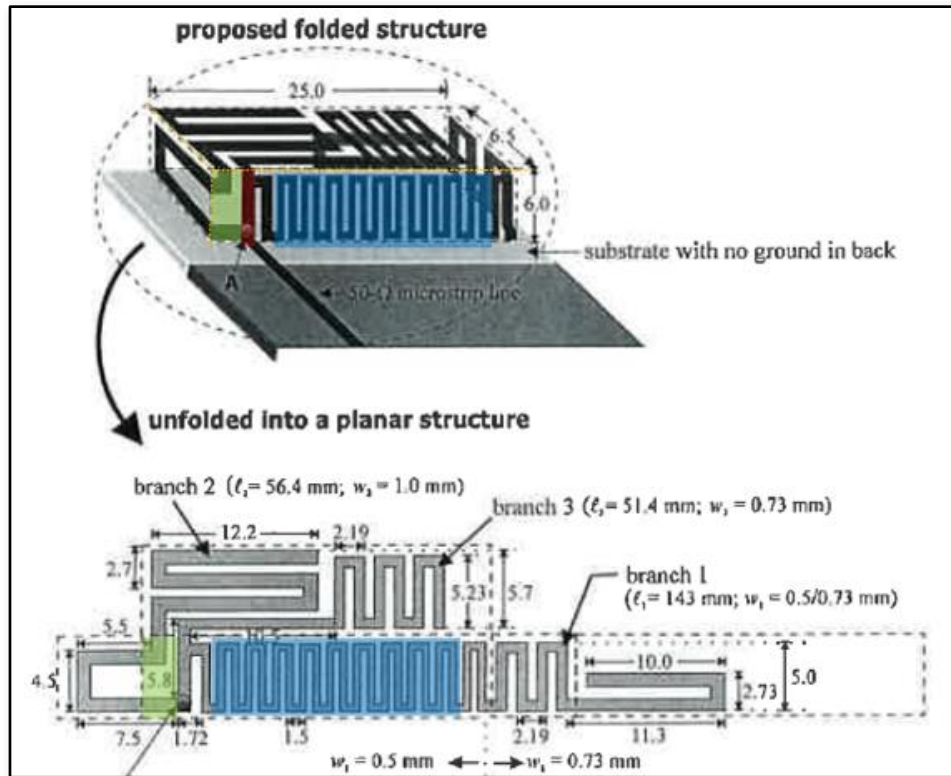
216. Tran+Teng's Branch 2 (*second radiating arm*, §IX.D.1.j ([1I]), §IX.D.14.c.i ([15J])) *comprises several substantially straight sections*, several of which I have highlighted green in Teng's Figure 1 below. As shown below, each of Branch 2's sections is formed from several substantially straight lengths of the

conducting strip, which reinforces that each of Branch 2's sections is a *substantially straight section*.



22. **Claim 28:** *The mobile communication device according to claim 25, wherein the second radiating arm and the grid-dimension section of the first radiating arm lie on a common surface.*

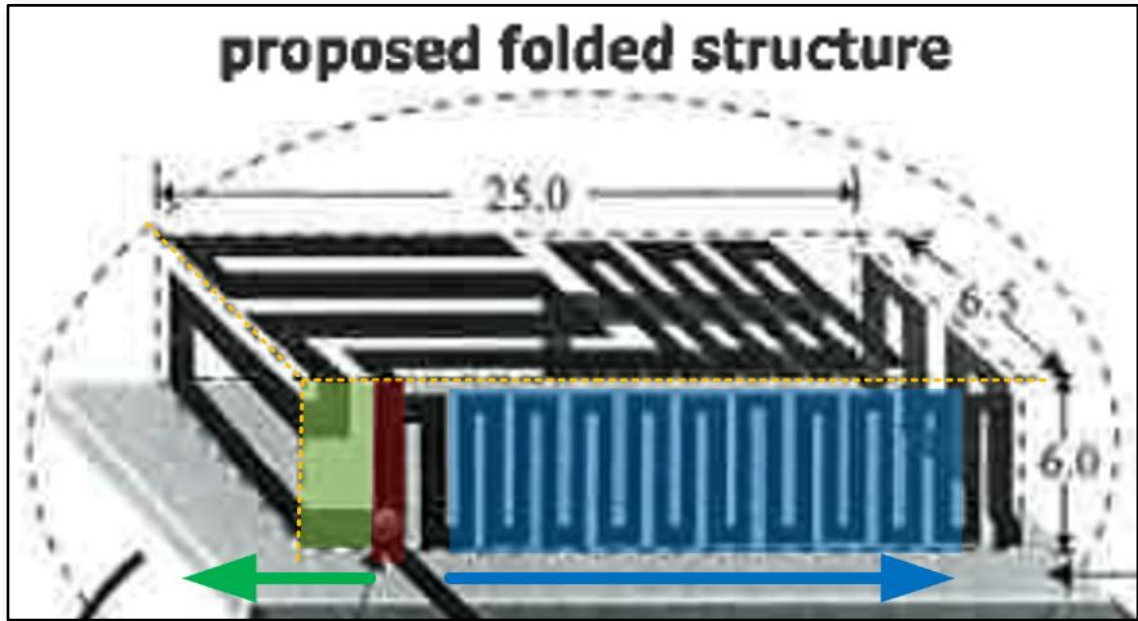
217. In Tran+Teng (see §IX.C above), a portion (green-highlighted below) of Branch 2 (*second radiating arm*, §IX.D.14.c.i [15J]) and Branch 1-1 (blue) (*grid-dimension section of the first radiating arm*, supra §IX.D.1.m [1L]) lie on a common surface (foreground surface of the rectangular box), as shown in Teng's Figure 1 (which I have highlighted below).



23. **Claim 29:** *The mobile communication device according to claim 25, wherein the grid-dimension section of the first radiating arm extends away from the common conductor along a first direction; and wherein the second radiating arm extends away from the common conductor along a second direction, the second direction being substantially parallel to the first direction.*

218. Tran+Teng's grid-dimension section of the first radiating arm (highlighted blue below) extends away from the common conductor (red) along a first direction (blue arrow) and the second radiating arm section extends along a second direction (green arrow) that is substantially parallel to the first direction, as shown in Teng's Figure 1 (which I have annotated below). See also §IX.D.1.m (above [1L]; where I discuss Tran+Teng's grid-dimension section of the first

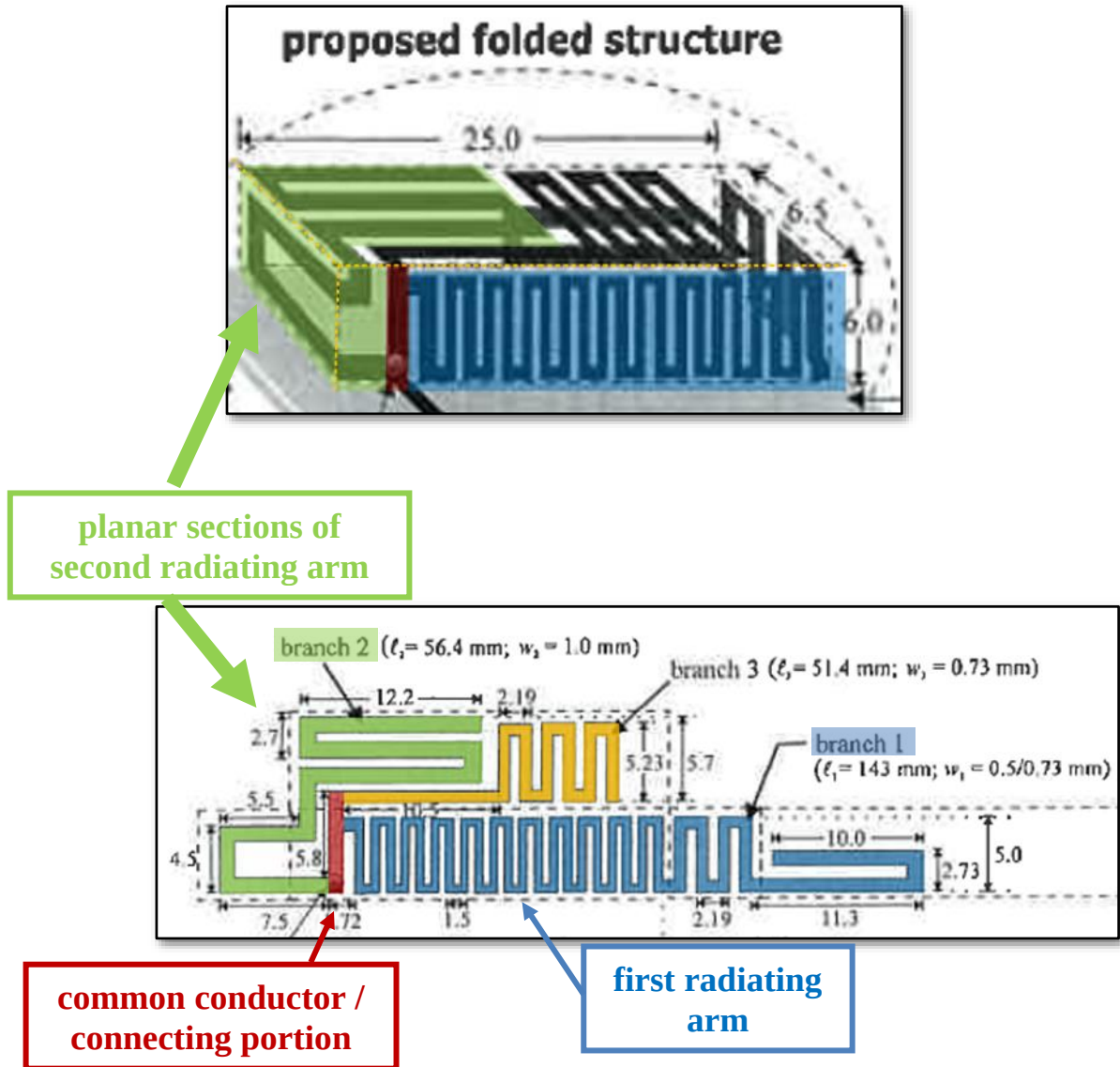
radiating arm); §IX.D.14.c.i (above [15K]; where I discuss Tran+Teng's second radiating arm, based on my discussion above in §IX.D.1.j ([1I])).



24. Claim 30

- a. **Limitation [30A]:** *The mobile communication device according to claim 29, wherein the antenna element comprises a connecting portion that connects the grid-dimension section and the planar section; and*

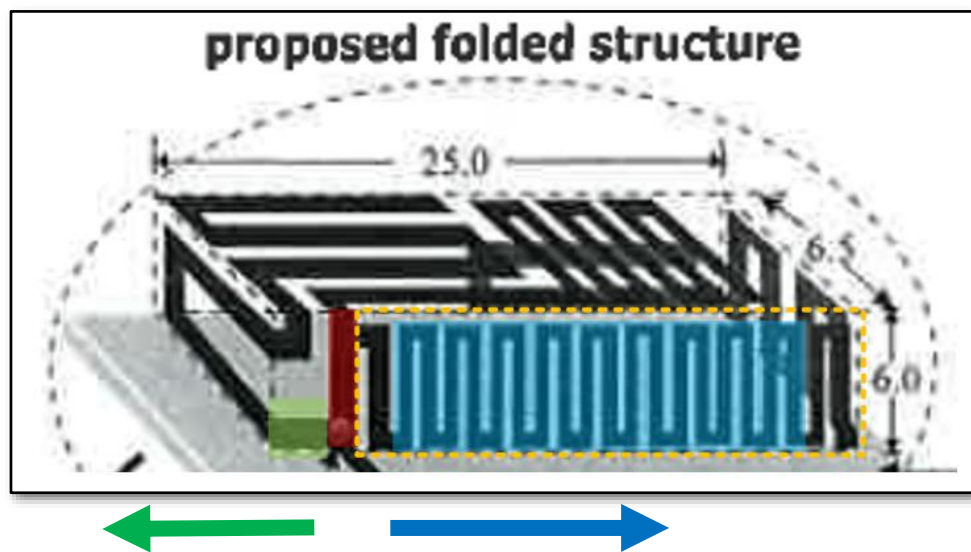
219. As I discussed above in §IX.D.16 (claim 17), Tran+Teng's *antenna element comprises a connecting portion* (red-highlighted below) comprising the same portion of the antenna element that meets the *common conductor* discussed above for limitation [1J], as I discussed above in §IX.D.1.k.



220. Tran+Teng's *first radiating arm* (blue above) comprises the GDC portion (*grid-dimension section*; see §IX.D.1.m ([1L])), and Tran+Teng's *second radiating arm* (green above) comprises the *planar section* (see §IX.D.14.d ([15K])). Thus, Tran+Teng's *connecting portion connects the grid-dimension section and planar section* in the same way the common conductor is connected to the first and second radiating arms, as I discussed above in §IX.D.1.k ([1J]).

b. Limitation [30B]: wherein the planar section extends away from the connection portion along a direction substantially opposite to the first direction.

221. As shown below in Teng's Figure 1 (which I have annotated below), one of Tran+Teng's *planar section* (green below) *extends away from the connection portion* (red) *along the direction indicated by the green arrow*, which is *substantially opposite to the first direction* (blue arrow, which I discussed above in §IX.D.21, claim 29).



25. Claim 31

222. Claim 31 is an independent claim that has many limitations that are identical, or substantially similar, to limitations in claim 1. See Appendix B (Claim List). In the first section below (§IX.D.25.a), I rely on the opinions I offered above for claim 1 to meet the identical or substantially similar limitations in claim 31, and then in the subsequent sections below (§§IX.D.25.b-d) I address any limitations of claim 31 that are not in claims 31-45.

a. Limitations [31PRE]-[31I], [31M]

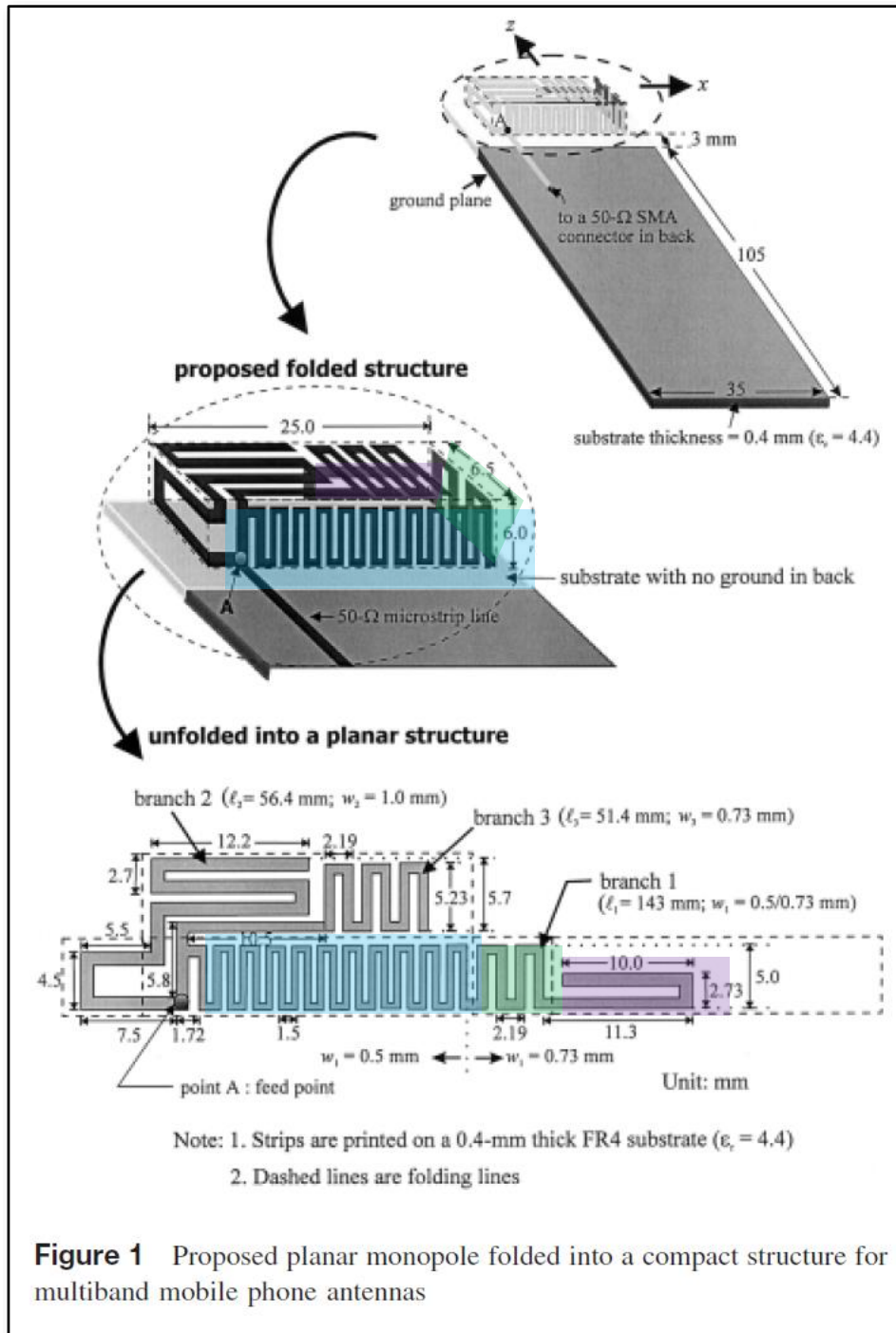
223. Tran+Teng meets the following limitations of claim 31 for the same reasons Tran+Teng meets the corresponding limitations below. EX1034 is a chart that compares the claim language for the limitations listed below, which supports my opinion regarding the corresponding limitations and discussions identified in the table below. See EX1034, 6-8.

Limitation of Claim 31	Corresponding Limitation of Claim 1 / 13	Discussed in the above section(s)
[31PRE]	[1PRE]	§IX.D.1.a
[31A]	[1A]	§IX.D.1.b
[31B]	[1B]	§IX.D.1.c
[31C]	[1C]	§IX.D.1.d
[31D]	[1D]	§IX.D.1.e
[31E]	[1E]	§IX.D.1.f
[31F]	[1F]	§IX.D.1.g
[31G]	[1G]	§IX.D.1.h
[31H]	[13A]	§IX.D.12.a
[31I]	[1G]-[1J]	§§IX.D.1.h ([1G])-IX.D.1.k ([1J])
[31M]	[1M]	§IX.D.1.n

b. Limitation [31J]: *wherein the antenna element comprises a first radiating arm arranged on two or more surfaces of the plurality of surfaces of the dielectric mounting structure;*

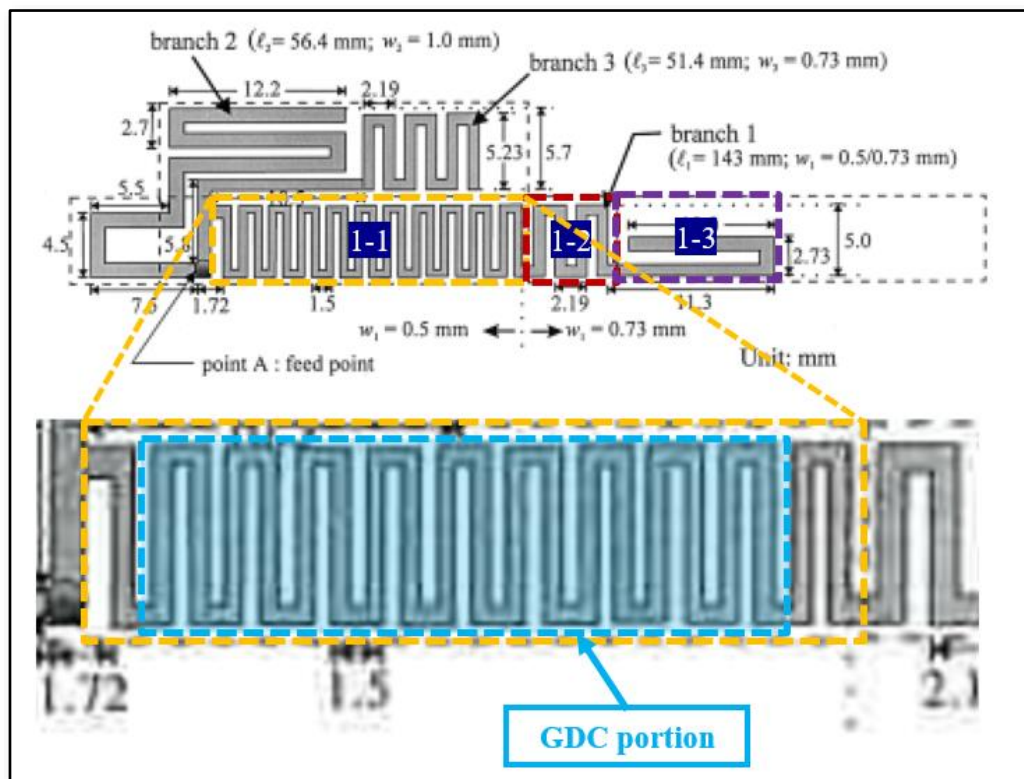
224. Tran+Teng's antenna element comprises Branch 1 (*first radiating arm*) arranged on multiple surfaces of the rectangular structure as I discussed above in §IX.D.1.j ([1I]; where I discuss *the first and second radiating arms*) and §IX.D.1.l ([1K]; where I discuss the different planes for the radiating arms).

225. Teng's Figure 1 (which I have annotated below) shows that in the rectangular ("folded") structure used in Tran+Teng's mobile device, Branch 1 (*first radiating arm*) is *arranged on two or more surfaces of the plurality of surfaces of the dielectric mounting structure* because Branch 1 is arranged on the front (blue), right (green) and back (purple) surfaces of the rectangular structure in Figure 1.



- c. **Limitation [31K]: the first radiating arm comprising: a first section shaped according to a grid-dimension curve;**

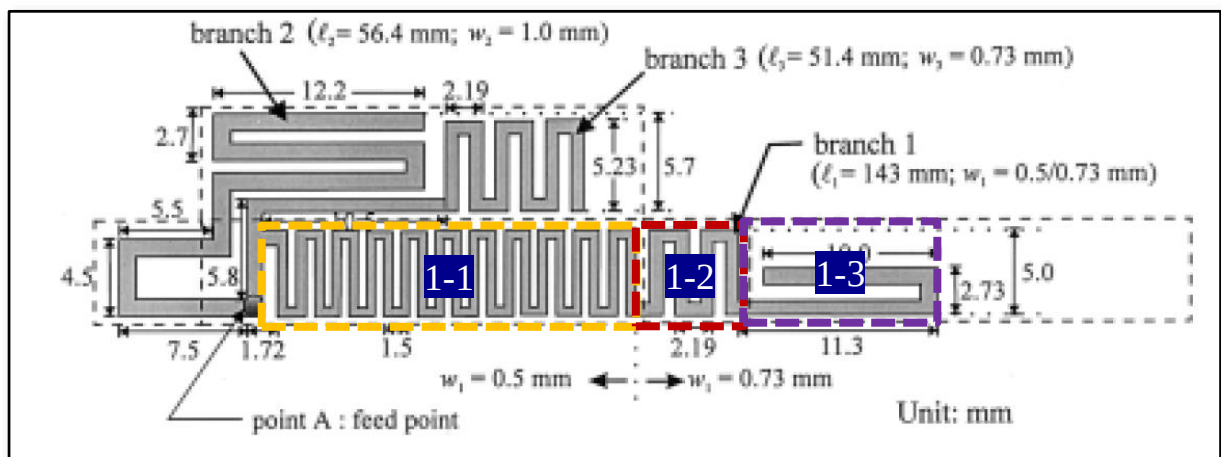
226. Tran+Teng's first radiating arm (Branch 1) comprises a GDC portion (first section) that is shaped according to a grid-dimension curve, as I explained above in §IX.D.1.m ([1L]). Below, I have highlighted the GDC portion of the first radiating arm again in Teng's Figure 1 (annotated detail below).

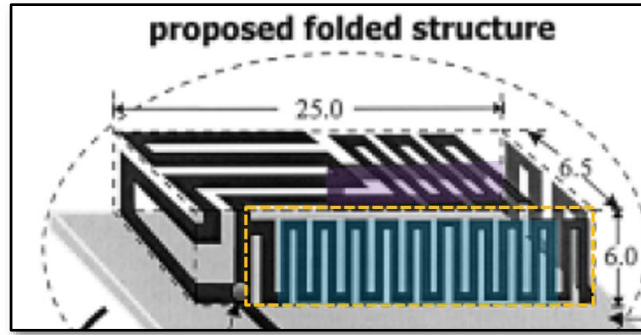


- d. **Limitation [31L]:** *[the first radiating arm comprising:] a second section connected to the grid-dimension section, the second section having a width different from a width of the first section; and*

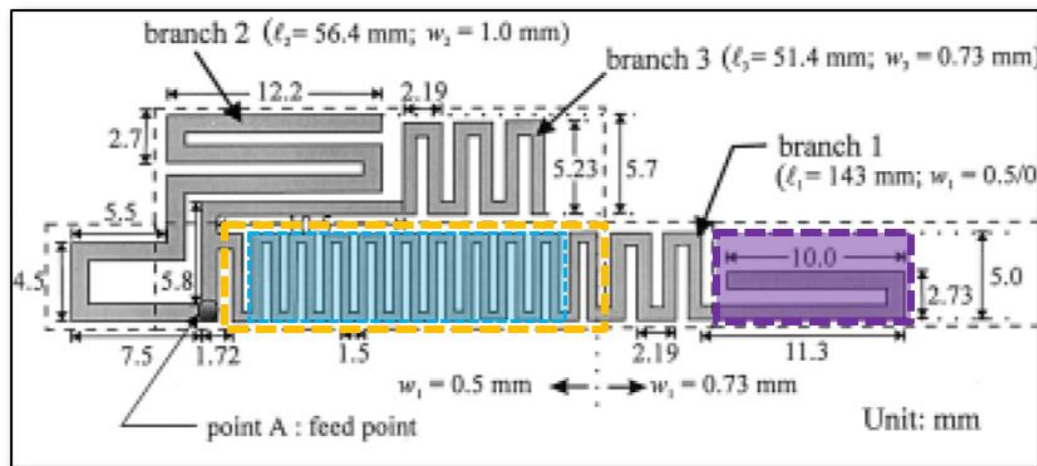
227. Limitation [31L] refers to “*the grid-dimension section*,” but there is no prior limitation in claim 31 that first refers to “*a grid-dimension section*” (i.e., there is no antecedent basis “*the grid-dimension section*”). However, claim 31 does recite a “*first section shaped according to a grid-dimension curve*” (Limitation [31L]), so Limitation [31M]’s reference to “*the grid-dimension section*” would be understood to refer to the “*first section shaped according to a grid-dimension curve*” (e.g., GDC portion) in Limitation [31L].

228. Tran+Teng’s Branch 1 (*first radiating arm*) comprises a portion that I have enclosed in a purple rectangle and labelled 1-3 below (*second section*), bounded by a fold line and representing the portion of Branch 1 disposed on the rear of the rectangular box. See §IX.D.1.m ([1L]); Teng, Fig. 1 (annotated detail below), 23-24.





229. Branch 1-3 (*second section, purple-highlighted below*) physically and electrically connects to the GDC portion of Branch 1-1 (*first section, blue-highlighted below*) because it is part of the same contiguous conductive material that forms the Tran+Teng antenna element. See §IX.D.25.c ([31K]); Teng, Fig. 1 (annotated detail, below).



230. The '365 patent makes a single reference to “width” in referring to “conductor plates/parasitic plane reflectors of antennas” (EX1001, 9:58-64) but never explains what “width” refers to.

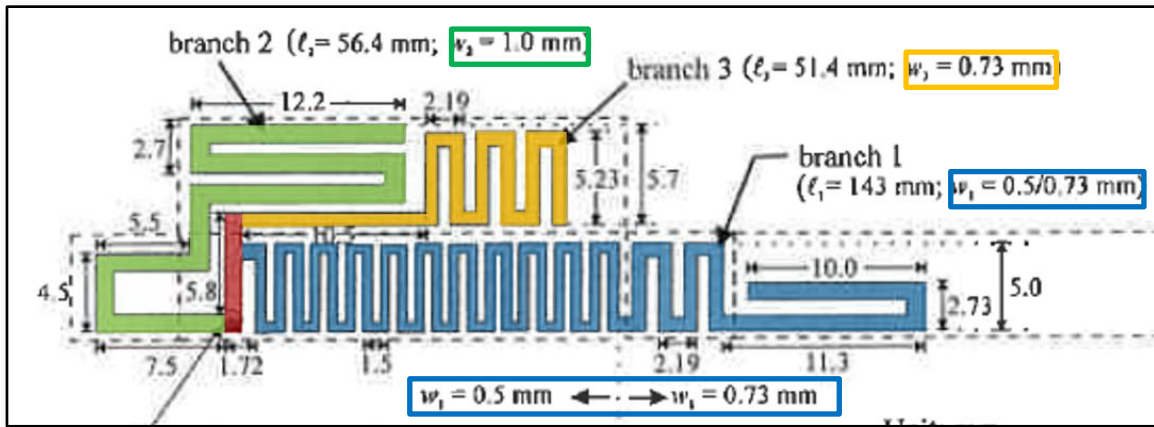
231. Table 1 below summarizes the GDC portion (*first section*) parameters—with width 0.5 mm, height 5.0 mm, and lateral extent 18.0 mm (nine repetitions of a 2.0 mm cell)—that **differ in every dimension** from Branch 1-3 (*second section*) parameters. See §IX.D.1.m ([1L]; where I discuss the dimensions of the GDC portion); Teng, Fig. 1.

Table 1

Section	trace width (mm)	height (mm)	lateral extent (mm)
GDC portion (blue above)	0.5	5.0	18.0
Branch 1-3 (purple above)	0.73	2.73	<11.3

232. Thus, based on the table above, **no matter which parameter** is deemed a “width” the GDC portion (*first section*) value **is different** from a Branch 1-3 (*second section*) value, and thus meets Limitation [31L].

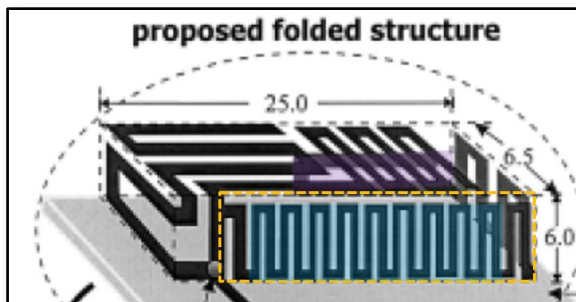
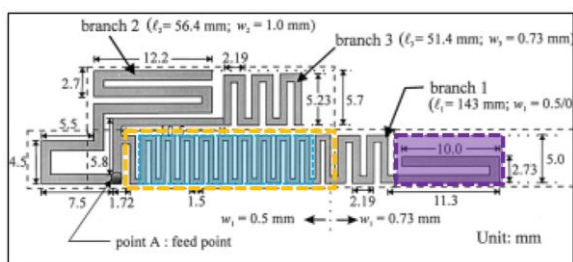
233. Regardless, when describing branches (as recited in Limitation [31L]) Teng uses the term “width” to mean the strip width (e.g., Teng’s w_1 , w_2 , w_3 annotated below) for each segment printed on the substrate to form the branch meandering patterns. Teng, Fig. 1 (annotated detail below), 23.



234. Given that the '365 patent does not redefine the term “width” to give it any other meaning, the term “width” as used in claim 31 should be given its plain meaning as used in the prior art, and therefore Teng’s explicit reference to a “strip **width**” meets the claimed *first radiating arm “width,”* and thus meets Limitation [31L], as demonstrated in the “trace width” column in Table 1 above.

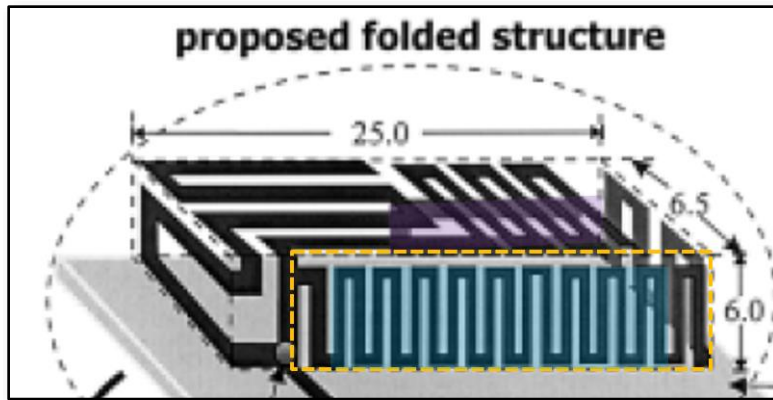
26. **Claim 32:** *The mobile communication device according to claim 31, wherein the first section is arranged on a first surface of said plurality of surfaces; and wherein the second section is arranged on a second surface of said plurality of surfaces, the second surface being different from the first surface.*

235. Tran+Teng’s *first section* (blue-highlighted below) is arranged on a *first surface* (the foreground surface of the rectangular box mounting structure) and the *second section* (purple) is arranged on a *second (different) surface* (the rear-facing surface of the rectangular dielectric mounting structure), as shown in Teng’s Figure 1 (annotated detail below), wherein the rectangular box encloses the dielectric as I explained above in §IX.D.12.a ([13A]).



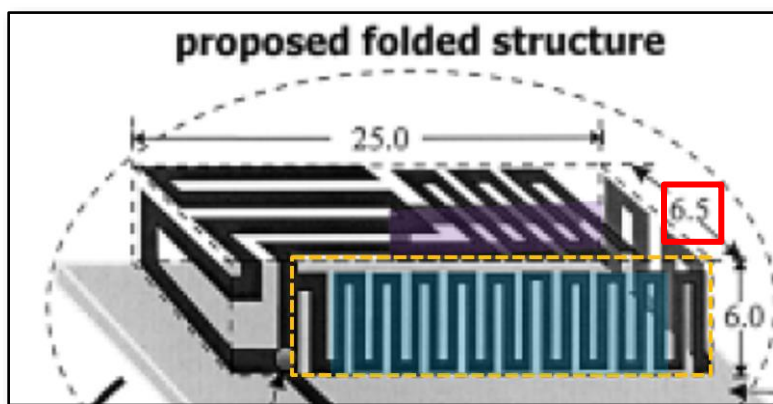
27. **Claim 33:** *The mobile communication device according to claim 32, wherein the first surface and the second surface are opposite surfaces of the dielectric mounting structure.*

236. As shown above in §IX.D.26 (claim 32), the GDC portion (*first section*, blue-highlighted below) is disposed on a *first surface* of Tran+Teng's rectangular box mounting structure and Branch 1-3 (*second section*; purple-highlighted below) is disposed on a *second surface* of Tran+Teng's rectangular box mounting structure, and as shown below from Teng Figure 1 (annotated detail below), those *first* and *second surfaces* are *opposite surfaces* of Tran+Teng's rectangular box. As I explained above in §IX.D.12.a ([13A]) and §IX.D.25.a ([31H]), Tran+Teng's rectangular box is disposed on a *dielectric mounting structure* and, in an obvious implementation of Tran+Teng, an additional foam core *dielectric mounting structure* would have been used for the reasons I discussed above with corroborating evidence (*see* §IX.D.12.a ([13A])).



28. **Claim 34:** *The mobile communication device according to claim 33, wherein the first surface and the second surface are substantially parallel surfaces spaced by a predetermined distance.*

237. As I discussed above in §IX.D.26 (claim 32), Tran+Teng's *first and second surfaces are substantially parallel* because they are opposing sides of a rectangular box, and are *spaced apart by a predetermined distance* (the 6.5 mm length rectangular dielectric mounting structure sides, as shown in Teng's Figure 1 (annotated detail below)).



29. **Claim 35: *The mobile communication device according to claim 31, wherein the first section extends along a first direction and the second section extends along a second direction, the second direction being different from the first direction.***

238. The '365 patent describes antenna sections as “extend[ing]” “from” or “towards” **a common reference point**, *i.e.*, the common conductor to which radiating arms are connected. EX1001, 3:1-10.

239. Claims 29-30 recite language—similar to claim 35—that the first radiating arm ***extends along a first direction***, the second radiating arm ***extends along a second direction*** and a section extends along a direction opposite to the first direction, and—like the specification—claims 29-30 identify a common conductor as a frame of reference for determining what direction an antenna section extends.

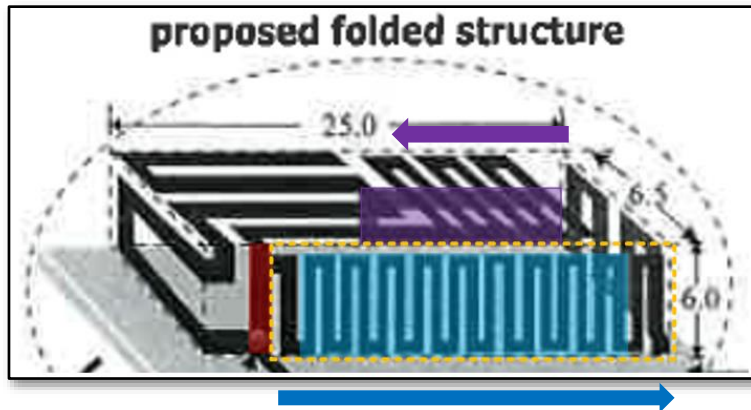
240. Claim 36 (discussed below §IX.D.30) depends from claim 35 and recites “*the second direction is substantially opposite to the first direction.*” So based on claim 35, the first and second directions must be “*different*” and based on claim 36, the first and second directions can be “*substantially opposite.*”

241. But neither claim 35 nor claim 36 identify any frame of reference to determine **which direction** an antenna segment extends—e.g., for two straight segments between points A and B, the '365 patent does not provide guidance as to whether each segment extends (1) from A to B; (2) from B to A; or (3) each in a

mutually opposite direction. Nothing in claims 35-36 determines which “*direction*” such a section can be considered to extend.

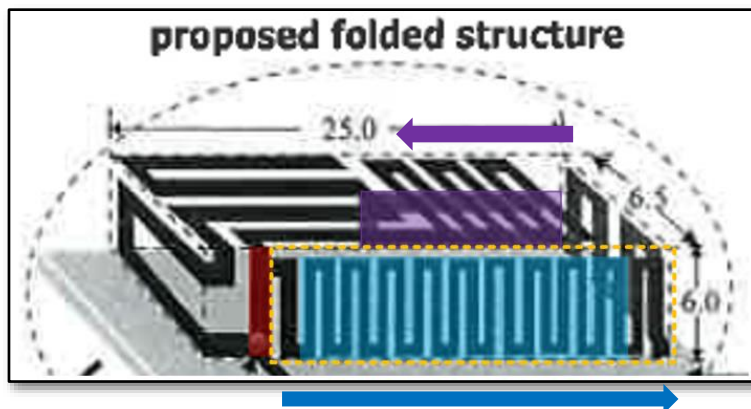
242. In view of the foregoing, a POSA would understand that it is appropriate in interpreting claim 35 (and claim 36 that depends therefrom) to choose a frame of reference for the antenna sections and then apply that frame of reference consistently to the first and second sections to determine whether they extend in “*different*” (claim 35) and “*opposite*” (claim 36) directions. In mapping claims 35-36 to Tran+Teng below, I have selected the common conductor to which the radiating arms are connected because that is the frame of reference described in the specification (EX1001, 3:1-10) and recited in other claims (claims 29-30).

243. The common conductor in Tran+Teng’s antenna is highlighted red in Teng Figure 1, which I have annotated below. In the folded monopole implementation of Tran+Teng’s antenna element, the *first section* (blue GDC portion below) *extends along a first direction* (indicated by the blue arrow) that is **away from** the common conductor (red) *and the second section* (purple) *extends along a second (different) direction* (indicated by the purple arrow) that is **towards** the common conductor, as shown in Teng’s Figure 1 (annotated below). That meets claim 35 because the *first and second directions are different*.



30. **Claim 36:** *The mobile communication device according to claim 35, wherein the second direction is substantially opposite to the first direction.*

244. Tran+Teng's *second direction* (purple arrow below) is *substantially opposite to the first direction* (blue arrow) when both are considered relative to the common conductor (red below), as shown in Teng's Figure 1 (which I have annotated below). *See also §IX.D.29 (above; claim 35; where I identify the first and second directions).*



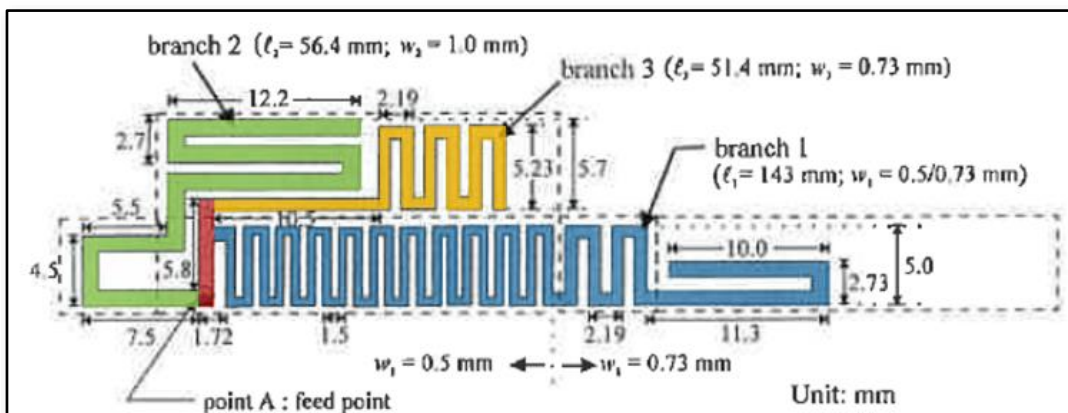
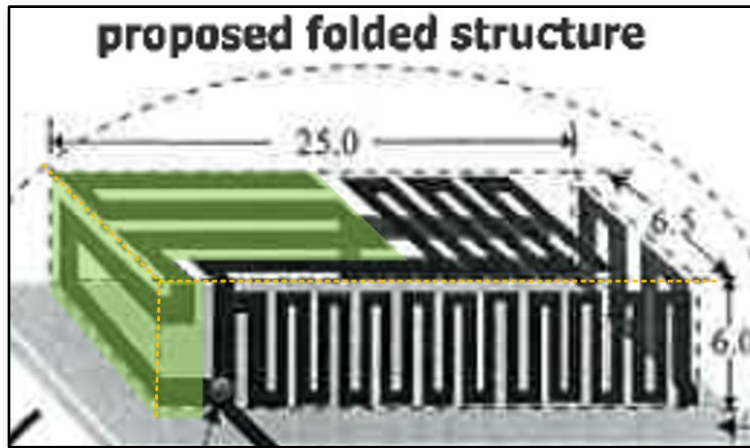
31. Claim 37

- a. **Limitation [37A]:** *The mobile communication device according to claim 31, wherein the antenna element further comprises: a common conductor; a second radiating arm; wherein each of the first radiating arm and the second radiating arm is connected to the common conductor; and:*

245. Claim 37 depends from claim 31. Tran+Teng meets claim 31 for the reasons I discussed above §IX.D.25. Tran+Teng meets the additional limitations in [37A] for the same reasons Tran+Teng meets Limitation [1I], as I discussed above §IX.D.1.j ([1I]). *See also* Teng, Fig. 1, p. 23.

- b. **Limitation [37B]:** *wherein the second radiating arm is arranged on at least one surface of the plurality of surfaces of the dielectric mounting structure.*

246. Tran+Teng's Branch 2 (*second radiating arm*; green below) is arranged on three (*at least one*) surface[s] of the plurality of surfaces of the dielectric mounting structure – the foreground face of the rectangular structure (next to the common conductor red), the left-hand side of the rectangular structure, and the top surface of the rectangular structure in Figure 1. *See also* §IX.D.12.b (above; [13B]; where I discuss one of the surfaces on which a portion of the *second radiating arm is arranged*); Teng, Fig. 1 (annotated detail below).

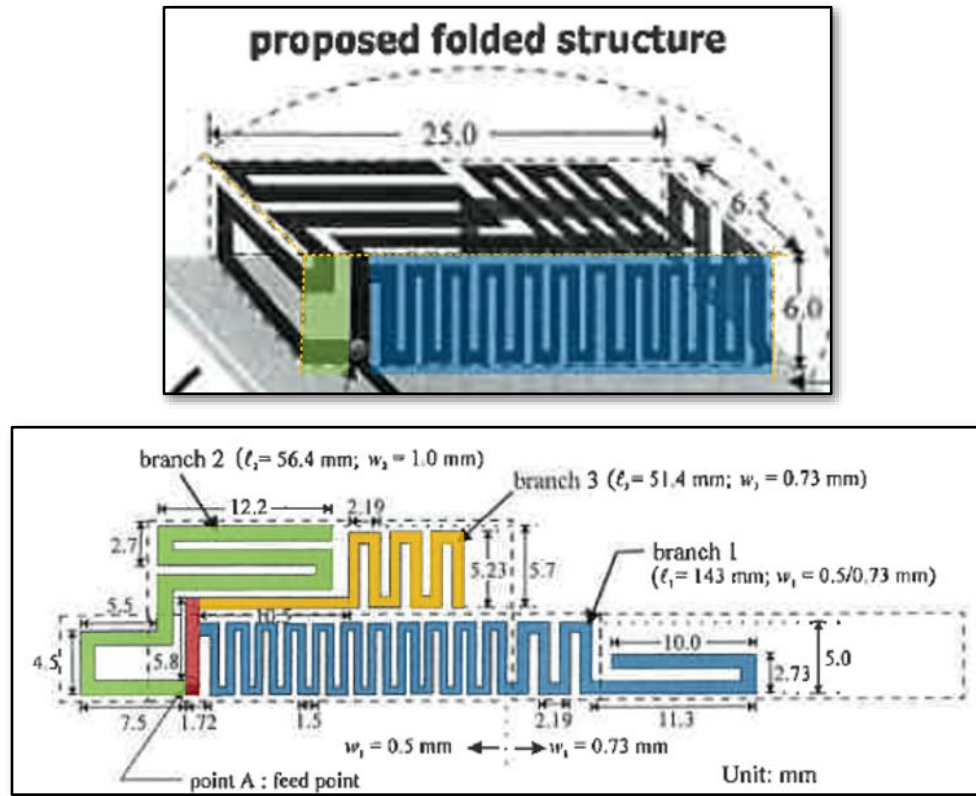


32. **Claim 38:** *The mobile communication device according to claim 37, wherein said at least one surface is one of the two or more surfaces on which the first radiating arm is arranged.*

247. Claim 38 depends from claim 37 and recites “wherein said at least one surface is one of the two or more surfaces on which the first radiating arm is arranged,” where claim 37’s “at least one surface” (on which the second radiating arm is arranged) (Limitation [37B]) is the antecedent for “said at least one surface.”

248. Tran+Teng meets claim 38 because Branch 2 (*second radiating arm*; green below) is disposed on the foreground face of the rectangular box enclosing

the dielectric mounting structure, where a portion of Branch 1 (*first radiating arm*; blue below) is also “*arranged*.” See also §IX.D.31 (above; claim 37; where I discuss the “*at least one surface*” limitation); Teng, Fig. 1 (annotated detail below).

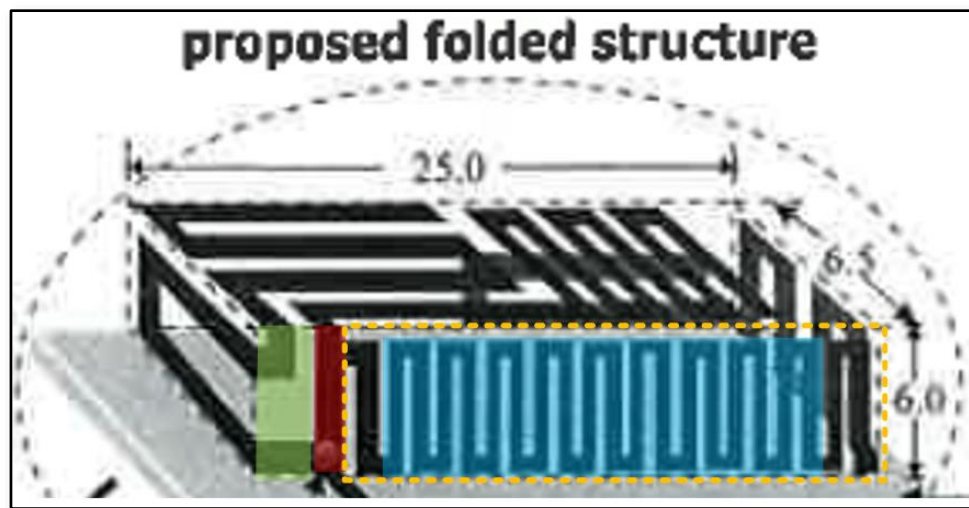


33. Claim 39: *The mobile communication device according to claim 38, wherein the first section of the first radiating arm is arranged on said at least one surface, so that said first section and the second radiating arm are on a common surface of the plurality of surfaces of the dielectric mounting structure.*

249. Claim 39 depends from claim 38 and recites “wherein the first section of the first radiating arm is arranged on said at least one surface, so that said first section and the second radiating arm are on a common surface of the plurality of surfaces of the dielectric mounting structure.”

250. The *first section* of Tran+Teng’s *first radiating arm* is Branch 1’s GDC portion (blue below), as I discussed above §IX.D.25 (claim 31).

Tran+Teng’s Branch 2 (green below) is the *second radiating arm*, as I discussed above §IX.D.32 (claim 38). As shown in Teng’s Figure 1 (annotated detail below), both the *first and second radiating arms* are “arranged” on the same (*common*) foreground *surface of the plurality of surfaces of the rectangular dielectric mounting structure*.



34. **Claim 40:** *The mobile communication device according to claim 37, wherein the second radiating arm has a uniform width.*

251. Claim 40 depends from claim 37 and recites “*wherein the second radiating arm has a uniform width.*” Tran+Teng’s Branch 2 (*second radiating arm*) has a uniform “strip **width**” of 1.0 mm, as shown in Teng’s Figure 1. See also Teng, 23-24; §IX.D.25.d (above; [31L], discussing a “width” limitation).

35. Claims 41-42:

Claim 41: *The mobile communication device according to claim 31, wherein an orthogonal projection of a footprint of the antenna element on a plane of the printed circuit board overlaps the ground plane layer in less than 50% of an area of said footprint.*

Claim 42: *The mobile communication device according to claim 37, wherein the second radiating arm comprises a plurality of segments.*

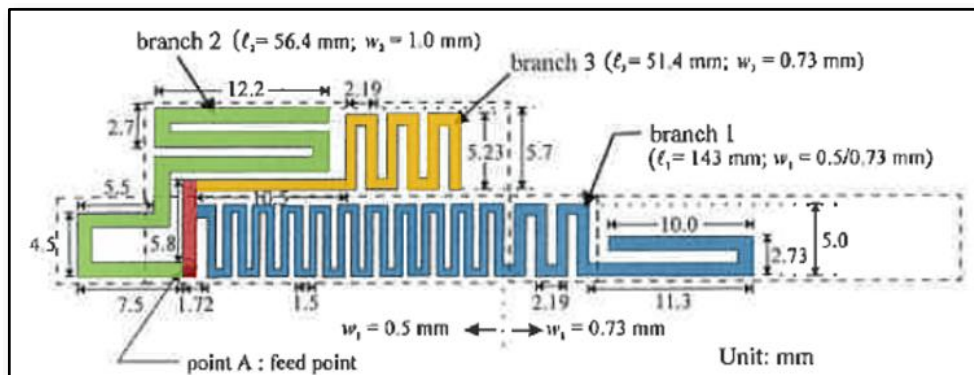
252. Tran+Teng meets the additional limitations in claims 41-42 for the reasons it meets the corresponding limitations below. EX1034 is a chart that compares the claim language for the limitations listed below, which supports my opinion regarding the corresponding limitations and discussions identified in the table below. See EX1034, 9.

Limitation	Corresponding limitation	Discussed in the above section(s)
41	12	§IX.D.11
42	[5A]	§IX.D.5.a

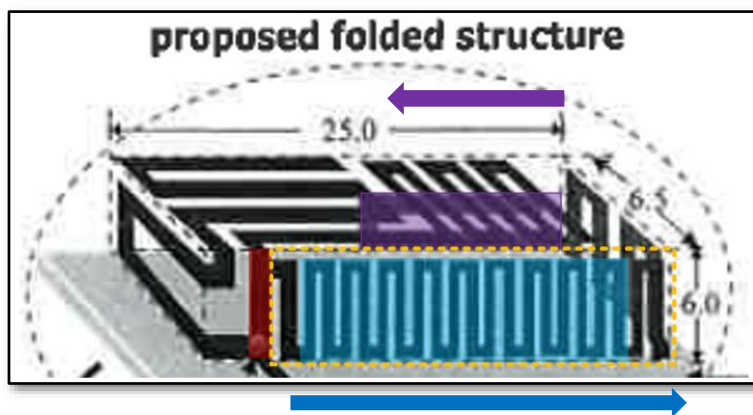
36. Claim 44: *The mobile communication device according to claim 37, wherein the first section of the first radiating arm is connected to the common conductor and extends away from the common conductor along a first direction; wherein the second section of the first radiating arm is connected to the first section and extends along a second direction; and wherein the second radiating arm extends away from the common conductor along a direction substantially opposite to the second direction*

253. Tran+Teng's first radiating arm (blue-highlighted below) and second radiating arm (green-highlighted below) are connected to the common conductor

(red-highlighted below). See §IX.D.31.a ([37A]); §IX.D.1.j ([1I]); Teng, Fig. 1 (annotated detail below).

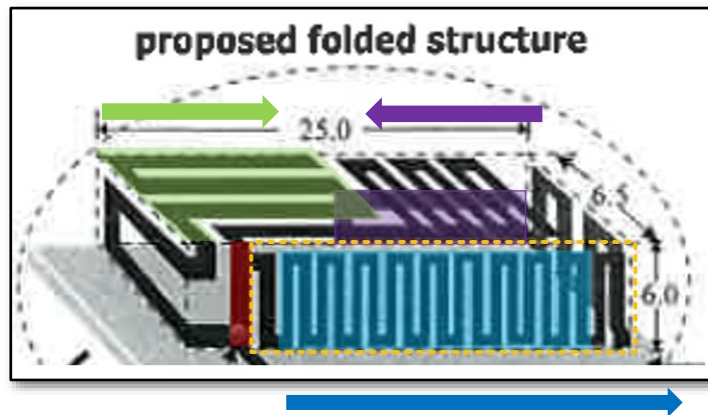


254. As I explained above in §IX.D.29 (claim 35), the first section of the first radiating arm (blue below) extends along the direction indicated by the blue arrow, which is away from the common conductor along a first direction and the second section of the first radiating arm (purple below) extends along a second direction indicated by the purple arrow.



255. As also shown below, the *second section* (purple) is *connected to the first section* (blue) because they are both part of the same conducting strip that comprises Tran+Teng's Branch 1 (*first radiating arm*), and the portion of

Tran+Teng's Branch 2 (*second radiating arm*) highlighted green below extends away from the common conductor along a direction indicated by the green arrow, which is substantially opposite to the second direction (purple arrow). Thus, Tran+Teng meets claim 44.



37. **Claim 45:** *The mobile communication device according to claim 31, wherein the mobile communication device operates as one of a personal digital assistant and a cellular telephone.*

256. As I discussed above in §IX.C (where I discuss the Tran+Teng combination), and §IX.D.1.a (where I discuss how Tran+Teng meets a *mobile communication device*), Tran+Teng's device operates as a "mobile cellular ... phone[]." Tran, 1:23-28; *see also* Teng, 22-23. By the early 2000s, it was also conventional and beneficial to have one device that operated both as a cellular telephone and personal digital assistant, to offer PDA functionality (e.g., email and calendar applications) along with voice calls. My opinion in this regard is corroborated by Tran, which discloses that its antenna (which is larger than Teng's antenna used in Tran+Teng, as I discussed above §IX.C) can be incorporated into

alternative “wireless device[s],” like “a portable computer, data terminal, ... or the like.” A POSA would have understood that a Personal Digital Assistant (PDA) is “like” a portable computer, in that it provides additional computer-like functionality. My opinion in this regard is further corroborated by EX1033, which discloses as background information that “[a] **PDA is a computer**” and that “[t]he PDA may be **combined with a wireless telephone**,” which was beneficial because “[i]t is more convenient for the user to have a single device on his belt, rather than having two.” EX1033, 1:14-31.

X. DECLARATION

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

I declare under penalty of perjury that the foregoing is true and correct.

Date: 2025-04-29 By: DM Pozar 4/29/2025
David Pozar, Ph.D.

APPENDIX A: MATERIALS CONSIDERED

Exhibit	Description
1001	U.S. Patent No. 8,456,365
1002	Prosecution History of U.S. Patent No. 8,456,365
1005	U.S. Patent No. 6,184,833 (“Tran”)
1006	Teng, P. L., & Wong, K. L., “Planar monopole folded into a compact structure for very-low-profile multiband mobile-phone antenna.” <i>Microwave and Optical Technology Letters</i> , vol. 33, no. 1, 2002, pp. 22-25 (“Teng”)
1007	Plaintiff’s Disclosure of Asserted Claims and Infringement Contentions Against Geotab Pursuant to Local Patent Rules 3-1 and 3-2, in <i>Fractus, S.A. v. Geotab Inc.</i> , No. 2:24-cv-01008 (E.D. Tex.), served March 12, 2025
1008	D.I. 75, Fractus’s Opening Claim Construction Brief, <i>Fractus, S.A. v. ADT LLC</i> , No. 2:22-cv-00412 (E.D. Tex. Nov. 16, 2023)
1009	D.I. 75-1, Exhibit 1 to D.I. 75, Fractus’s Opening Claim Construction Brief, <i>Fractus, S.A. v. ADT LLC</i> , No. 2:22-cv-00412 (E.D. Tex. Nov. 16, 2023)
1010	D.I. 92, Joint Claim Construction Chart, <i>Fractus, S.A. v. ADT LLC</i> , No. 2:22-cv-00412 (E.D. Tex. Jan. 4, 2024)
1011	D.I. 115, Claim Construction Order, <i>Fractus, S.A. v. ADT LLC</i> , No. 2:22-cv-00412 (E.D. Tex. Feb. 25, 2024) (Payne, M.J.)
1012	D.I. 127, Order, <i>Fractus, S.A. v. ADT LLC</i> , No. 2:22-cv-00412 (E.D. Tex. Mar. 15, 2024) (Gilstrap, D.J.)
1013	D.I. 82, Defendants ADT LLC and Vivint, Inc.’s Responsive Claim Construction Brief, <i>Fractus, S.A. v. ADT LLC</i> , No. 2:22-cv-00412 (E.D. Tex. Dec. 14, 2023)
1014	U.S. Patent Application Publication No. 2004/0135729 A1 (“Talvitie”)
1015	U.S. Patent Application Publication No. 2004/0052272 A1 (“Frank”)
1016	U.S. Patent No. 6,008,774 (“Wu”)
1017	U.S. Patent No. 6,005,519 (“Burns”)
1018	U.S. Patent Application Publication No. 2002/0011953 A1 (“Reece”)
1019	U.S. Patent No. 6,956,530 B2 (“Kadambi”)
1020	U.S. Patent No. 6,665,927 B1 (“Dow”)
1021	International PCT Publication No. WO 02/087294 A1 (“Chua”)
1022	U.S. Patent Application Publication No. 2003/0156065 A1 (“Jo”)
1023	U.S. Patent No. 6,218,989 (“Schneider”)
1024	U.S. Patent No. 7,245,196 (“Baliarda”)

Exhibit	Description
1025	U.S. Patent No. 5,596,401 (“Kusuzawa”)
1026	U.S. Patent Application Publication No. 2003/0092420 A1 (“Sugimoto”)
1027	U.S. Patent Application Publication No. 2002/0158806 A1 (“Caimi”)
1028	U.S. Patent Application Publication No. 2004/0051672 A1 (“Nevermann”)
1029	U.S. Patent No. 6,459,413 B1 (“Tseng”)
1030	U.S. Patent Application Publication No. 2003/0006936 A1 (“Aoyama”)
1031	Pey-Ling Teng et al., “PIFA with a Bent, Meandered Radiating Arm for GSM/DCS Dual-Band Operation.” <i>IEEE Antennas and Propagation Society International Symposium. Digest. Held in conjunction with: USNC/CNC/URSI North American Radio Sci. Meeting (Cat. No.03CH37450)</i> , Columbus, OH, USA, vol. 3, 2003, pp. 107-110, doi: 10.1109/APS.2003.1219801.
1032	Chiu, C., Teng, P., & Wong, K., “Shorted, folded planar monopole antenna for dual-band mobile phone.” <i>Electronics Letters</i> , vol. 39, no. 18, 2003, pp. 1301-1302.
1033	U.S. Patent No. 6,233,464 B1 (“Chmaytelli”)
1034	U.S. Patent No. 8,456,365 Claim Limitation Comparison Chart
1035	U.S. Patent Application Publication No. 2004/0150561 A1 (“Tillery”)
1038	Pages from R. Graf, <i>Modern Dictionary of Electronics</i> (Newnes: 7th ed. 1999)
1039	Pages from S. Gilbilisco, ed., <i>The Illustrated Dictionary of Electronics</i> (McGraw-Hill: 8th ed. 2001)
1040	Pages from Pozar, <i>Microwave Engineering</i> (3rd ed. 2005)
1041	U.S. Patent Application Publication No. 2001/0011964 (“Sadler”)
1042	U.S. Patent Application Publication No. 2003/0124982 A1 (“Saari”)

APPENDIX B: U.S. PATENT NO. 8,456,365 CLAIM LIST

Ref	Limitation
[1PRE]	A mobile communication device, comprising:
[1A]	a device housing;
[1B]	a printed circuit board,
[1C]	the printed circuit board comprising: a ground plane layer;
[1D]	a feeding point;
[1E]	a communication circuitry, the communication circuitry being mounted on the printed circuit board;
[1F]	wherein the communication circuitry is coupled to the feeding point and to the ground plane layer;
[1G]	a multi-band antenna capable of operating at multiple frequency bands, the multi-band antenna including an antenna element;
[1H]	wherein the antenna element operates in cooperation with the ground plane layer;
[1I]	the antenna element comprising: a common conductor; a first radiating arm connected to the common conductor; a second radiating arm connected to the common conductor;
[1J]	wherein the common conductor includes a feeding port, the feeding port being coupled to the feeding point;
[1K]	wherein at least a portion of the first radiating arm and at least a portion of the second radiating arm are arranged on different planes;
[1L]	wherein the first radiating arm is at least partially shaped according to a grid-dimension curve; and
[1M]	wherein the printed circuit board, the communication circuitry, and the multi-band antenna are arranged inside the device housing.
[2A]	The mobile communication device according to claim 1, wherein the first radiating arm comprises a first plurality of segments;
[2B]	wherein each segment of the first plurality of segments is smaller than 1/10 of a lowest operating free-space wavelength of the multi-band antenna;

[2C]	wherein the segments are spatially arranged such that each pair of adjacent segments forms a corner; and
[2D]	wherein no two adjacent and connected segments form another longer straight segment; and
[2E]	wherein none of said segments intersect with another segment other than to form a closed loop.
3	The mobile communication device according to claim 2, wherein the first plurality of segments comprises at least one curved segment.
4	The mobile communication device according to claim 2, wherein the first plurality of segments comprises at least ten segments.
[5A]	The mobile communication device according to claim 2, wherein the second radiating arm comprises a second plurality of segments;
[5B]	wherein each segment of the second plurality of segments is smaller than 1/10 of a lowest operating free-space wavelength of the multi-band antenna;
[5C]	wherein the segments are spatially arranged such that each pair of adjacent segments forms a corner; and
[5D]	wherein no two adjacent and connected segments form another longer straight segment; and
[5E]	wherein none of said segments intersect with another segment other than to form a closed loop.
6	The mobile communication device according to claim 5, wherein the first plurality of segments comprises more segments than the second plurality of segments.
7	The mobile communication device according to claim 1, wherein the grid-dimension curve has a grid dimension larger than 1.3.
8	The mobile communication device according to claim 1, wherein the grid-dimension curve has a grid dimension larger than 1.5.
9	The mobile communication device according to claim 1, wherein the second radiating arm is at least partially shaped according to a second grid-dimension curve.
10	The mobile communication device according to claim 9, wherein the grid-dimension curve and the second grid-dimension curve have different lengths.

11	The mobile communication device according to claim 9, wherein the grid-dimension curve and the second grid-dimension curve have different grid dimensions.
12	The mobile communication device according to claim 1, wherein an orthogonal projection of a footprint of the antenna element on a plane of the printed circuit board overlaps the ground plane layer in less than 50% of an area of said footprint.
[13A]	The mobile communication device according to claim 1, comprising: a dielectric mounting structure having a plurality of surfaces;
[13B]	wherein at least a portion of the first radiating arm is arranged on a first surface of said plurality of surfaces; and wherein at least a portion of the second radiating arm is arranged on a second surface of said plurality of surfaces, the second surface being different from the first surface.
14	The mobile communication device according to claim 13, wherein the first surface and the second surface are opposite surfaces of the dielectric mounting structure.
[15PRE]	A mobile communication device, comprising:
[15A]	a device housing;
[15B]	a printed circuit board,
[15C]	the printed circuit board comprising: a ground plane layer;
[15D]	a feeding point;
[15E]	a communication circuitry, the communication circuitry being mounted on the printed circuit board;
[15F]	wherein the communication circuitry is coupled to the feeding point and to the ground plane layer;
[15G]	a multi-band antenna capable of operating at multiple frequency bands, the multi-band antenna including an antenna element;
[15H]	wherein the antenna element is coupled to the feeding point and operates in cooperation with the ground plane layer;
[15I]	the antenna element comprising: a first conductor, the first conductor comprising a first radiating arm having a grid-dimension section shaped according to a grid-dimension curve;

[15J]	a second conductor arranged at a predetermined distance from the first conductor and electromagnetically coupled to the first conductor,
[15K]	the second conductor comprising a planar section; and
[15L]	wherein the printed circuit board, the communication circuitry, and the multi-band antenna are arranged inside the device housing.
16	The mobile communication device according to claim 15, wherein the first conductor and the second conductor are electrically connected.
17	The mobile communication device according to claim 16, wherein the antenna element comprises a connecting portion that connects the first radiating arm and the planar section.
18	The mobile communication device according to claim 17, wherein a width of the grid-dimension section is smaller than a width of the planar section.
19	The mobile communication device according to claim 15, wherein the grid-dimension curve features a grid dimension larger than 1.3.
[20A]	The mobile communication device according to claim 15, wherein the grid-dimension curve comprises at least ten connected segments;
[20B]	wherein said segments are each smaller than 1/10 of a lowest operating free-space wavelength of the multi-band antenna;
[20C]	wherein the segments are spatially arranged such that no two adjacent and connected segments form another longer straight segment;
[20D]	wherein none of said segments intersect with another segment other than to form a closed loop;
[20E]	wherein each pair of adjacent segments forms a corner; and
[20F]	wherein any portion of the grid-dimension curve that is periodic along a fixed straight direction of space is defined by a non-periodic curve that includes at least ten connected segments in which no two adjacent and connected segments define a straight longer segment.

21	The mobile communication device according to claim 15, wherein the multi-band antenna comprises: a dielectric mounting structure having a plurality of surfaces; wherein at least a portion of the first radiating arm is arranged on a first surface of said plurality of surfaces; and wherein at least a portion of the second conductor is arranged on a second surface of said plurality of surfaces, the second surface being different from the first surface.
22	The mobile communication device according to claim 21, wherein the grid-dimension section is arranged on the first surface; and wherein the planar section is arranged on the second surface.
23	The mobile communication device according to claim 21, wherein the first surface and the second surface are two opposite surfaces of the dielectric mounting structure.
24	The mobile communication device according to claim 21, wherein the first surface and the second surface are substantially parallel.
25	The mobile communication device according to claim 15, wherein the antenna element further comprises: a common conductor; a second radiating arm connected to the common conductor; and wherein the first radiating arm is connected to the common conductor.
26	The mobile communication device according to claim 25, wherein the second radiating arm comprises a substantially straight section.
27	The mobile communication device according to claim 25, wherein the second radiating arm comprises a second grid-dimension section, the second grid-dimension section being shaped according to a second grid-dimension curve.
28	The mobile communication device according to claim 25, wherein the second radiating arm and the grid-dimension section of the first radiating arm lie on a common surface.
29	The mobile communication device according to claim 25, wherein the grid-dimension section of the first radiating arm extends away from the common conductor along a first direction; and wherein the second radiating arm extends away from the common conductor along a second direction, the second direction being substantially parallel to the first direction.

[30A]	The mobile communication device according to claim 29, wherein the antenna element comprises a connecting portion that connects the grid-dimension section and the planar section; and
[30B]	wherein the planar section extends away from the connection portion along a direction substantially opposite to the first direction.
[31PRE]	A mobile communication device, comprising:
[31A]	a device housing;
[31B]	a printed circuit board,
[31C]	the printed circuit board comprising: a ground plane layer;
[31D]	a feeding point;
[31E]	a communication circuitry, the communication circuitry being mounted on the printed circuit board;
[31F]	wherein the communication circuitry is coupled to the feeding point and to the ground plane layer;
[31G]	a multi-band antenna capable of operating at multiple frequency bands, the multi-band antenna including:
[31H]	a dielectric mounting structure having a plurality of surfaces;
[31I]	an antenna element, the antenna element being coupled to the feeding point and operating in cooperation with the ground plane layer;
[31J]	wherein the antenna element comprises a first radiating arm arranged on two or more surfaces of the plurality of surfaces of the dielectric mounting structure;
[31K]	the first radiating arm comprising: a first section shaped according to a grid-dimension curve;
[31L]	a second section connected to the grid-dimension section, the second section having a width different from a width of the first section; and
[31M]	wherein the printed circuit board, the communication circuitry, and the multi-band antenna are arranged inside the device housing.
32	The mobile communication device according to claim 31, wherein the first section is arranged on a first surface of said plurality of surfaces; and wherein the second section is arranged on a second surface of said plurality of surfaces, the second surface being different from the first surface.

33	The mobile communication device according to claim 32, wherein the first surface and the second surface are opposite surfaces of the dielectric mounting structure.
34	The mobile communication device according to claim 33, wherein the first surface and the second surface are substantially parallel surfaces spaced by a predetermined distance.
35	The mobile communication device according to claim 31, wherein the first section extends along a first direction and the second section extends along a second direction, the second direction being different from the first direction.
36	The mobile communication device according to claim 35, wherein the second direction is substantially opposite to the first direction.
[37A]	The mobile communication device according to claim 31, wherein the antenna element further comprises: a common conductor; a second radiating arm; wherein each of the first radiating arm and the second radiating arm is connected to the common conductor; and
[37B]	wherein the second radiating arm is arranged on at least one surface of the plurality of surfaces of the dielectric mounting structure.
38	The mobile communication device according to claim 37, wherein said at least one surface is one of the two or more surfaces on which the first radiating arm is arranged.
39	The mobile communication device according to claim 38, wherein the first section of the first radiating arm is arranged on said at least one surface, so that said first section and the second radiating arm are on a common surface of the plurality of surfaces of the dielectric mounting structure.
40	The mobile communication device according to claim 37, wherein the second radiating arm has a uniform width.
41	The mobile communication device according to claim 31, wherein an orthogonal projection of a footprint of the antenna element on a plane of the printed circuit board overlaps the ground plane layer in less than 50% of an area of said footprint.
42	The mobile communication device according to claim 37, wherein the second radiating arm comprises a plurality of segments.

43	The mobile communication device according to claim 37, wherein the second radiating arm is shaped according to a second grid-dimension curve.
44	The mobile communication device according to claim 37, wherein the first section of the first radiating arm is connected to the common conductor and extends away from the common conductor along a first direction; wherein the second section of the first radiating arm is connected to the first section and extends along a second direction; and wherein the second radiating arm extends away from the common conductor along a direction substantially opposite to the second direction.
45	The mobile communication device according to claim 31, wherein the mobile communication device operates as one of a personal digital assistant and a cellular telephone.