

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AFFORDABLE WIRE MANAGEMENT, LLC,
Petitioner,

v.

CAMBRIA COUNTY ASSOCIATION FOR THE BLIND AND
HANDICAPPED, INC.,
Patent Owner.

IPR2024-00139
Patent 10,177,551 B1

DECLARATION OF OMID BEIK, Ph.D.

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1. I, Omid Beik, Ph.D., declare as follows:

I. Introduction

2. I, Omid Beik, Ph.D., have been retained by Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C. on behalf of Petitioner Affordable Wire Management, LLC (“AWM” or “Petitioner”) as an independent expert to opine on the patentability of U.S. Patent No. 10,177,551 (the “’551 patent”).

3. I understand that Petitioners seek a determination that claims 1-19 of the ’551 patent are unpatentable, and this Declaration is being filed in support of the invalidation of those claims.

4. If called to testify as an expert witness, I expect to provide testimony regarding, among other things, the level of skill, education and experience of a person skilled in the fields solar electric power systems technologies during the relevant time for this case.

5. I reserve the right to supplement this Declaration if additional information that affects my opinions becomes available. It may be necessary for me to revise or supplement this Declaration, or submit a supplemental or responsive Declaration, based on any response by Patent Owner.

6. I receive \$225 per hour for my services. My compensation is not contingent upon the particular opinions that I provide, and I have no financial interest

in the outcome of this matter. I have no ownership or beneficial interest in any of the parties to this case.

7. I reserve the right to supplement this Declaration if additional information that affects my opinions becomes available. It may be necessary for me to revise or supplement this Declaration, or submit a supplemental or responsive Declaration, based on any response by Patent Owner.

II. Experience and Qualifications

8. I am currently an Assistant Professor (tenure-track) in the Department of Electrical Engineering at Colorado School of Mines (“CSM”), Golden, CO, a position that I have held since August 2023. I have a research laboratory, ePower Hubs (<https://www.epowerhubs.com/>), where my team of graduate students and I work on different aspects of electrical power grids, renewable energy systems, and electrification.

9. Prior to joining CSM, I started my academic in the Department of Electrical and Computer Engineering at North Dakota State University (NDSU), Fargo, ND, where I was a tenure-track Assistant Professor from October, 2021 to July, 2023.

10. During my academic career, my research has been supported by: (i) a startup grant from CSM, (ii) a startup grant from North Dakota State University (“NDSU”), (iii) research grants where I have been principal investigator on three

National Aeronautics and Space Administration (“NASA”) research grants under Established Program to Stimulate Competitive Research (“EPSCoR”), (iv) an NDSU foundation grant, (v) and an industry collaborative project that I secured with CorVent Inc., Fargo, ND.

11. Prior to joining academia, I spent a number of years in the industry in Canada. From 2020 to 2021, I was a Senior Manager with Forte (Everwin) Mobility Co. Ltd. in Aurora, Ontario, Canada, where I led the research and development of an electric powertrain for an electric van.

12. In 2019, I founded Enercs Inc., an early-stage technology startup in Toronto, Canada that specialized in research and development of state-of-the-art technologies in power electronics, electric machines, and drives for applications in renewable energy systems and electrification.

13. From 2018 to 2019, I was a Lead R&D Engineer with Mirus International Inc. in Brampton, Ontario, Canada, where I developed an active power filter for reducing harmonics in the distribution grid. From 2017 to 2018, I was a Senior Engineer with Magna Powertrain Inc. in Concord, Ontario, Canada, where I designed electrified products for automotive applications.

14. Prior to my industry experience, from 2016 to 2017, I was Postdoctoral Research Fellow at McMaster University in Hamilton, Ontario, Canada, where I

worked on a collaborative project with Safran Electronics & Defense on developing a mini digital core module (“MDCM”) for aerospace applications.

15. I received my Ph.D. degree in Electrical and Computer Engineering from McMaster University in 2016. My Ph.D. focused on research and development of renewable energy systems and their integration to the electric power grid. From 2011 to 2012, I was also a Postgraduate Researcher at the University of Manchester, in the UK, where I worked on research and development of hybrid and electric vehicles powertrains.

16. In 2009, I received a Master of Science from Department of Electrical Engineering, Shahid Beheshti University, Abbaspour School of Engineering, in Tehran, Iran. My master thesis was on stability analyses of electric power grids. In 2007, I received a Bachelor of Science from Department of Electrical and Electronics Engineering, Yazd University, in Yazd, Iran. My undergraduate research project was on electric drives for AC permanent magnet motors.

17. I authored and co-authored several books which are listed below:

- *DC Wind Generation Systems, Design, Analysis, and Multiphase Turbine Technology*, Springer, 2020.
- *Wind and Solar Power Systems: Design, Analysis, and Operation*, CRC Press, 2021.
- *Multiphase Hybrid Electric Machines: Applications for Electrified Powertrains*, Springer, 2021.
- *Spacecraft Power Systems*, CRC Press, 2024.

18. I have authored and co-authored a portfolio of peer-reviewed journal & conference papers. For a complete list my publications see my google scholar page (<https://scholar.google.com/citations?user=xcPNRoQAAAAJ&hl=en>).

19. I am Senior Member of Institute of Electrical and Electronics Engineers (“IEEE”), and have served as an Editor for IEEE Transactions on Energy Conversion and IEEE Power Engineering Letters, and Associate Editor for IEEE Transactions on Transportation Electrification and IEEE Electrification eNewsletter. I have also served in various roles in the organizing committee of IEEE/International conferences.

20. A copy of my curriculum vitae is provided as **Appendix A**.

III. Materials Considered

21. My opinions are based on my education, training, background and experience, the documents I reviewed, and information available to me to date. I have considered the materials cited herein and the exhibits listed in Appendix B. To the extent I am provided with additional documents or information in this proceeding, I reserve the right to modify or expand upon my opinions based on such new information, and in response to any additional reports and testimony.

IV. Legal Standard

22. In preparing this declaration, certain patent law concepts have been explained to me, including the legal standard for interpreting claims, as well as those for assessing written description, enablement, and obviousness.

23. I have been informed by counsel that the Patent Trial and Appeal Board (“PTAB”) applies the same claim construction standard used in district courts, where the claims are given their ordinary meaning as understood by one skilled in the art at the time of effective filing date, informed by the claim language itself, the specification, and the prosecution history. I also understand that “extrinsic evidence”—i.e., evidence other than the patent and prosecution history—can be relevant in determining how a skilled artisan would understand terms of art used in the claims. I have been informed, however, that extrinsic evidence may not be used to contradict the meaning of the claims as described in the intrinsic evidence—i.e., evidence in the claim language itself, the specification, and the prosecution history.

24. I have been informed by counsel that a patent specification must enable a person of ordinary skill in the art to make and use the full scope of the claimed invention without undue experimentation as of its effective filing date.

25. I have been informed by counsel that, in addition to being required to be enabled, a claim in a granted patent must also be sufficiently supported by the disclosure in the patent’s specification, read in the context of what one of skill in the art would have known at the time of the effective filing date. I understand that the basic inquiry for written description is whether the specification provides sufficient information for a skilled artisan to recognize that the named inventors possessed the full scope of the claimed invention.

26. I have further been informed by counsel that a claim is obvious if the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art (“POSA” or “POSITA”). I have been informed that whether the differences between the claimed invention and the prior art are obvious depends on factors including the scope and content of the prior art, the level of ordinary skill in the art, the differences between the claimed invention and the prior art, and secondary considerations of nonobviousness.

27. I also understand that whether a patent claim is obvious is determined from the perspective of a POSITA. I further understand that a claimed invention is obvious if a POSITA, before the effective filing date, would have been motivated to select, combine, or modify the relevant prior art elements during the normal course of research and development to yield the claimed invention with a reasonable expectation of success. I was also informed that when a claim recites a range, if prior art discloses a portion of the claimed range, the entire claimed range is obvious.

V. Summary of My Opinions

28. Claims 1-19 of the ’551 Patent recite a grounding system for grounding cables that are supported with a cable support system, comprised of (1) a multi-function line, (2) mounting assemblies, (3) and spaced piles, each made from conductive materials.

29. Claims 1-19 of the '551 Patent are invalid in view of grounds 1-5 below.

VI. The '551 Patent

30. It is my understanding that the '551 patent was filed as U.S. Patent Application No. 15/725,668 (the "'668 application") on October 5, 2017, and does not claim priority to any earlier-filed applications.

31. I understand that the '551 patent relates to "[a] grounding system, structured to ground a number of cables supported by a support assembly." (EX1001, Abstract).

VII. Person of Ordinary Skill in the Art

32. As discussed above, the subject matter of the '551 Patent is directed to grounding systems for suspending cable assemblies. Based on my understanding of the technology, education, and experience level of those working in this field, it is my opinion that a POSITA working in the field of the '551 Patent at the relevant time would have had a bachelor's degree in a pertinent discipline, such as electrical engineering, civil engineering, mechanical engineering or equivalent with 2-3 years of experience in electrical power systems, planning, and design, with the understanding that the number of years of experience could be higher or lower given the level of education and vice versa.

VIII. State of the Art

33. I have reviewed the '551 Patent in detail. It generally concerns a grounding system for a suspended cable assembly, in particular a grounding assembly comprising conductive elements to replace the need to splice grounding cables into a conductor wire, which as demonstrated by my experience above, I have particular expertise in. The evolution of this field up to the time of the alleged invention in October 2017¹ involved advancements in different aspects of grounding systems. The grounding in electrical distribution systems date back to 1900 when the steel poles used in multi-grounded concepts were grounded to conductive pipes. EX1008, 2. Grounding systems have been improved over the following decades in terms of design, material, and methods of connecting ground conductors to the earth. While different conductive materials have been used for grounding, the most common conductor is copper, either bare or insulated with polyvinylchloride (PVC) or high molecular weight polyethylene (HMWPE). In some applications messenger or support wires may be used as the ground wire. Additionally, the support structures, brackets, hangers, and poles may be used as grounding media. Varying designs and architectures have been used to reduce the resistance of the path of the ground current while considering other factors such as safety and mechanical strength.

¹ Patent holder's claimed priority date is October 5, 2017.

34. Some of the further advancements in grounding systems include:

- Smart Grounding Systems: Which generally refers to use of smart devices and sensors to monitor, and control the grounding of different equipment, systems, and grids. These systems usually operate based on reporting real-time data for the ground resistance, impedance, and other parameters.
- Grounding enhancement materials and devices to improve the quality and effectiveness of the ground connection. Examples of this are adding conductive or electrolytic substances, such as salts, gels, or rods, to the soil or the grounding electrode, structures, brackets, and such.

35. “Grounding” generally refers to providing a path for stray current to be safely conducted to the earth. In systems, grids, and certain equipment, a ground wire, cable, structure, or other mechanism is required. This allows non-load current (*i.e.*, stray current resulting from a short circuit, fault, lightening, or any other non-load currents) to be guided to the ground. Grounding in electrical systems is necessary to dissipate the energy of the stray current. If a path is not provided, the energy may dissipate in the air by ionizing the air around it, which sometimes appears as sparks or flashes. When a human contacts a live ungrounded surface, the stray current passes through the body which may cause electrocution. One of the main goals in designing a grounding system is to design a path with a low resistance to ensure that a stray

current will always be dissipated through the ground wire, and not any other parallel paths.

36. Grounding electrical distribution systems have been implemented since at least as early as 1880s, when Thomas Edison started his Pearl Street Central Generating Station. EX1008, 1. In his system, Edison connected a neutral return cable to pre-existing subterranean pipe systems, which “could be considered the first grounding electrode.” *Id.*, 2

37. In the early 20th century, a desire arose for standardized codes to safeguard against hazards presented by the lack of uniformity among the electrical distribution systems of various states, towns and cities. *Id.*, 3. Among such codes were the National Electrical Code (“NEC”), which is the main authority in providing standards for the electrical systems in the U.S. and is sponsored by the National Fire Protection Association (“NFPA”). *Id.* The NEC, from its conception in 1911 to today, applies to electrical systems for residences, commercial and industrial facilities. *Id.* Long before the time of the purported invention to this day, the NEC provided methodologies for effective electrical grounding. EX1007, 98 (Article 250). For example, the 2008 NEC provides extensive regulations for grounding. *See, e.g., Id.*, Article 250.1 (“This article covers general requirements for grounding and bonding [and] [m]ethods of grounding and bonding”). Other standards setting organizations, such as the Institute of Electrical and Electronics Engineers (“IEEE”) have published

standards for grounding systems as early as 1982, and have issued revised versions in 1991 and most recently in 2007. EX1028, *passim*.

38. It was well understood long before the time of the invention that one could connect metal components of an electrical distribution system to ground the system due to the electric conductivity of the metal components:

(2) Grounding of Electrical Equipment. Normally non-current-carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected to earth so as to limit the voltage to ground on these materials.

(3) Bonding of Electrical Equipment. Normally non-current-carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected together and to the electrical supply source in a manner that establishes an effective ground-fault current path.

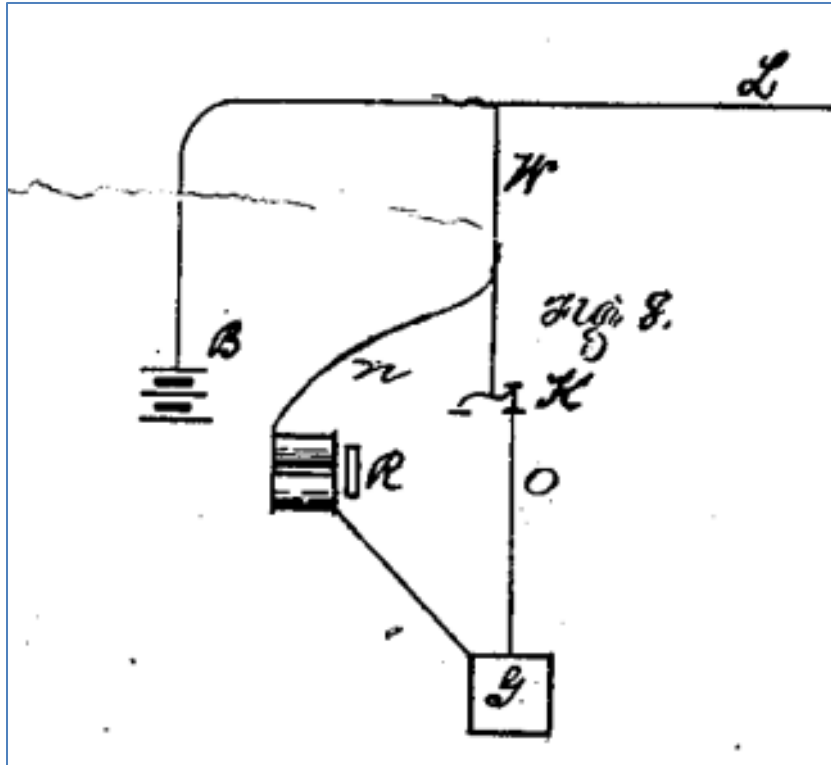
(4) Bonding of Electrically Conductive Materials and Other Equipment. Normally non-current-carrying electrically conductive materials that are likely to become energized shall be connected together and to the electrical supply source in a manner that establishes an effective ground-fault current path.

EX1007, 99 (250.4(A)(2)-(4)) (annotated in yellow). The IEEE similarly acknowledges that a grounding system is defined by its boundaries, *i.e.* a grounding system exists when there is a physical connection of metallic components and terminates when there is a lack of physical connection of metallic components:

1.2.6 grounding system: A system that consists of all interconnected grounding connections in a specific power system and is defined by its isolation from adjacent grounding systems. The isolation is provided by transformer primary and secondary windings that are coupled only by magnetic means. Thus, the system boundary is defined by the lack of a physical connection that is either metallic or through a significantly high impedance.

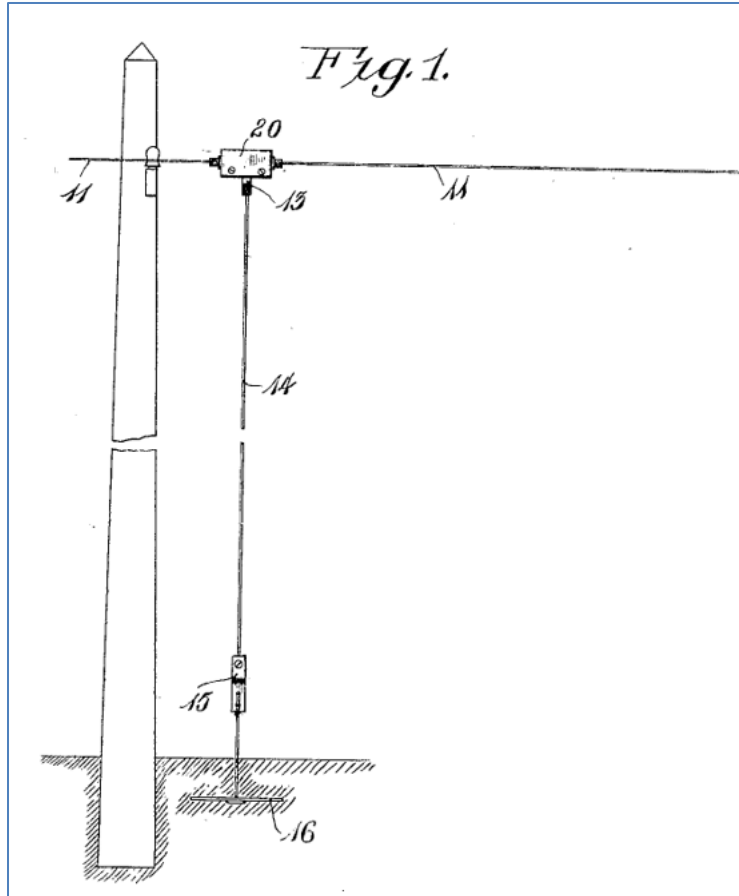
EX1028, 13 (1.2.6). As seen above, both the NEC and IEEE provide that various metal components used in any electrical system can be connected together in a manner that establishes an effective ground-fault current path.

39. Electrical distribution systems utilized the connection of various metal components to provide a safe grounding path since as early as the 1880's, where the grounding systems started as single-point grounding which was done at the substation or transformer location. Later improvements included multi-grounded systems where different points across the system, *i.e.* all the piles, transformer and other equipment, were grounded. For example, U.S. Patent No. 231,552 provides "the current flows from the local battery B at the sending-station, through the wire *o* and through the key *K* ... to the main line *L*, the relay *R* being operated by a[n] [electrical] leak from the side wire, *n*, to the ground at *G*":



EX1009, Fig. 9.

40. Less than two decades later, inventors such as Hall disclosed the systems “to be attached to ... electric conducting wires for the purpose primarily of preventing damage to operators or instruments due to over charges of electricity from lightning[.]” EX1010, 10-14. Specifically, Hall disclosed connecting device (20) to conducting cable (11), with a ground line (14) running from device (20) to a detachable connection (15), and eventually to a plate buried underground (16):



Id., Fig. 1.

41. Accordingly, stray current from lightning would pass from the electrical distribution system through ground line 14 into the earth where the stray current can safely dissipate. *Id.*, 79-86. Note, in some electrical grids and systems artisans used a dedicated wire or cable for lightening that is separate from the ground wire or cable, however, both function in a similar manner, *i.e.* providing a low-resistance path for the non-load current. Similar methods for grounding were disclosed in 1940 by Browder, who taught using “a vertical wire ... attached to the side of the pole and extend[ing] downwardly to the ground whereby the conductor 48 is grounded.” EX1011, 8:8-12.

42. Aerial cable support systems, in both utility and solar electrical distribution systems, typically comprise (1) piles (or utility poles) comprised of metal, wood, concrete or composite materials, (2) a tension member running between piles or between the pile and the ground or other electrical equipment (*e.g.*, a messenger wire, a catenary cable, cable tray, a guy-wire, or any equipment supported by such tension member) comprised of galvanized steel or other metal, and (3) mounting structures for coupling the tension member to each pile (*e.g.*, an arm or bracket extending off of and coupled to a pile) comprised of galvanized steel or other metal.

43. Aerial cable support systems require tension members to support the current carrying cables against the tensile force of gravity. Cable supports such as messenger wires or trays, may deflect under load when suspended across a span. The maximum amount of deflection occurs in the middle of the span, and is calculated based on (i) the length of the span, (ii) the load that the support is supporting, (iii) the strength of material (measured as elastic modulus), and (iv) the momentum of inertia of the side rails. For a cable supported by a tension member the amount of deflection increases as the length of the tension member or its load increases. For a current carrying cable, higher currents require a thicker and therefore heavier cable, which in turn increases the load that the support is supporting. Absent the support, the forces in the current carrying cable will cause it to deflect, which over time may weaken both the cable conductor and its insulation. In turn this increases likelihood of faults and

short circuits as the cables come in contact with the ground or other conductive equipment. It may also cause injury or death if a person comes in contact with it. Further, while tension members are typically made from durable materials with strong elastic modulus such as galvanized steel, current carrying cables typically comprise highly conductive metals such as copper that due to their material properties have lower elastic modulus. Such highly conductive metals like copper are not desirable candidates as tension members because they experience large deflection. Therefore, copper current-carrying cables are typically unable to support their own weight when drawn over large distances between two piles.

2.5 Step 5: Conduct Simplified Hand Calculation

The maximum vertical sagging displacement and the greatest bending stress at middle of span can be estimated based on following simplified formula.

Assumption:

- (1) The material is linear elastic
- (2) The side rail is prismatic, which means that cross-section remains constant throughout its length.

Maximum vertical deflection for simple span in Figure 11 is

$$\delta = \left| \frac{-wx(L^3 - 2Lx^2 + x^3)}{24EI} \right| \quad (6)$$

$$\text{With } \delta_{\max} = \frac{5wL^4}{384EI} \quad \text{at } x = L/2 \quad (7)$$

where E is Elastic modulus (N/mm²), I is Moment of Inertia of side rail (mm⁴), L is Support span (mm), x is Distance from pin support, w is Load per unit length (N/mm), and $\delta_{\max}$ is Maximum deflection (mm).

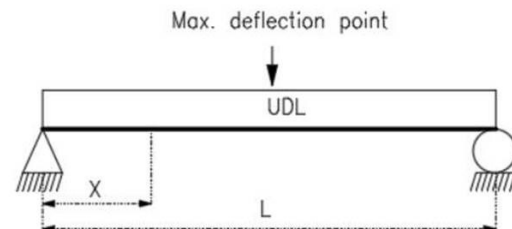
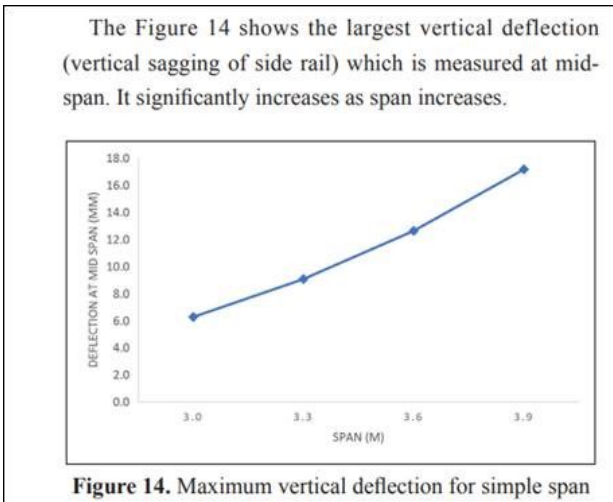


Figure 11. Simple beam with UDL

When cable ladders are installed across several supports with UDL as Figure 12, the maximum sagging displacement is

$$\delta_{\max} = \frac{0.0031 \times w \times L^4}{E \times I} \quad \text{at mid of intermediate span (8)}$$

where E is Modulus of elasticity (N/mm²), I is Moment of Inertia of side rail (mm⁴), w is Load per unit length (N/mm), L is Support span (mm), $\delta_{\max}$ is Maximum deflection (mm), and E and I are constant.

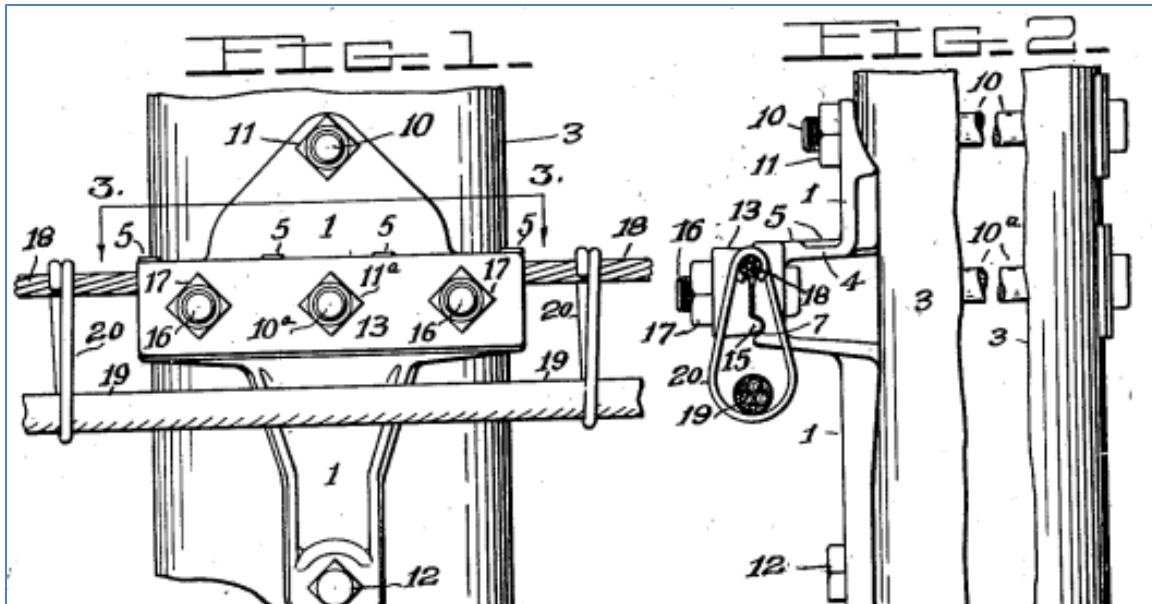


EX1029, 7-9.

44. The use of piles, or utility poles, proliferated in the mid-19th century during the advent of the telegraph system. EX1012, 5. By the early 20th century, utility poles were carrying telephone lines, telegraph lines, as well as electrical current carrying cables. *Id.*, 9. In the mid-19th century, piles or utility poles were predominantly made of wood, but steel utility poles were introduced as early as the 1930's due to their flame retardant properties and durable nature. Such steel piles may not require a full-length copper grounding wire because they are already self-conducting for grounding purposes. As noted by the American Galvanizers Association, "no installation of a ground wire may be required" when using steel piles as a result of their conductive properties. EX1030. Weighing approximately 60% less than wood structures, galvanized steel poles are also easier and less expensive to handle and install. *Id.*; EX1013, 15.

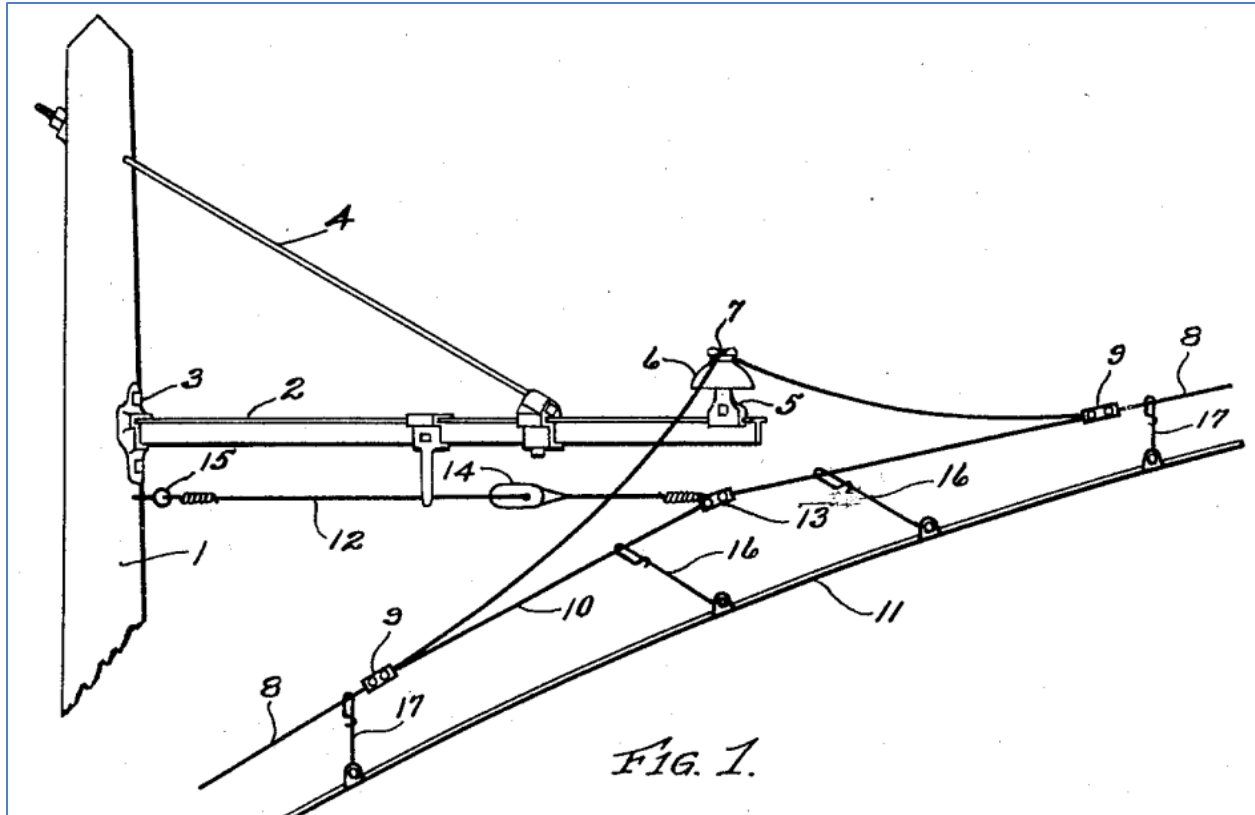
45. Similarly, the use of metal or steel tension members such as messenger wires or catenary cables have been used to support current carrying cables since the early 1900's. *See, e.g.*, EX1014, 2:105-107 (“ ... a conductor-supporting device, the combination with a messenger cable and a conductor[.]”); EX1015, 1:32-34 (“ ... suspending the trolley [conductive] wire from a messenger wire.”); EX1016, 1:9-12 (“[o]ur invention relates to a support for conductors and ... to the supporting of trolley wires from catenary or messenger cables.”). Since at least the mid-20th century, other tension members, such as cable trays, have been used to provide support to current carrying cables. *See, e.g.*, EX1017, 1:15-21 (“[the] present invention relates to cable trays or shelves for use in electric generating plants ... to support large numbers of conductors such as cables, wires”); EX1018, 1:7-10 (“[t]his invention relates ... to the structure of cable trays for carrying electric power cables in suspended positions”); EX1019, 1:24-29 (“This invention relates to supporting members for cables ... or other conductors; and more particularly, to an improved cable supporting tray”).

46. A variety of mounting structures have been used since the 19th century to couple tension members to piles or utilities poles. For example, in 1930, Williams disclosed a “clamping plate” (13) with bolts (16) passed through it that upon tightening secure a messenger (18) (supporting current carrying cable 19) to a utility pole (3):



EX1020, Figs. 1-2.

47. Notably, Williams provided for the use of metal components, and the use of a messenger cable that “is always grounded[.]” *Id.*, 1:7-13. Alternatively, horizontal arms extending from pile have been used as a mounting structure to couple the tension members to the piles or utilities poles. For example, in 1929, Stromberger disclosed “an upright pole member 1 projecting from the ground with horizontal arm 2 projecting from the pole and secured thereto by means of the bracket 3 and the support from 4 ... [with] arm 2 [configured] to receive the messenger cable 8”:



EX1021, 1:24-31; Fig. 1.

48. A simple and cost effective method to create a ground path for electric distribution systems is to exploit the conductivity of various metal components, including the tension member, pile, and mounting structures. *See* EX1022, 5-7. When only using conductive materials, a support system has a path to ground via each metal component in the structure.

49. Indeed, the NEC specifically provides for messenger wires to be simultaneously used both as structural support for conductors and as the equipment grounding conductor itself. For example, Chapter 3 of the NEC, which covers messenger cable supported wiring, provides that when the messenger wire is used in a

support system, the same messenger wire may be used as a grounding conductor and shall be supported at dead ends (terminal supports):

396.30 Messenger.

(A) **Support.** The messenger shall be supported at dead ends and at intermediate locations so as to eliminate tension on the conductors. The conductors shall not be permitted to come into contact with the messenger supports or any structural members, walls, or pipes.

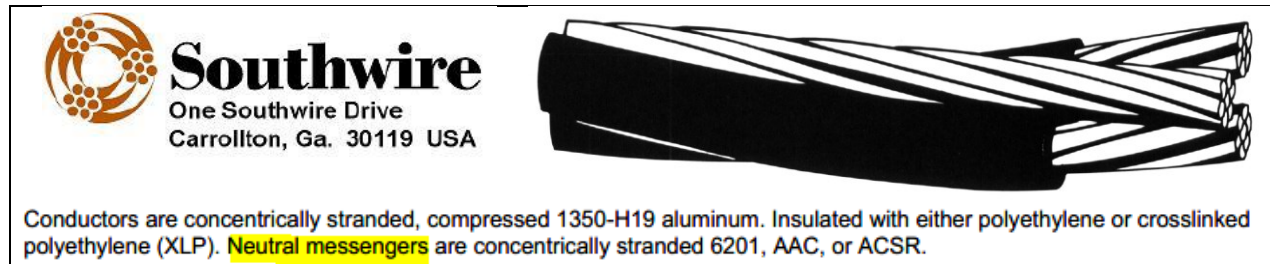
(B) **Neutral Conductor.** Where the messenger is used as a neutral conductor, it shall comply with the requirements of 225.4, 250.184(A), 250.184(B)(7), and 250.186(B).

(C) **Equipment Grounding Conductor.** Where the messenger is used as an equipment grounding conductor, it shall comply with the requirements of 250.32(B), 250.118, 250.184(B)(8), and 250.186(D).

EX1007, 241 (Article 396.30).

50. In accordance with the NEC and the well-known benefit of using the messenger cables as a grounding conductor, companies selling wires to be used as messenger cables have strengthened their capability to serve as equipment ground. Neutral messengers may be solid copper or more commonly concentrically stranded aluminum conductor steel reinforced (ACSR), while one conductor is manufactured with an extruded ridge for phase identification in a bundle. The neutral messenger wire in many electrical distribution systems may be bundled with the three-phase wires in a cable. The messenger wire will not have any insulation, while the phase wires may be insulated with either polyethylene or crosslinked polyethylene. For example, as early

as 2003 Southwire—a prominent electrical cable manufacturer—has been selling a triplex service drop cable that it advertises as including a “neutral messenger.” EX1023, 1. In my experience in this industry, “neutral messenger” refers to a messenger cable that doubles as a grounding conductor.



Id. (excerpts).

51. By way of further example, as early as 2010, WesternPower—an electrical network company—has been using a Hendrix messenger wire specifically designed which “supports the three phase conductors, breaks the fall of tree branches, and act as a lightning shield and the system neutral.” EX1024, 13.

3.3 Messenger Wire

The messenger wire (also known as the catenary wire) is the supporting wire in the Hendrix Covered Conductor System configuration. It acts as the 'backbone' of the system because it supports the three phase conductors, breaks the fall of tree branches, acts as a lightning shield and the system neutral.

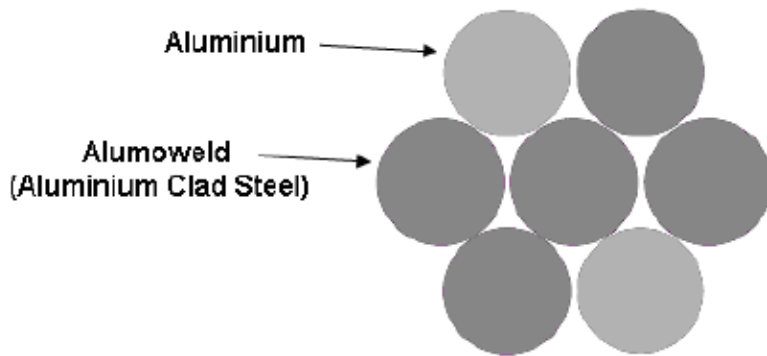


Figure 3-2: 052AWA Messenger Wire

Id. (annotated).

52. As yet another example, in 2001, Akasaka disclosed “[a] ground wire [that] is carried between the pylons above the conductors to electrically interconnect the pylons and also provide protection to the conductor from disturbances such as lighting[.]” EX1025, [0002]. Akasaka also explained that [t]he service requirements for the ground wire require it to be electrically conductive as well as self-supporting.” *Id.*, [0003].

IX. The Prior Art

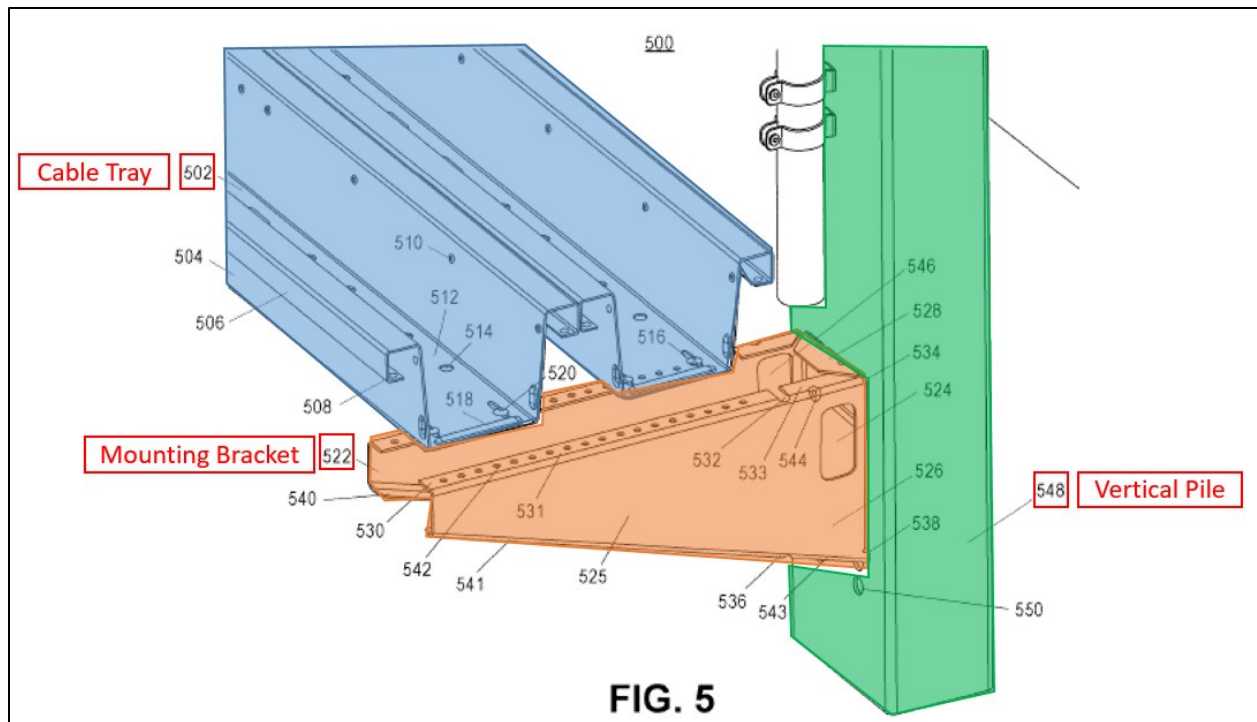
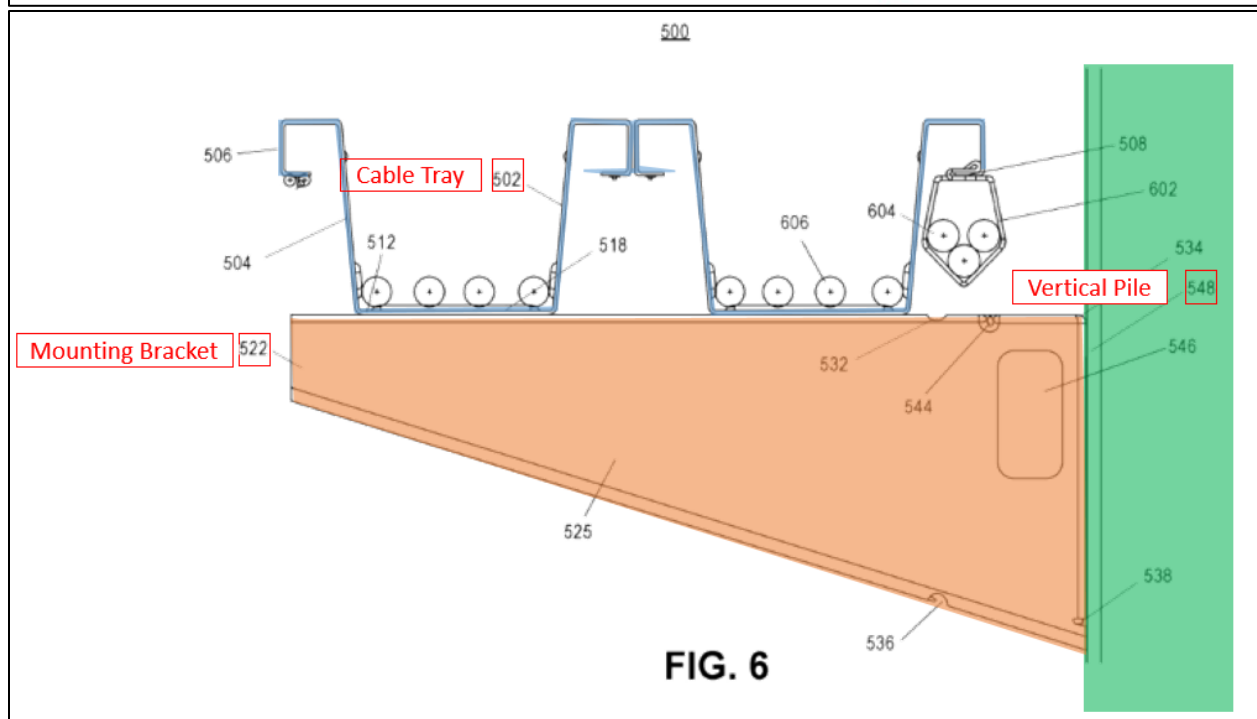
53. By the time of the alleged invention of the '551 Patent, persons of ordinary skill in the art were already aware of grounding systems for support assemblies using a conductive medium such as messenger cables and/or cable trays

coupled to conductive mounting assemblies, and support structures such as conductive piles.

1. Grushkowitz

54. I understand that “Solar Collector Cable Support Tray and Support System” to Grushkowitz and has a priority date of March 2, 2015. I understand that Grushkowitz is prior art to the ’551 Patent.

55. Grushkowitz teaches “the realization that at least one component of certain types of larger solar energy systems can be simplified so as to reduce component costs.” EX1003, 2:7-10. Grushkowitz discloses a “support system” comprising “cable trays and vertically-oriented piles” and “mounting brackets” that in combination “provides a ground path from a cable tray, to the mounting bracket, to the pile, and then to the ground to dissipate transient voltages” in a solar energy system. *Id.*, Abstract. Grushkowitz further discloses the use of cable trays, mounting brackets, vertical piles, and hardware that “comprise metal (e.g. steel, aluminum, titanium, etc.) or other conductive material[s]” which form “a continuous ground path” from the components to the earth. *Id.*, 10:63-11:8.



EX1003, Figs. 5 and 6 (annotated).

2. Petersen

56. I understand that “Pole Top Extension for Aerial Cable” issued to Petersen and has a priority date of February 25, 1959. I understand that Petersen is prior art to the ’551 Patent.

57. Petersen “relates in general to pole top extensions for aerial cable and more particularly relates to a horizontally offset extension adapted to be attached to the top of a utility pole[.]” EX1004, 1:9-12. Specifically, Petersen discloses a “pole top extension bracket [that] comprises a channel support means 11 and angular tension brace means 12.” *Id.*, 1:53-55. Petersen goes on to disclose that “brace means 12” includes “a vertical extending end portion 26” that “extends above the arms 14 and 15 of the channel member for supportingly engaging [a] neutral messenger cable.” *Id.*, 2:1-8. “[P]ortion 26” of Petersen’s assembly further comprises a “ground clamp means 29” which is comprised of “two clamping jaw members” that keep the neutral messenger wire in place and in a grounded electrical communication. *Id.*, 2:34-50.



EX1005, p. 5;

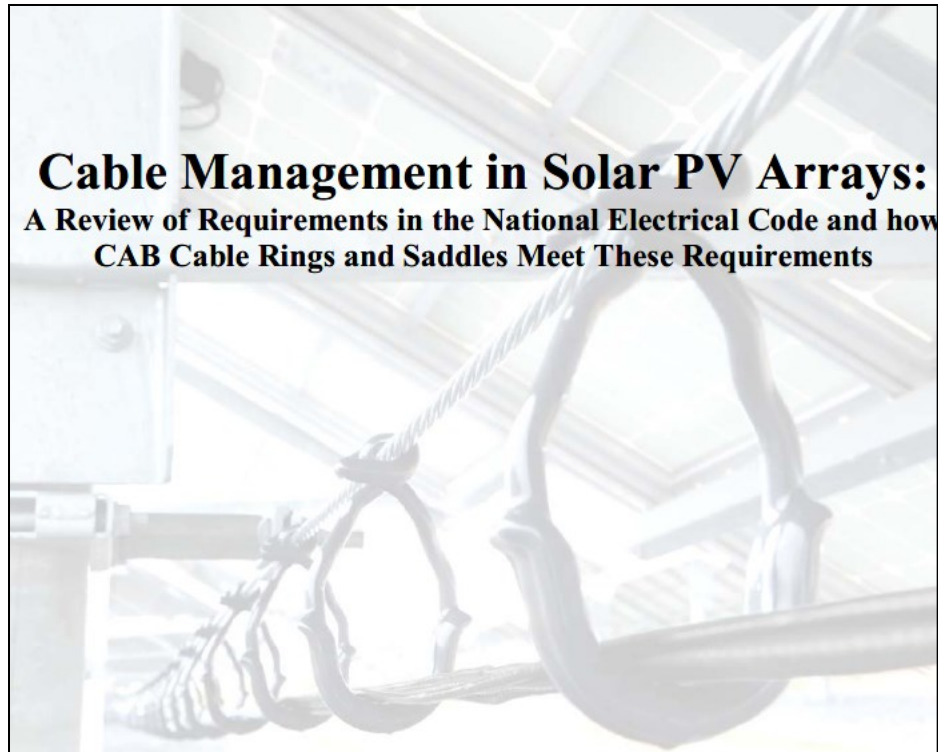


Id.

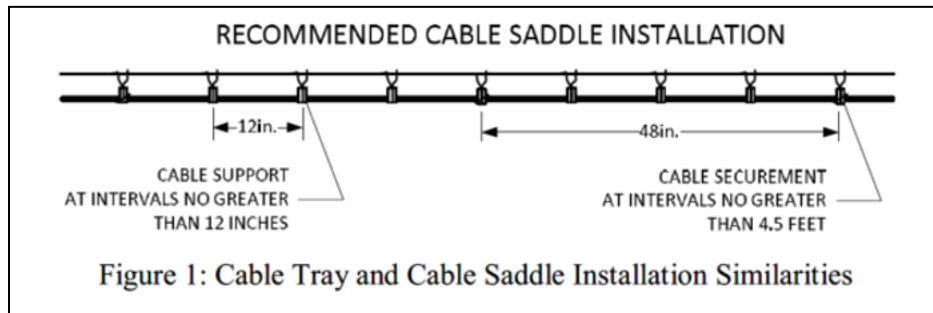
4. CAB Whitepaper

60. The Whitepaper titled “Cable Management in Solar PV Arrays: A Review of Requirements in the National Electrical Code and how CAB Cable Rings and Saddles Meet These Requirements” was prepared for CAB by Brooks Engineering (Version 1.3) (“CAB Whitepaper” (EX1006)) and was published September 18, 2014. The CAB Whitepaper is referenced and disclosed in the CAB Website. EX1005, p. 4-5. I understand that the CAB Whitepaper is prior art to the ’551 Patent.

61. The CAB Whitepaper discloses cable management systems, including how CAB products can be used in compliance with the NEC. EX1006, 3. The CAB Whitepaper discloses images depicting grounding systems structured to ground a number of cables supported by a support assembly comprising a multi-function line and mounting assemblies comprising multi-function line couplings:



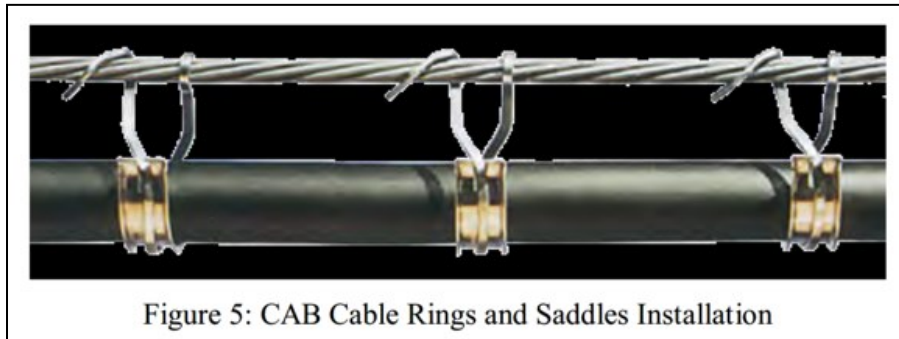
EX1006, 3;



Id., 12;



Id.;

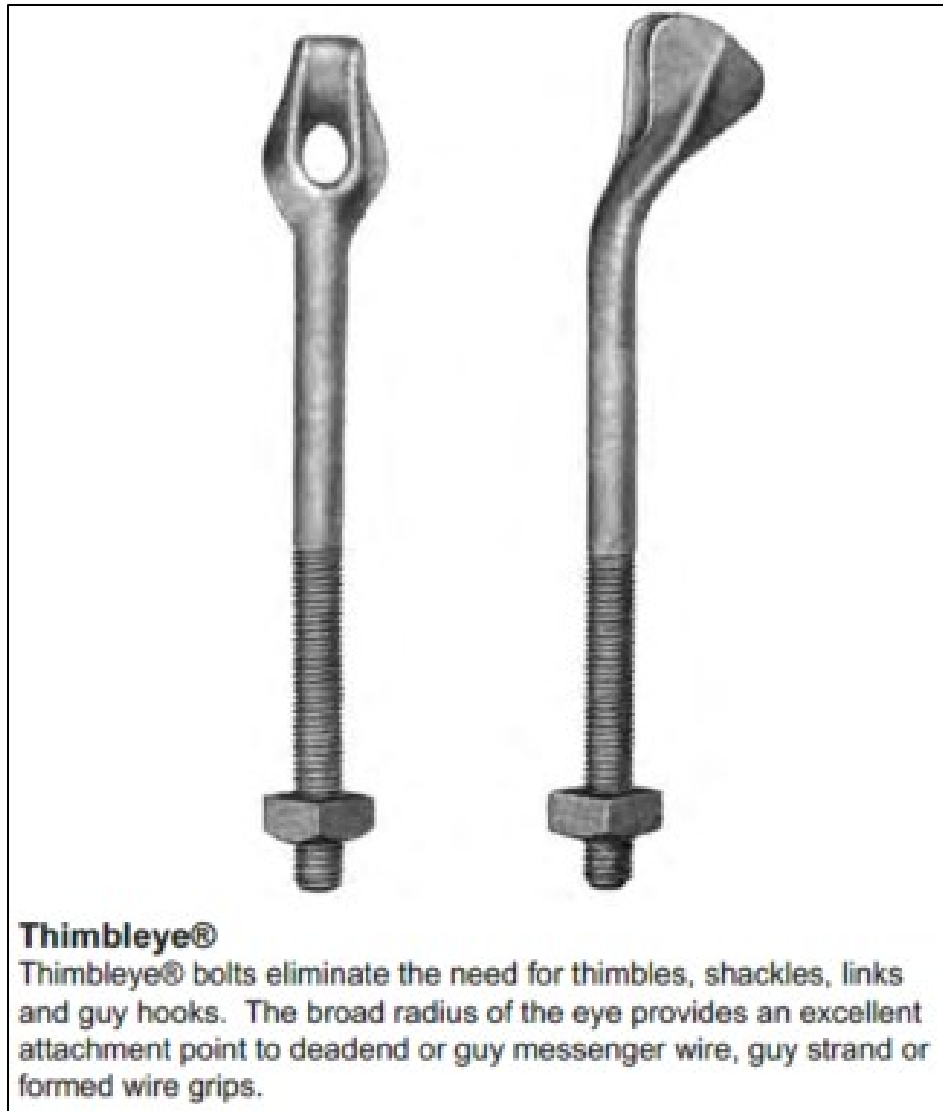


Id., 14.

5. MacLean

62. The MacLean “Pole Line Hardware Catalog” was issued in May of 2010 (EX1027 “MacLean”). MacLean Power Systems is a manufacturer of utility power system and telecommunication equipment that I am familiar with. MacLean Power Systems is widely known in the electrical distribution system industry. I understand that McClean is prior art to the ’551 Patent.

63. MacLean discloses hundreds of products available as of 2010 for use in the utility power and telecommunication systems, including electrical grounding and cable support systems. *See generally*, EX1027. MacLean discloses terminal support assemblies for aerial messenger wires, including thimble-eye bolts:



EX1027, 14.

X. Invalidity Grounds

64. In general, I do not see anything that could be considered new or non-obvious as it relates to the '551 Patent claims. At the time of the filing of the application, as I have stated previously and as is recounted in the specifications, grounding systems using similar structures and techniques were well-known. The prior art discloses precisely the system and assembly claimed in the independent claims of

Affordable Wire Management, Exhibit No. EX1002

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the '551 Patent. There is nothing surprising about the '551 Patent claims from a technical perspective, when viewed against the backdrop of the substantial prior art.

65. In particular, claims 1-12, 18-19 are unpatentable as obvious for Ground 1, claims 1-19 the '551 Patent are unpatentable as obvious for Grounds 2-3, and claims 13-17 are unpatentable as obvious for Ground 4-5. It is my opinion that Grounds 1-5 demonstrate that a POSITA would have considered the claimed apparatus of the '551 Patent obvious at the time of the invention in October 2017. The cited references alone and/or combination disclose the alleged invention for the same reasons and for the same objectives. This makes sense, as the industry at the time was focused on developing more efficient and affordable grounding structures and assemblies.

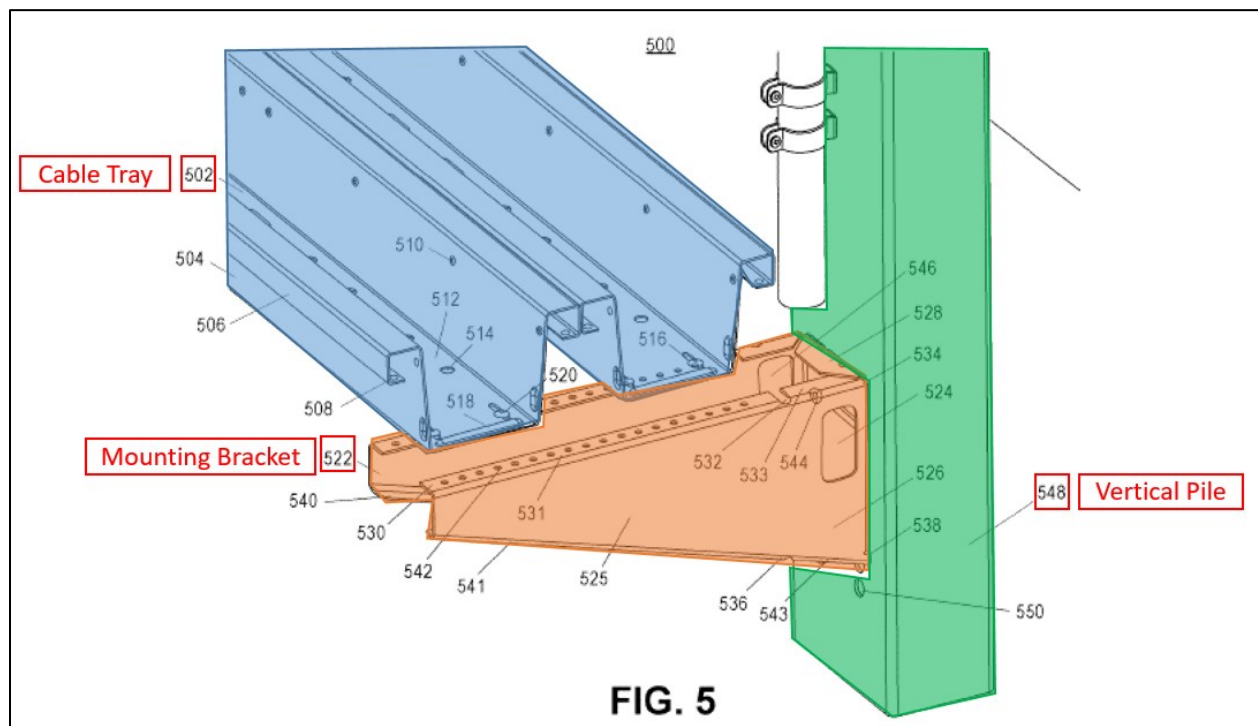
XI. Ground 1: Claims 1-12, 18-19 of the '551 patent are obvious in view of Grushkowitz alone or in combination with the knowledge of a POSITA at the time of the alleged invention.

1. **Independent Claim 1[a]:** A grounding system structured to ground a number of cables supported by a support assembly, said support assembly including a plurality of spaced, conductive piles, said grounding system comprising:

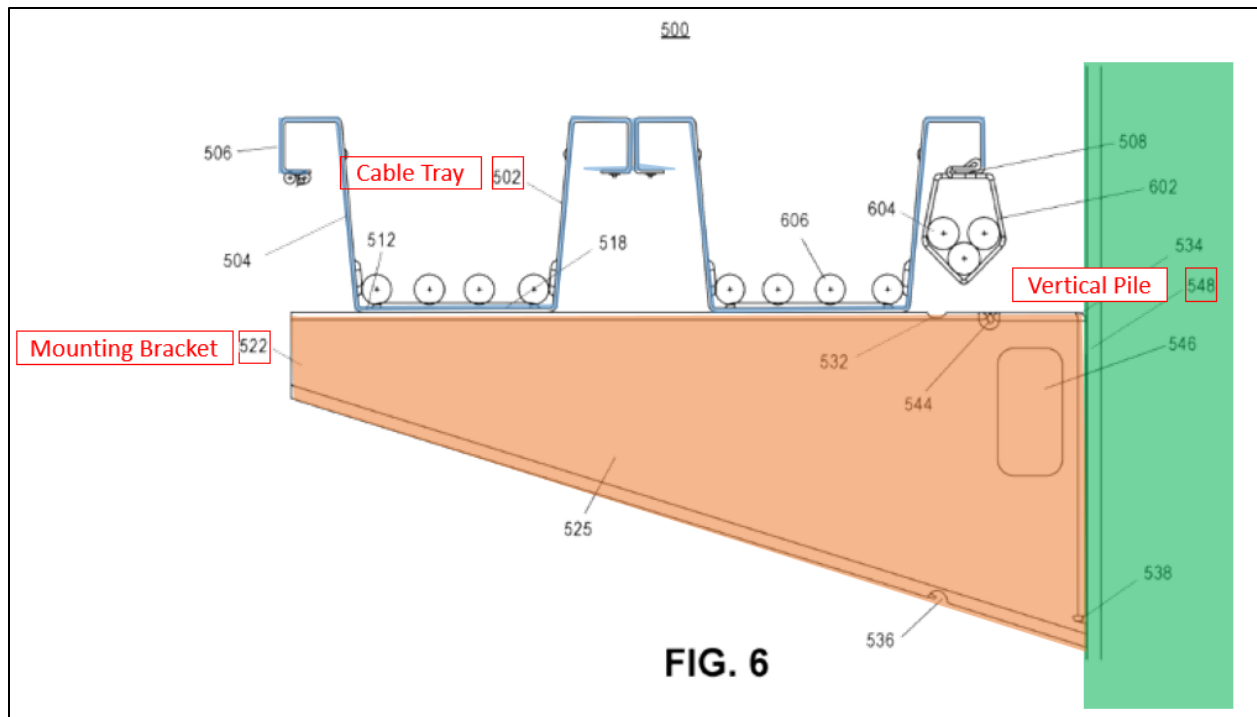
66. Grushkowitz discloses a grounding system to ground cables supported by a support system. Grushkowitz explains that their system of interconnected metal components that supports current cables creates a grounding path. EX1003, 7:67-8:3 (“cable tray and support system provides a continuous (i.e. not sliding) electrical

grounding path from the cable trays 502 to the vertically –oriented pile 548 the mounting bracket 522 without using jumpers.”).

67. Grushkowitz’s system also uses a plurality of spaced conductive piles. For example Grushkowitz discloses mounting cable trays with “mounting brackets” that are “coupled to the vertically-oriented piles 548” that are spaced apart. *Id.*, 7:56-61.



Id., Fig. 5 (providing “a perspective view of a cable support tray and mounting bracket” fixed to a pile. *Id.*, 1:56-58).



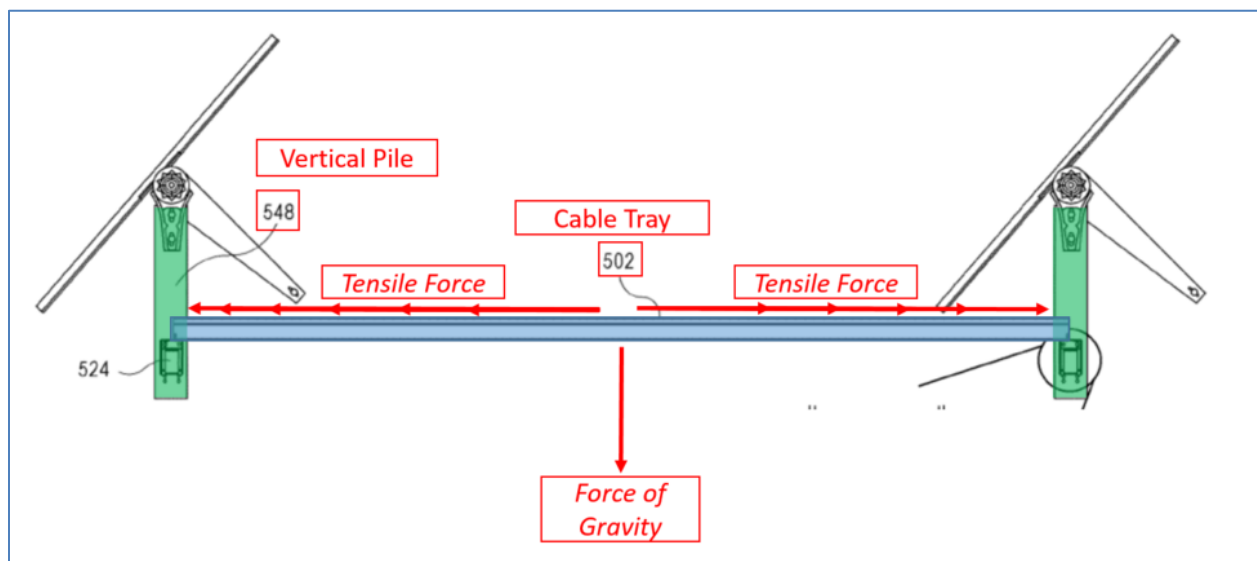
Id., Fig. 6 (annotated) depicting “a cross-sectional view of a cable support tray and mounting bracket” that is fixed to piles. *Id.*, 1:59-61. Grushkowitz discloses supporting cables 606 with the cable tray 502, as can be seen in Fig. 6 above. *Id.*, 11:27-31.

68. Grushkowitz also explains that their components are made of conductive materials. *Id.*, 11:4-8 (“the cable tray 502, fastener 520, mounting bracket 522, fastener 804, and pile 548 all comprise metal (e.g. steel, aluminum, titanium, etc.) or other conductive material[s]”). When the conductive parts are connected, they forms “a continuous ground path ... from the cable tray 502, to the fastener 520, to the mounting bracket 522, to the fastener 804, to the pile 548, and into the earth[.]”. *Id.* Accordingly, Grushkowitz discloses a grounding system structured to ground a number of cables

supported by a support assembly, said support assembly including a plurality of spaced, conductive piles.

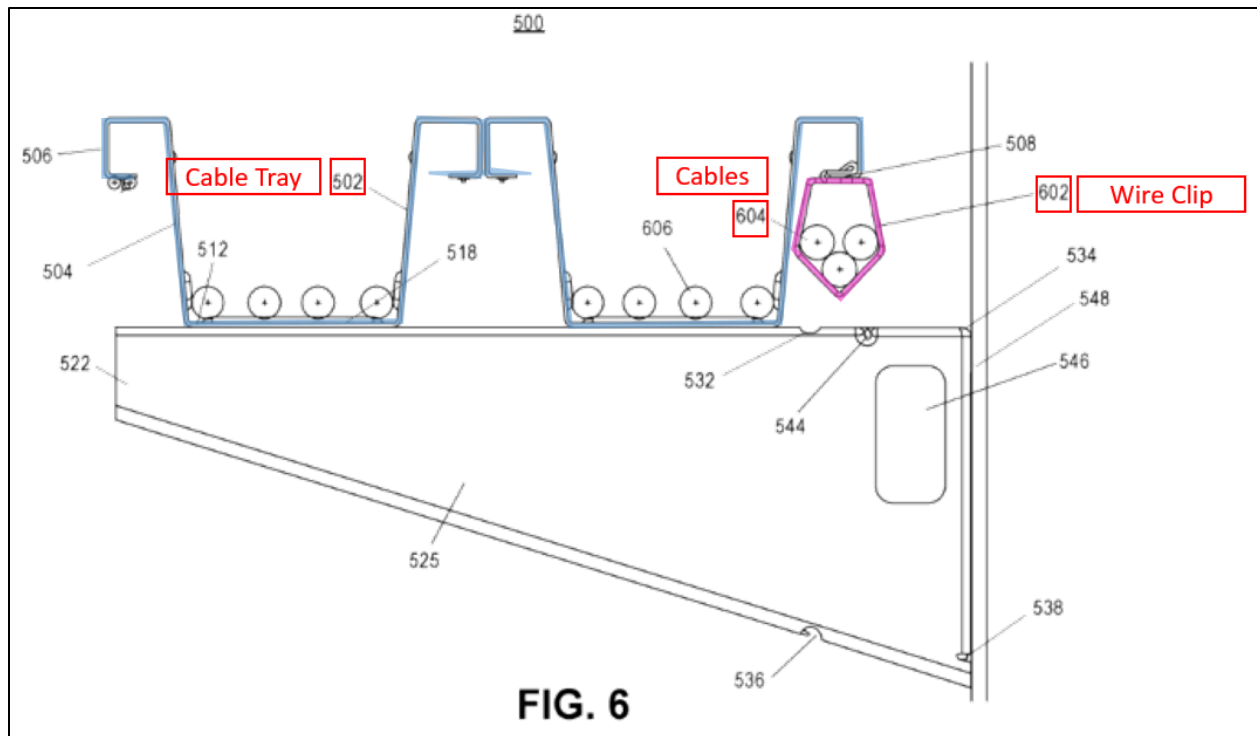
2. Independent Claim 1[b]: a multi-function line assembly including a multi-function line:

69. The '551 Patent defines “multi-function line” as a “tension member that supports current wires and/or cable hangers, and, which is conductive.” EX1001, 2:37-40. As discussed *supra*, the definition of multi-function line would include cable trays, like those used in Grushkowitz’s system. Grushkowitz discloses a metal cable tray 502 (which supports current wires) is subjected to tensile forces as a result of gravity and the weight of current wires supported thereon:



EX1003, Fig. 8A (excerpted and annotated).

70. Grushkowitz further discloses a multi-function line supporting cable hangers, which I understand would subject cable tray 502 to tensile forces:



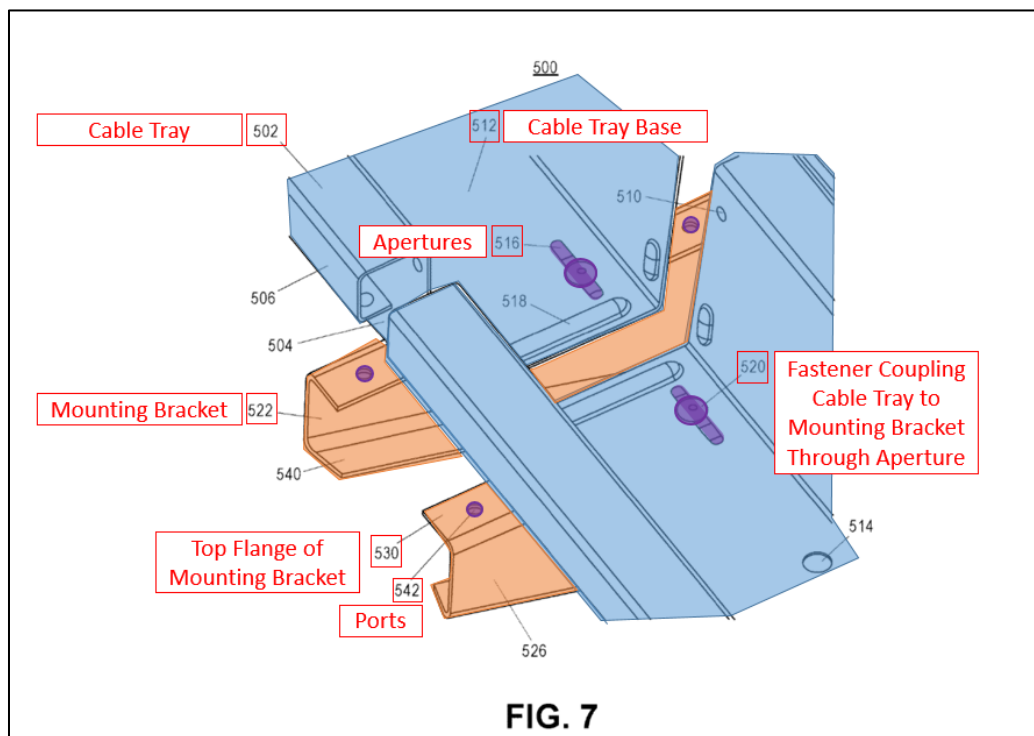
EX1003, Fig. 6 (annotated); 11:16-18 (“Coupled to the rim 508 on cable tray 502 ... is a wire clip 602” which “may be used to support cables 604.”). Accordingly, Grushkowitz alone, or in view of the knowledge of a POSITA at the time of the alleged invention discloses or renders obvious “a multi-function line assembly including a multi-function line.”

3. Independent Claim 1[c]: a number of conductive mounting assemblies, each said conductive mounting assembly structured to be coupled to said multi-function line and to a conductive pile:

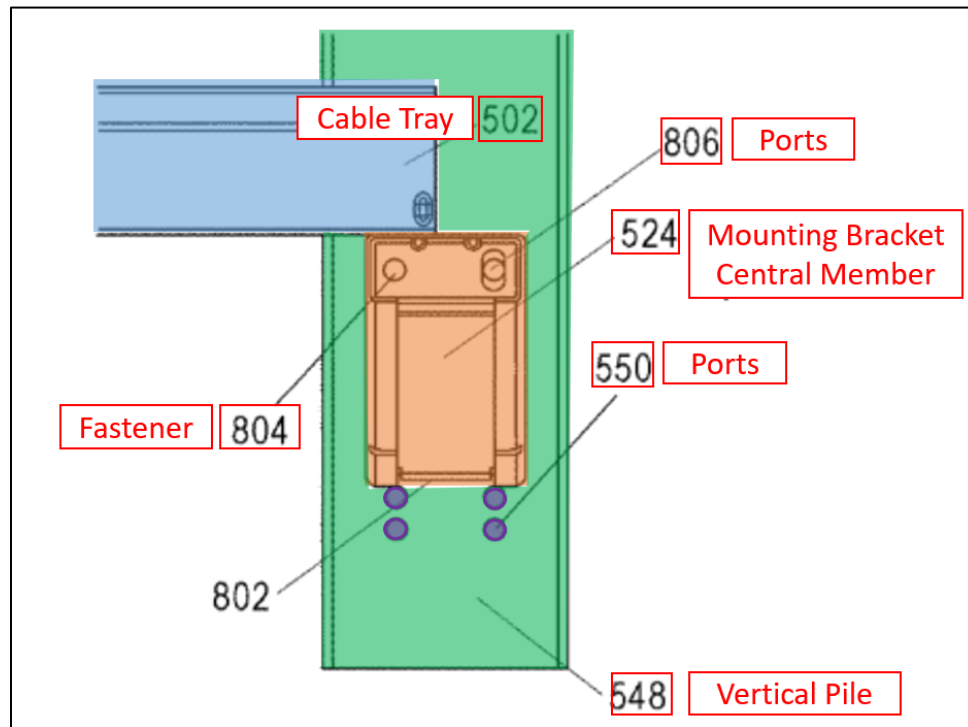
71. Grushkowitz discloses fixing a cable tray to a mounting bracket made of conductive materials. EX1003, 7:50-54 (“cable tray 502 and the mounting bracket 522 may be made of galvanized steel[.]”) *see also* 8:46-50 (““cable tray 502 ... includes one or more apertures 516 in the base 512” of cable tray 502”), and 9:41-44 (ports 542

on the top flange of mounting bracket 522 which are “adapted to receive fastener 520, thus coupling the base 512 of the cable tray 502 to the top flange 530” of the mounting bracket 522). The ’551 Patent states that conductive materials include galvanized steel. EX1001, 8:18-28. Accordingly, Grushkowitz discloses a number of conductive mounting assemblies structured to be coupled to said multi-function line.

72. Grushkowitz also discloses conductive mounting assemblies structured to be coupled to a conductive pile by teaching that the couplings used to attach fasteners 520 and 804 are also made of conductive materials. EX1003, 10:66-11:3. Grushkowitz also teaches that “pile 548 includes a plurality of ports 550 adapted to receive a fastener 804 ... to couple the mounting bracket 522 to the pile 548[.]” *Id.*, 8:14-18. Grushkowitz’s assembly is depicted in Figs. 7 and 8A:



EX1003, Fig. 7 (annotated, depicting conductive mounting bracket structured to be coupled to conductive cable tray (multi-function line) via conductive fasteners inserted through cable tray-apertures into mounting bracket ports).



Id., Fig. 8A (excerpted and annotated, depicting conductive mounting bracket structured to be coupled to conductive vertical pile via conductive fasteners inserted through mounting bracket-ports into vertical pile-ports). Accordingly, Grushkowitz discloses a number of conductive mounting assemblies (mounting bracket, fasteners) structured to be coupled to a conductive cable tray (multi-function line) and to a conductive vertical pile.

4. **Independent Claim 1[d]**: wherein said multi-function line assembly is coupled to, and in electrical communication with, said number of conductive mounting assemblies:

73. Grushkowitz discloses coupling the cable tray (multi-function line) to the number of mounting brackets, all of which comprise conductive materials, and accordingly are in contact, and therefor in electrical communication, with each other. *Id.* 10:63-11:13. Further, Grushkowitz teaches that such an assembly creates “a continuous ground path ... from the cable tray 502, to the fastener 520, to the mounting bracket 522, to the fastener 804, to the pile 548, and into the earth at the site of the solar energy collector system 10” which I understand to mean that cable tray 502 is in electrical communication with mounting bracket 522. *Id.*, 10:67-11:8. Accordingly, Grushkowitz discloses a multi-function line assembly that is coupled to, and in electrical communication with a number of conductive mounting assemblies.

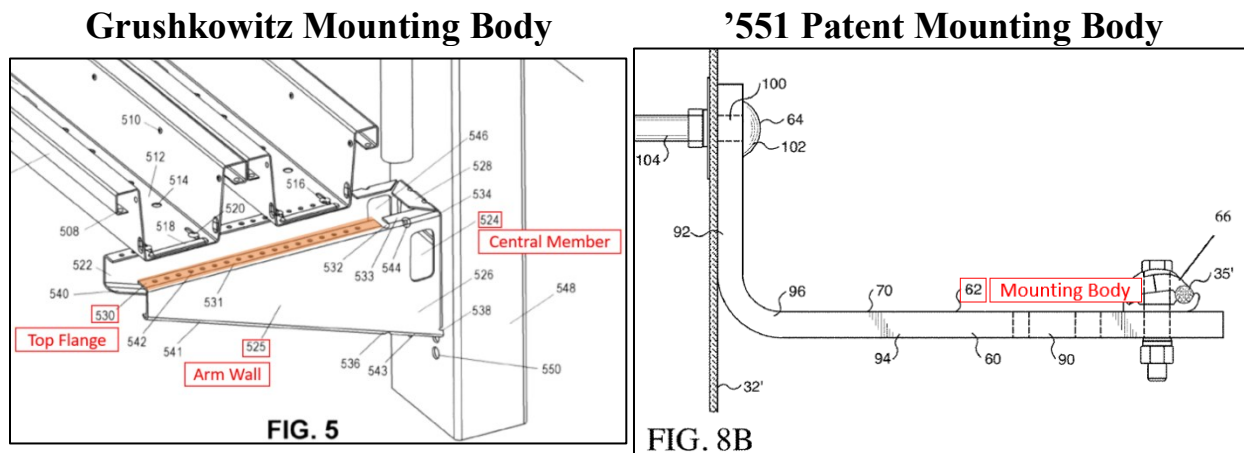
5. **Dependent Claim 2[a]**: The grounding system of claim 1 wherein:

74. As explained directly above, Grushkowitz renders obvious claim 1 of the '551 Patent.

6. **Dependent Claim 2[b]**: each said conductive mounting assembly includes a mounting body, a support coupling, and a number of multi-function line couplings; and:

75. Grushkowitz discloses a conductive mounting bracket which includes a mounting body in the form of top flange 530, which “extends outwardly from the arm wall 525 in a second direction toward the central member 524” of the mounting bracket

522. EX1003, 9:18-20. The '551 Patent provides figures depicting “mounting body 62”, including Figure 8B which depicts mounting body 62 as a portion of the mounting assembly. EX1001, Fig. 8B.



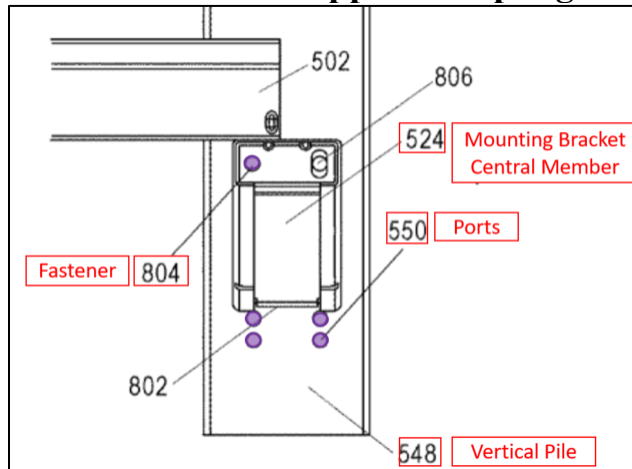
EX1003, Fig. 5 (excerpted and annotated)

EX1001, Fig. 8B (annotated)

76. Grushkowitz, therefore, discloses a conductive mounting assembly including a mounting body.

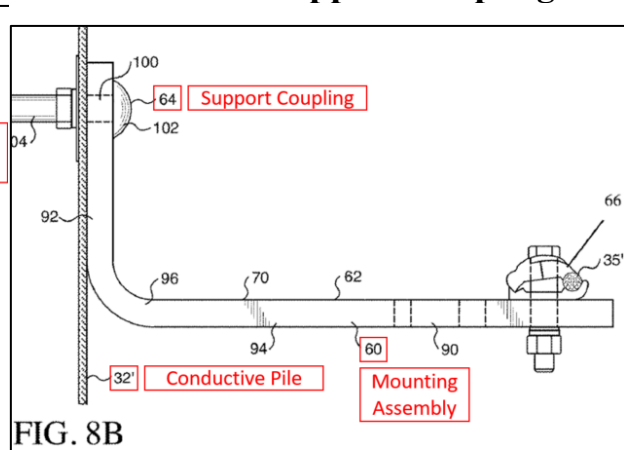
77. Grushkowitz discloses a mounting bracket that includes a support coupling. EX1003, 7:56-58; 8:14-18 (“[t]he mounting bracket 522 is coupled to the vertically-oriented pile 548 by one or more fasteners 804” and that “pile 548 includes a plurality of ports 550 adapted to receive fastener 804 ... to couple the mounting bracket 522 to the pile 548”).

Grushkowitz Support Coupling



EX1003, Fig. 8A (excerpted and annotated)

'551 Patent Support Coupling

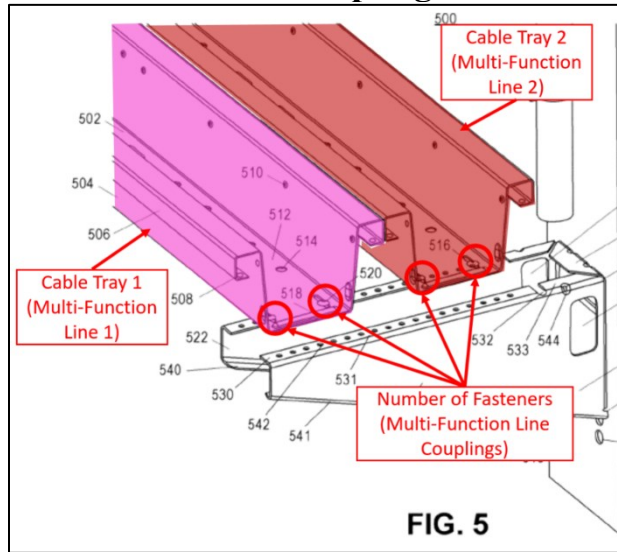


EX1001, Fig. 8B (annotated)

78. Accordingly, Grushkowitz discloses a conductive mounting assembly including a support coupling.

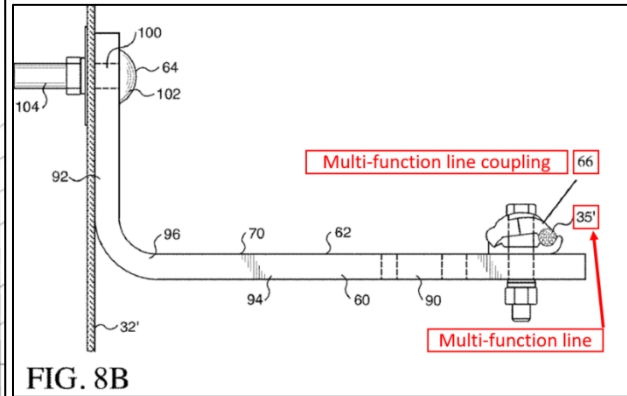
79. Grushkowitz discloses a mounting bracket that includes a number of multi-function line couplings. For example, Grushkowitz discloses at least two multi-function line couplings in the form of fasteners which couple cable tray 502 (multi-function line) to mounting bracket 522 (mounting assembly):

Grushkowitz Multi-Function Line Coupling



EX1003, Fig. 5, (excerpted and annotated);

'551 Patent Multi-Function Line Coupling



EX1001, Fig. 8B (annotated)

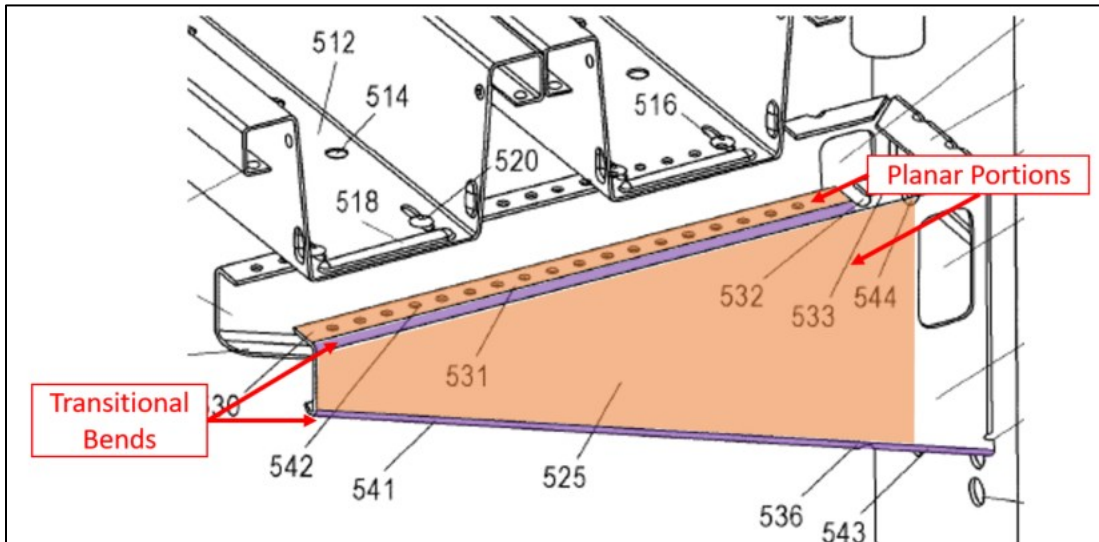
80. Accordingly, Grushkowitz discloses a conductive mounting assembly including a number of multi-function line couplings.

7. Dependent Claim 2[c]: each said multi-function line coupling defines a conductive path.

81. Grushkowitz discloses or renders this claim limitation obvious. Grushkowitz discloses that “the cable tray 502, fastener 520, mounting bracket 522, fastener 804, and pile 548 all comprise metal” resulting in “a continuous ground path ... from the cable tray 502, to the fastener 520, to the mounting bracket 522, to the fastener 804, to the pile 548, and into the earth at the site of the solar energy collector system 10.” EX1003, 10:67-11:8. Accordingly, Grushkowitz discloses or renders obvious each multi-function line coupling defining a conductive path.

9. Dependent Claim 4: The grounding system of claim 3 wherein each said mounting body has a simplified shape.

84. The mounting bracket 522 disclosed by Grushkowitz is comprised of a single piece of metal that is bent at certain portions to give the mounting bracket its shape:



EX1003, Fig. 5 (excerpted and annotated with planar portions of mounting bracket 522 in orange, and transitional bends of mounting bracket 522 in purple).

85. The '551 Patent defines “simplified shape” as “a body or assembly including generally planar portions and transitional bends or welds between the generally planar portions.” EX1001, 9:62-64. Accordingly, Grushkowitz discloses a mounting body that has a simplified shape because the orange portions of the mounting bracket are planar and the planar portions meet one another at transitional bends.

10. Dependent Claim 5[a]: The grounding system of claim 2 wherein:

86. As explained above, Grushkowitz discloses or renders obvious claim 2.

11.Dependent Claim 5[b]: each said mounting body is a conductive body:

87. As explained above, Grushkowitz's mounting bracket is a body used to mount a multi-function line cable tray that is made from conductive material and is therefore a mounting body that is a conductive body. Accordingly, Grushkowitz discloses a mounting body that is a conductive body.

12.Dependent Claim 5[c]: each said mounting body conductive body is a partially conductive body.

88. Grushkowitz's mounting body is made of galvanized steel. EX1003, 7:46-54. The '551 Patent defines "partially conductive" as any material that "conducts electricity" including "galvanized steel[.]" EX1001, 8:18-28. Accordingly Grushkowitz discloses a mounting body conductive body that is a partially conductive body.

13.Dependent Claim 6: The grounding system of claim 2 wherein each said multi-function line coupling is a clamping assembly.

89. As explained above, Grushkowitz discloses or renders obvious claim 2 of the '551 Patent. Grushkowitz discloses that the fasteners used to couple cable tray 502 (multi-function line) to mounting bracket 522, "may be any of a rivet, nut and bolt, screw, etc." EX1003, 8:53-54. The '551 Patent defines "clamping assembly" as "two elements acting in concert, i.e., together, as well as a bias device such as, but not limited to, a ... threaded rod." EX1001, 10:50-53. Grushkowitz therefore discloses a coupling (fastener 520) that is a clamping assembly because a nut and bolt assembly comprises

two elements acting in concert (the nut and the head of a bolt) with a threaded rod bias device (the threaded length of a bolt). Accordingly, Grushkowitz discloses or renders obvious the grounding system of claim 2 wherein each said multi-function line coupling is a clamping assembly.

14. Dependent Claim 7: The grounding system of claim 6 wherein each said multi-function line coupling includes one of a clam-shell assembly, a split bolt, a U-bolt, or a lay-in lug assembly.

90. As explained directly above, Grushkowitz discloses or renders obvious claim 6 of the '551 Patent. Grushkowitz discloses coupling cable tray 502 (multi-function line) to the mounting bracket 522 using a nut and bolt assembly, which would include a threaded rod passing through a threaded nut. EX1003, 8:53-54. The '551 Patent defines a "split bolt assembly" as an assembly which "includes a threaded rod including a passage and a threaded passage, passage, and/or a nut." EX1001, 10:56-58. Grushkowitz discloses that that fasteners 520 (multi-function line couplings) are not limited to nut and bolt assemblies (i.e. "fasteners 520 may be any of a rivet, nut and bolt, screw, etc." EX1003, 8:53-54), and can therefore be any assembly capable of coupling cable tray 502 to mounting bracket 522. Grushkowitz therefore discloses a multi-function line coupling that includes one of a clam-shell assembly, a split bolt, a U-bolt, or a lay-in lug assembly.

91. Furthermore, assemblies such as clam-shell assemblies, split bolts, U-bolts, and lay-in lug assemblies were widely known in the art prior to the alleged

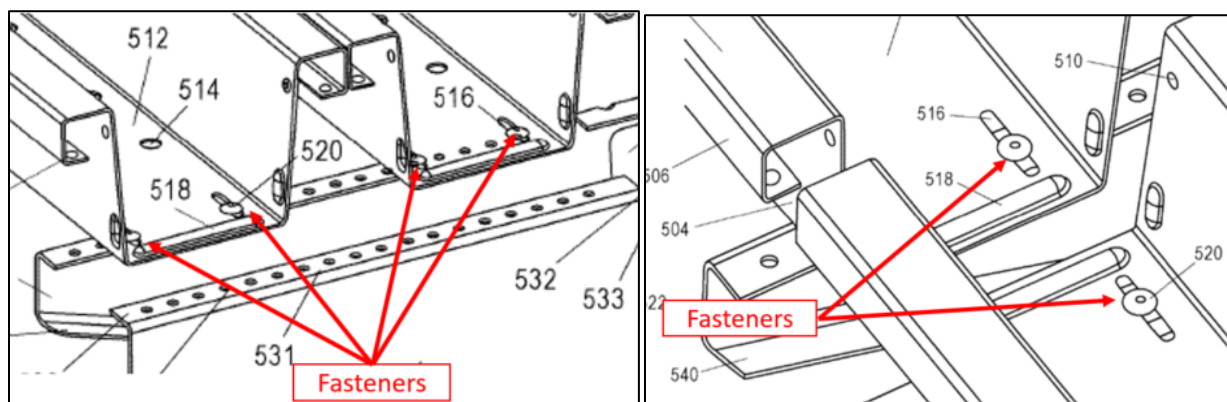
invention as different possible assemblies to fix together components of a grounding system and/or cable support system. *See, e.g.* EX1007, 70,45, 70-166. Accordingly, Grushkowitz discloses or renders obvious the grounding system of claim 6 wherein each said multi-function line coupling includes one of a clam-shell assembly, a split bolt, a U-bolt, or a lay-in lug assembly.

15. Dependent Claim 8[a]: The grounding system of claim 2 wherein:

92. As discussed above, Grushkowitz discloses or renders obvious claim 2.

16. Dependent Claim 8[b]: said number of multi-function line couplings includes a plurality of multi-function line couplings:

93. As discussed above, Grushkowitz's mounting bracket includes a number of couplings to coupling the cable tray to the mounting bracket, and the use of a number of spaced conductive piles, each pile having its own respective mounting bracket and number of multi-function line couplings. Grushkowitz utilizes a plurality of fasteners to couple the cable tray 502 to mounting bracket 522:



EX1003, Figs. 5, 7 (excerpted and annotated). Accordingly, Grushkowitz discloses or renders obvious a number of multi-function line couplings includes a plurality of multi-function line couplings.

17. Dependent Claim 8[c]: each said multi-function line coupling spaced one of a first effective distance, a second effective distance, or a third effective distance from another multi-function line coupling.

94. Grushkowitz teaches that “[t]he cable trays 502 installed on solar energy collector system 10 may vary in length” and that in some embodiments, the cable trays 502 may be between 9 and 22 feet long, although it will be understood that other lengths may be used.” EX1003, 8:25-28. The ’551 Patent defines “first effective distance” as “between less than one foot to about one hundred feet apart,” “second effective distance” as “between one foot and about fifty feet apart,” and “third effective distance” as “between about five feet and about thirty feet apart.” EX1001, 11:2-7. Accordingly, Grushkowitz discloses multi-function line (cable tray 502) couplings (fasteners 520) a first effective distance, a second effective distance, or a third effective distance from another cable tray 502 fastener 520.

95. To the extent Grushkowitz does not expressly disclose a first, second, or third effective distance, such spacing-distances would have been obvious to a POSITA at the time of the alleged invention because current carrying cables have to be spaced apart at a certain distance. For example, IEEE Standard 142 explains that current carrying cables create magnetic fields, hence when they are placed adjacently, their

magnetic fields must not cross-link with one another because this will cause circulating currents between the two current carrying cables. EX1028, 80-81. Furthermore, the National Safety Code, Rule 235G specifies that vertical spacing between conductive cables shall not be less than 4 to 12 inches, depending upon the span lengths. EX1031, 1-2. Combined with IEEE specifications regarding magnetic field cross-linking, POSITAs at the time of the alleged invention understood that such vertical spacing requirements are applicable for horizontally spacing conductors on mounting brackets. Accordingly, Grushkowitz discloses or renders obvious each said multi-function line coupling spaced one of a first effective distance, a second effective distance, or a third effective distance from another multi-function line coupling.

18. Dependent Claim 9: The grounding system of claim 1 wherein said multi-function line assembly does not include any grounding splices.

96. Grushkowitz discloses a grounding system that does not require a grounding splice because “the cable tray and support system 500 provides a continuous (i.e., not sliding) electrical grounding path from the cable trays 502 to the vertically-oriented pile 548 the mounting bracket 522 without using jumpers.” EX1003, 7:67-8:3. A grounding splice is a conductive element that is spliced into a conductive element, then electrically coupled to a pile or ground cable. EX1001, 2:6-12. Grounding splices are necessary when there is not a continuous electrical path between grounding components.

97. Grushkowitz discloses a grounding system wherein the multi-function line assembly does not include, or need, any grounding splices. It would have been obvious to a POSITA at the time of the alleged invention that the grounding system disclosed by Grushkowitz does not require any grounding splices because the coupled conductive components in Grushkowitz's system would already provide a sufficient path to ground, obviating the need for any grounding splice. Accordingly, Grushkowitz discloses or renders obvious the grounding system of claim 1 wherein said multi-function line assembly does not include any grounding splices.

19. Dependent Claim 10: The grounding system of claim 1 wherein said multi-function line assembly does not include any medial grounding splices.

98. Grushkowitz discloses a grounding system that does not require a medial grounding splice because "the cable tray and support system 500 provides a continuous (i.e., not sliding) electrical grounding path from the cable trays 502 to the vertically-oriented pile 548 the mounting bracket 522 without using jumpers." EX1003, 7:67-8:3. It would have been obvious to a POSITA at the time of the alleged invention that the grounding system disclosed by Grushkowitz does not require any grounding splices because the coupled conductive components in Grushkowitz's system would already provide a sufficient path to ground, obviating the need for any grounding splice. Accordingly, Grushkowitz discloses or renders obvious the grounding system of claim

1 wherein said multi-function line assembly does not include any medial grounding splices.

20. Dependent Claim 11: The grounding system of claim 1 wherein said multi-function line includes one of a highly conductive body or a partially conductive body.

99. Grushkowitz discloses that “cable tray 502 ... may be made of galvanized steel[.]” EX1003, 7:50-54. Grushkowitz discloses a multi-function line (cable tray 502) that includes a partially conductive body (galvanized steel) because it is made of steel. The ’551 Patent defines, “highly conductive” as a material “that has minimal resistance to electricity ... [f]or example copper wire” and “partially conductive” as a material “that conducts electricity, but with some resistance ... [f]or example, galvanized steel[.]” EX1001, 8:18-28. Grushkowitz therefore discloses or renders obvious the grounding system of claim 1 with a multi-function line that includes one of a highly conductive body or a partially conductive body.

21. Dependent Claim 12: The grounding system of claim 1 wherein said multi-function line includes strands selected from the group consisting of: copper strands, copper-clad steel strands, galvanized strands, conductive alloy strands, partially conductive, alloy strands, or composite strands.

100. Grushkowitz discloses that “[t]he cable tray 502 ... may be made of galvanized steel, although other materials may be used such as metals like aluminum, titanium, electrically conductive composite materials, or electrically conductive polymers” which a POSITA at the time of the alleged invention would have understood

to include copper, copper-clad steel, conductive alloys, partially conductive alloys, and composite materials because such materials were widely known in the art. EX1003, 7:50-54; *see e.g.*, EX1028, 79, 94, 96-97, 174-175, EX1007, 230.23, 250.120, 250.122. For example the 1959 Advance Reports of the NEC, rule 250-91 states that grounding conductors can be copper, or any corrosion resistant material, which would have included copper-clad steel or copper alloys. EX1032, 250-91. Further it was well known prior to October 2017 that using a cable tray 502 consisting of such materials would result in a multi-function line that provides conductivity as well as the strength needed for a support assembly. Accordingly, Grushkowitz discloses a multi-function line that includes strands selected from the group consisting of: copper strands, copper-clad steel strands, galvanized strands, conductive alloy strands, partially conductive, alloy strands, or composite strands.

22. Dependent Claim 18: The grounding system of claim 1 wherein said multi-function line assembly includes a conductive terminal support.

101. As discussed above, Grushkowitz discloses or renders obvious claim 1 of the '551 Patent. The '551 Patent states “[a]s used herein, a “conductive terminal support 44” that “is structured to couple a multi-function line 35 to a support, draw the multi-function line 35 taut, and provide a current path between the multi-function line 35 and the support.” EX1001, 7:19-23. Grushkowitz’s grounding system would comprise a pile at the end of the support system that would keep cable tray 502

adequately supported so as to maintain a taught assembly, and provide a current path between the cable tray 502 and pile 548. EX1003, 10:67-11:8. Accordingly, Grushkowitz in view of the knowledge of a POSITA discloses a multi-function line assembly that includes conductive terminal support.

23.Independent Claim 19[a]: A mounting assembly for a grounding system structured to ground a number of cables supported by a support assembly, said support assembly including a plurality of spaced, conductive piles, said grounding system including a multi-function line assembly with a multi-function line, said mounting assembly comprising:

102. Grushkowitz discloses or renders it obvious this claim element obvious. As discussed above, Grushkowitz's grounding system is structured to ground cables supported by cable trays that are fixed to a plurality of spaced piles by mounting brackets, which I understand to disclose or render obvious this claim element. Accordingly, Grushkowitz discloses or renders obvious a mounting assembly for a grounding system structured to ground a number of cables supported by a support assembly, said support assembly including a plurality of spaced, conductive piles, said grounding system including a multi-function line assembly with a multi-function line, said mounting assembly comprising.

24.Independent Claim 19[b]: a mounting body, a support coupling, and a number of multi-function line couplings.

103. Grushkowitz alone, or in view of the knowledge of a POSITA at the time of the alleged invention, discloses or renders this limitation obvious. As discussed

above, Grushkowitz's system teaches using mounting brackets, support couplings, and cable tray fasteners, and therefore discloses or renders obvious a mounting body, a support coupling, and a number of multi-function line couplings.

25.Independent Claim 19[c]: each said multi-function line couplings structured to be coupled to said multi-function line.

104. Grushkowitz alone, or in view of the knowledge of a POSITA at the time of the alleged invention, discloses or renders this limitation obvious. As discussed above, the structure of Grushkowitz's cable tray fasteners are designed to couple the cable tray to the mounting bracket, and therefore discloses or renders obvious each said multi-function line couplings structured to be coupled to said multi-function line.

26.Independent Claim 19[d]: each said support coupling structured to be coupled to a conductive pile; and.

105. Grushkowitz alone, or in view of the knowledge of a POSITA at the time of the alleged invention, discloses or renders this limitation obvious. As discussed above, the structure of Grushkowitz's mounting brackets is designed to be complimentary with the fasteners on the conductive piles in Grushkowitz's system, and therefore discloses or renders obvious said support coupling structured to be coupled to a conductive pile.

27.Independent Claim 19[e]: wherein, when said multi-function line assembly is coupled to, and in electrical communication with said

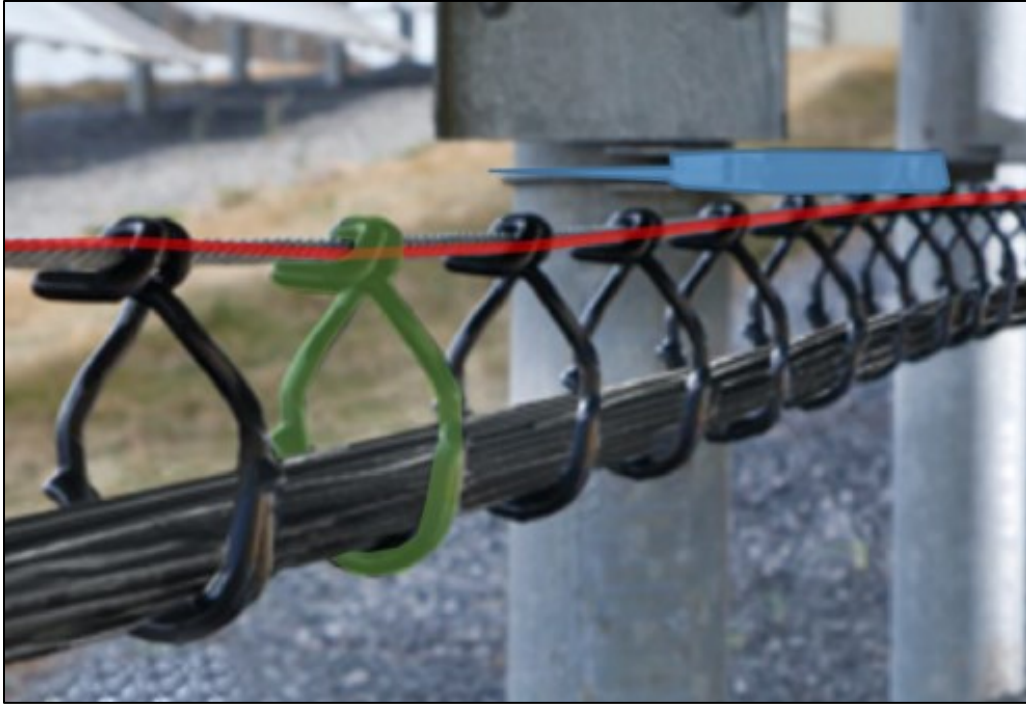
multi-function line couplings, each said multi-function line coupling defines a conductive path.

106. Grushkowitz alone, or in view of the knowledge of a POSITA at the time of the alleged invention, discloses or renders this limitation obvious. As discussed above, Grushkowitz's assembly creates "a continuous ground path ... from the cable tray 502, to the fastener 520, to the mounting bracket 522, to the fastener 804, to the pile 548, and into the earth at the site of the solar energy collector system 10[.]" Accordingly, Grushkowitz discloses or renders obvious a multi-function line assembly that is coupled to, and in electrical communication with said multi-function line couplings, each said multi-function line coupling defining a conductive path.

XII. Ground 2: Claims 1-19 of the '551 patent are obvious in view of the CAB Website in combination with the CAB Whitepaper, and further in view of the knowledge of a POSITA at the time of the alleged invention.

1. **Independent Claim 1[a]:** A grounding system structured to ground a number of cables supported by a support assembly, said support assembly including a plurality of spaced, conductive piles, said grounding system comprising:

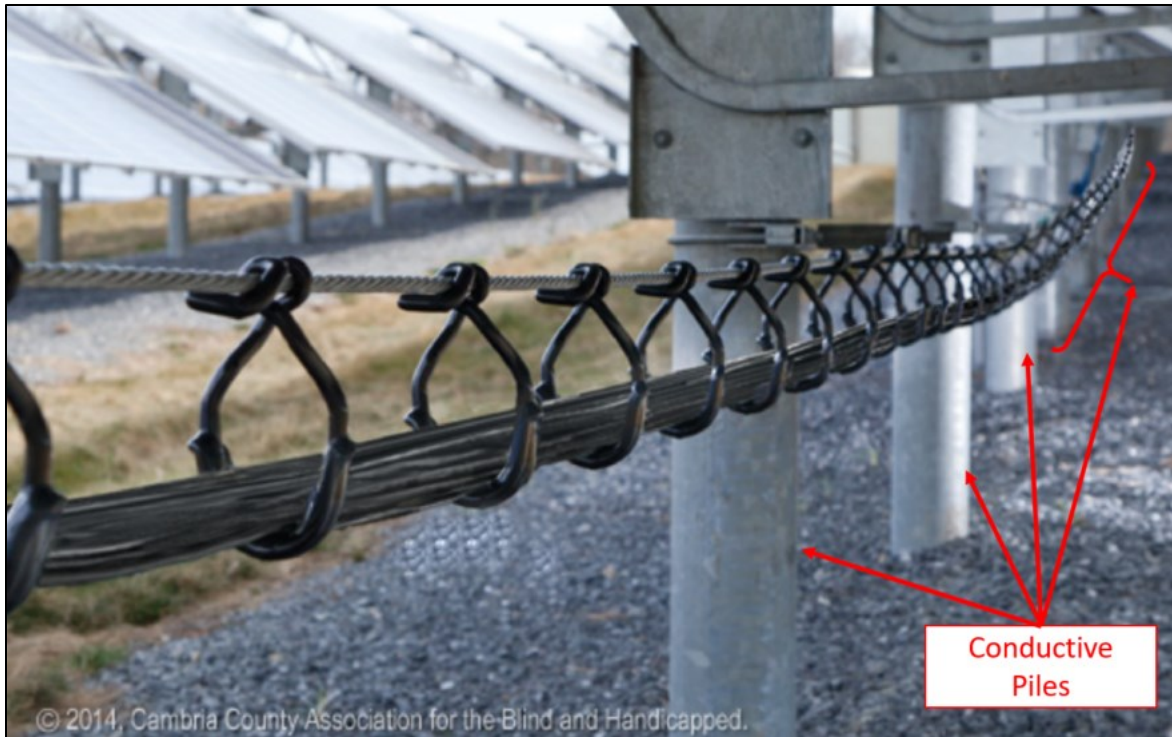
107. The CAB Website depicts a support assembly supporting current carrying cables:



EX1005, 5 (annotated, depicting a messenger wire (red) supported by brackets (blue), with black current-carrying cables hung on the messenger wire).

108. As can be seen above, images on the CAB Website depict black current carrying cables that are supported by a metal messenger wire. The metal messenger wire is coupled to a number of spaced metal piles with metal brackets, as depicted above. A grounding system is achieved in the image above because all of the components are in contact with each other and are made of metal which is conductive. Accordingly, the CAB Website discloses a grounding system structured to ground a number of cables supported by a support assembly.

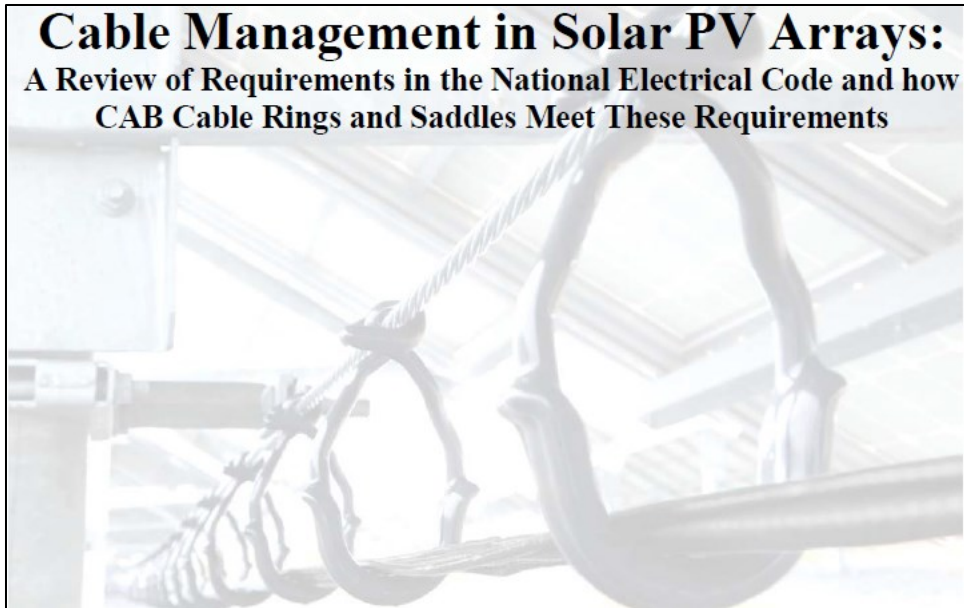
109. The CAB Website discloses a support assembly that includes a plurality of spaced metal piles:



Id. (annotated).

110. Based on the appearance and conventional materials used in the electric industries, the piles depicted above appear to be made of galvanized steel which is a material that conducts electrical current. Accordingly the CAB Website discloses a support assembly including a plurality of spaced, conductive piles.

111. The CAB Whitepaper discloses the same grounding system structured to ground a number of cables supported by a support assembly, as well as spaced conductive piles. The CAB Website depicts a messenger wire fixed to conductive piles with brackets, with black current-carrying cables supported on the messenger wire via cable hangers:



EX1006, 3.

112. Accordingly, the CAB Whitepaper also discloses a grounding system structured to ground a number of cables supported by a support assembly, said support assembly including a plurality of spaced, conductive piles.

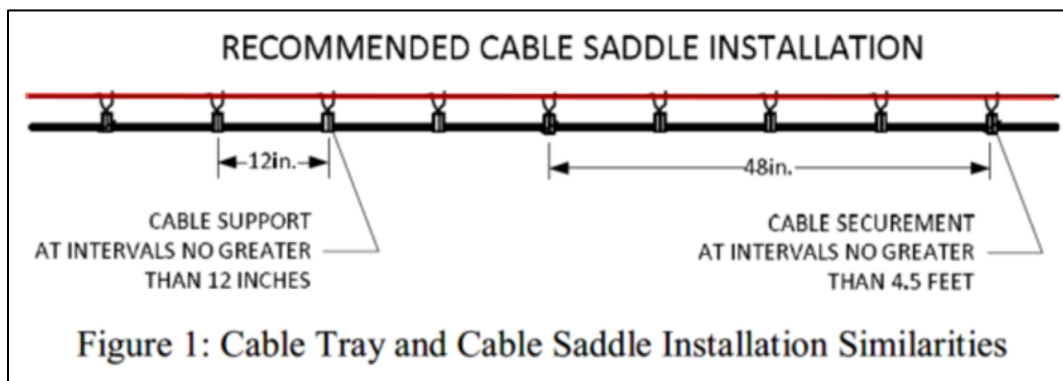
2. Independent Claim 1[b]: a multi-function line assembly including a multi-function line:

113. Both the CAB Website and CAB Whitepaper depict a metal messenger wire attached to spaced piles supporting current carrying cables and hangers. EX1005, 5. For example, the CAB Website depicts a messenger wire that appears to be made of galvanized steel:



Id., (annotated with multi-function line supporting current wires and/or cable hangers in red).

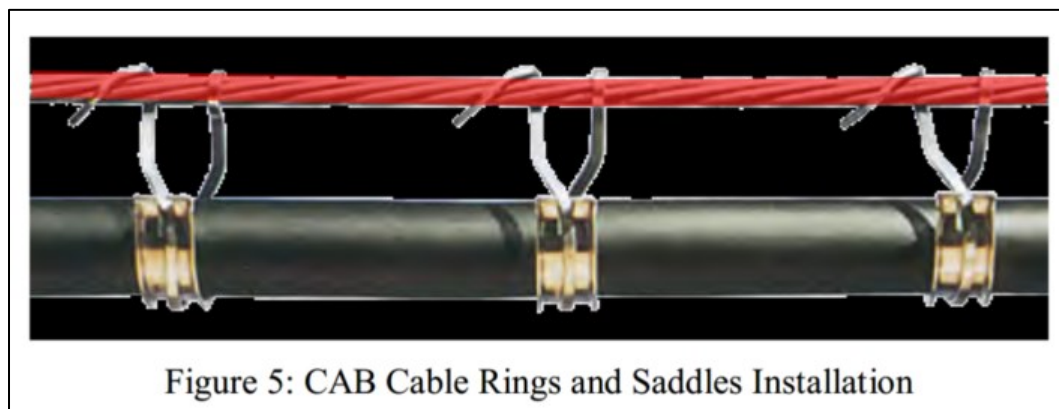
114. Further, the CAB Whitepaper depicts a metal messenger wire attached to spaced piles supporting current carrying cables and hangers. EX1006, 3.



Id., 12 (excerpted and annotated with messenger wire in red).



Id., annotated with messenger wire in red.



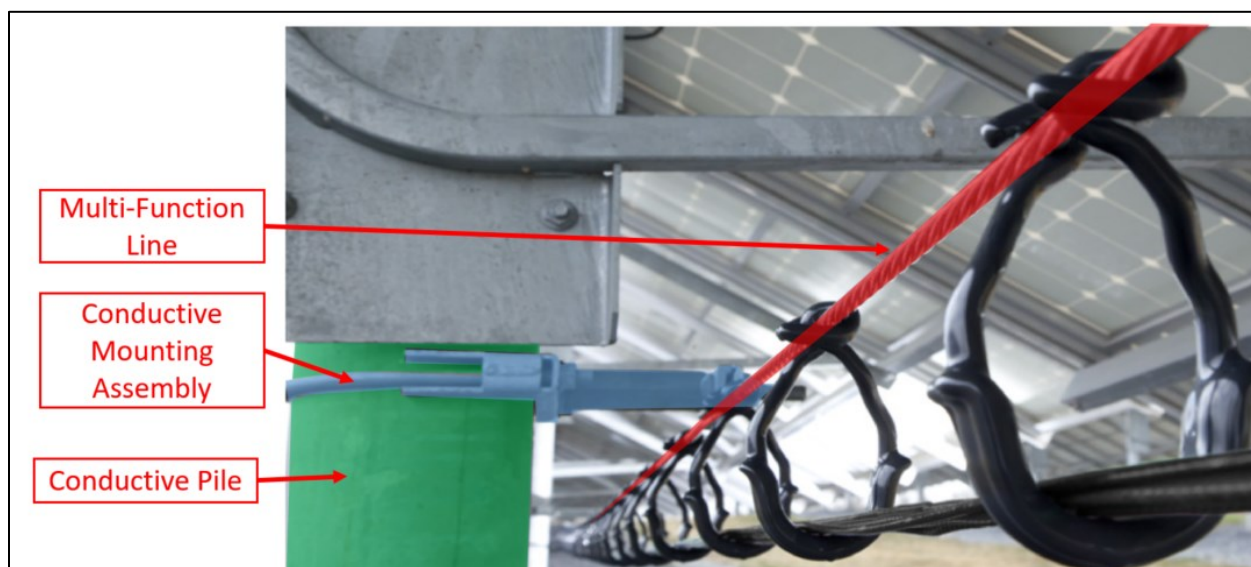
Id., 14 (annotated with messenger wire in red).

115. The messenger wire depicted in the CAB Website and CAB Whitepaper is metal. Specifically, it appears to be made from galvanized steel which is a material that conducts electrical current. The conductive messenger wire depicted in both the CAB Whitepaper and CAB Website is subject to tensile forces of gravity and the weight of the wires and/or cable hangers supported thereon. The '551 Patent defines a “multi-function line” as “a tension member that supports current wires and/or cable hangers” and “is conductive.” EX1001, 2:37-40.

116. Accordingly, the CAB Website and CAB Whitepaper disclose a multi-function line assembly comprising a multi-function line.

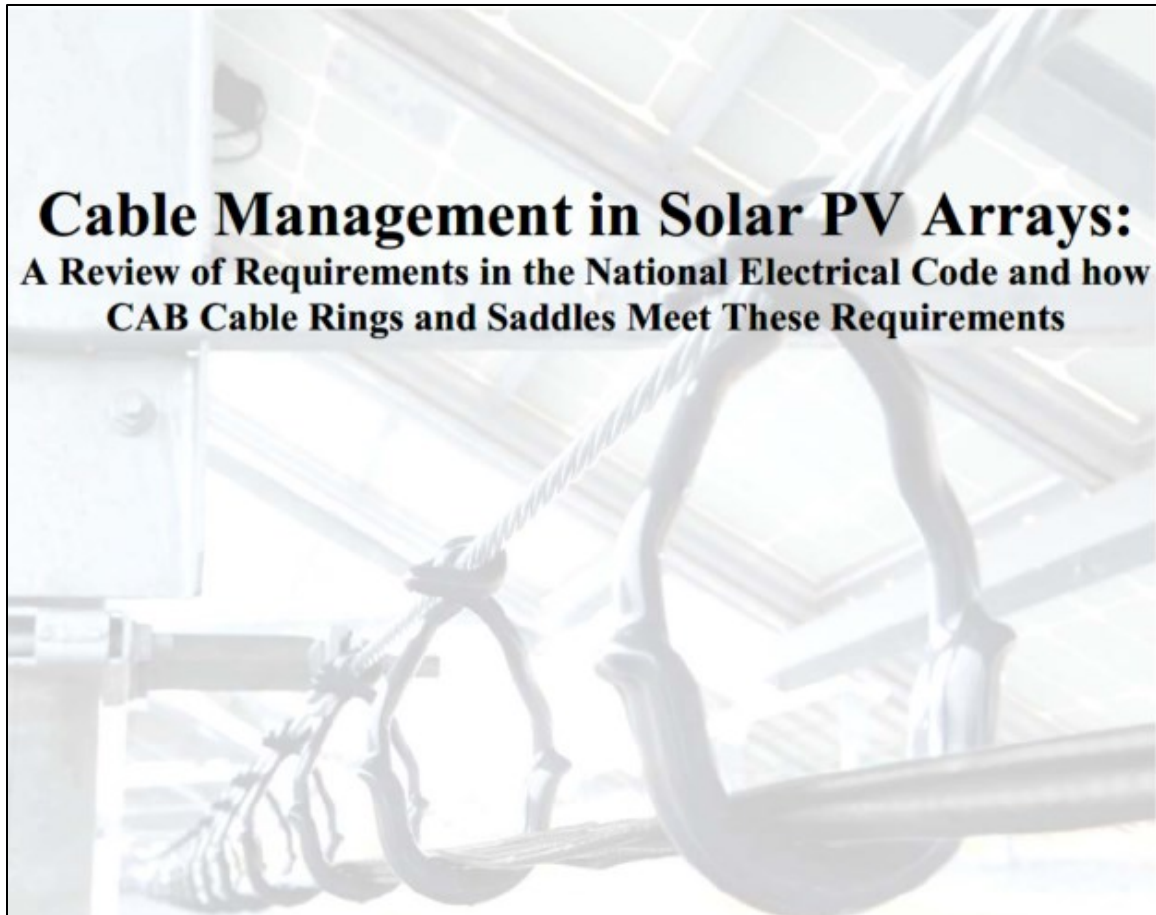
3. **Independent Claim 1[c]**: a number of conductive mounting assemblies, each said conductive mounting assembly structured to be coupled to said multi-function line and to a conductive pile:

117. The CAB Website depicts a number of metal mounting assemblies. Specifically, the metal mounting assemblies appear to be comprised of galvanized steel which is a material that conducts electrical current. The mounting assemblies depicted by the CAB Website are structured to couple a multi-function line to a pile that appears to be made from galvanized steel, which is a material that conducts electrical current:



EX1005, 5 (annotated with conductive metal mounting assembly (blue) structured to be coupled to multi-function line (red), and conductive metal pile (green)).

118. The CAB Whitepaper depicts a nearly identical photo of a conductive mounting assembly:



EX1006, 3.

119. Accordingly, both the CAB Website and CAB Whitepaper disclose a number of conductive mounting assemblies, each structured to be coupled to said multi-function line and to a conductive pile.

4. **Independent Claim 1[d]**: wherein said multi-function line assembly is coupled to, and in electrical communication with, said number of conductive mounting assemblies:

120. As discussed above, the CAB Website and CAB Whitepaper disclose a multi-function line assembly coupled to a conductive mounting assembly. A POSITA at the time of the alleged invention would have understood that such an assembly,

using metallic (i.e. conductive) components, would result in such components being in electrical communication with one another. When electrically conductive materials (such as metal) are in contact with each other, they are in electrical communication with one another. The CAB Website and CAB Whitepaper depict conductive materials (metal messenger wire, mounting assembly, and pile) in contact with each other, which means that the multi-function line is in electrical communication with the mounting assemblies (as well as with the piles).

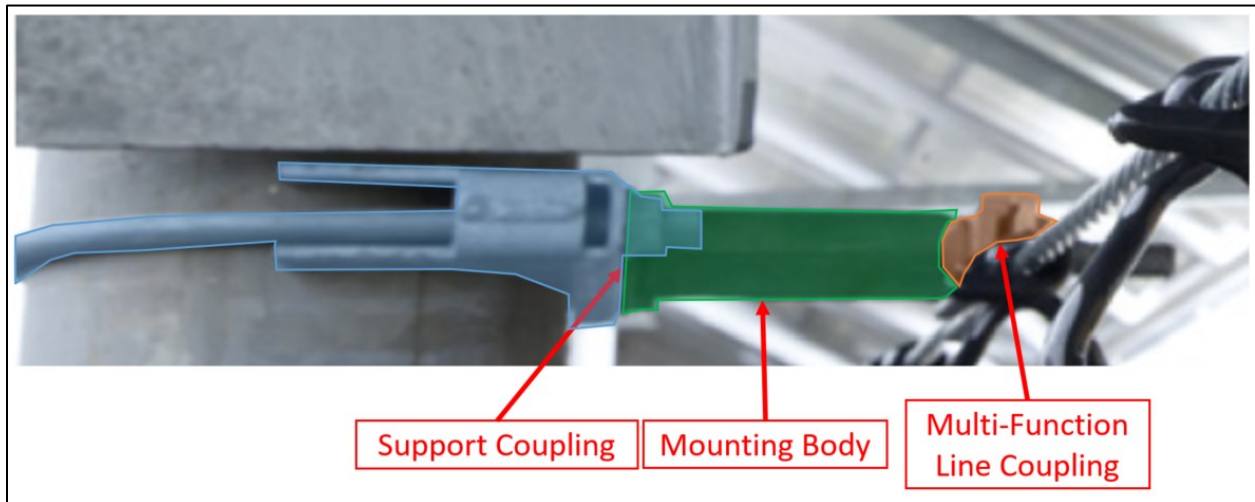
121. Further, the CAB Whitepaper discloses utilizing a “grounded steel messenger wire” (EX1006, 14), which a POSITA at the time of the alleged invention would have understood to mean the messenger wire (i.e. multi-function line) is in contact, *i.e.* electrical communication, with the mounting assembly, and conductive pile. Accordingly, the CAB Website in view of the CAB Whitepaper disclose a multi-function line assembly coupled to, and in electrical communication with, a number of conductive mounting assemblies.

5. Dependent Claim 2[a]: The grounding system of claim 1 wherein:

122. As discussed above, the CAB Website in view of the CAB Whitepaper disclose or render obvious claim 1.

6. **Dependent Claim 2[b]**: each said conductive mounting assembly includes a mounting body, a support coupling, and a number of multi-function line couplings; and:

123. The CAB Website depicts a mounting assembly with a mounting body, a support coupling, and at least one multi-function line coupling:



EX1005, 5 (excerpted and annotated with support coupling in blue, mounting body in green, and multi-function line coupling in orange).

124. As can be seen above, the mounting assembly depicted in the CAB Whitepaper comprises a coupling that couples the multi-function line to the mounting body, and the mounting body is coupled to the vertical pile by the support coupling, all of which appear to be made from galvanized steel, which is a conductive material. Similarly, the CAB Whitepaper discloses the same assembly, including a support coupling, mounting body, and multi-function line coupling. Each mounting assembly on each of the plurality of spaced conductive piles in the system depicted by the CAB Website and CAB Whitepaper contains these same components.

125. A POSITA at the time of the alleged invention would have been motivated to the extend the size of the mounting body disclosed by the CAB Website and CAB Whitepaper in order to facilitate coupling additional messenger wire couplings if a support assembly required more than one messenger, and would have understood that by using components made of metal, the assembly would be conductive. For example, it would have been simple to extend the length of the mounting body (depicted in green above) and affix an additional multi-function line assembly on top of the mounting body. In such configuration a POSITA would have known that (i) mounting body must support plurality of wires, (ii) there must a method of connecting messenger wire to the mounting body, such as clamps, brackets, bolt and nuts, thimble-eye connection, or anything of sort, and (iii) the connection must be maintained by keeping in contact conductive components. Accordingly, the CAB Website in view of the CAB Whitepaper render obvious that each said conductive mounting assembly includes a mounting body, a support coupling, and a number of multi-function line couplings.

7. **Dependent Claim 2[c]:** each said multi-function line coupling defines a conductive path.

126. The CAB Website depicts using metal, specifically galvanized steel messenger wire and couplings. Galvanized steel conducts electrical current, and according when the CAB Website's messenger wire is coupled to the mounting

assembly, a conductive path is formed. Further, the CAB Whitepaper teaches using “a grounded steel messenger wire” which means that in order to be grounded, the messenger wire must be in contact, *i.e.* electrical communication, with the mounting assembly via the messenger wire coupling. EX1006, 14.

127. Accordingly, the CAB Website and CAB Whitepaper render obvious a multi-function line coupling defining a conductive path.

8. Dependent Claim 3: The grounding system of claim 2 wherein each said mounting body is one of a conductive body or a conductive body assembly.

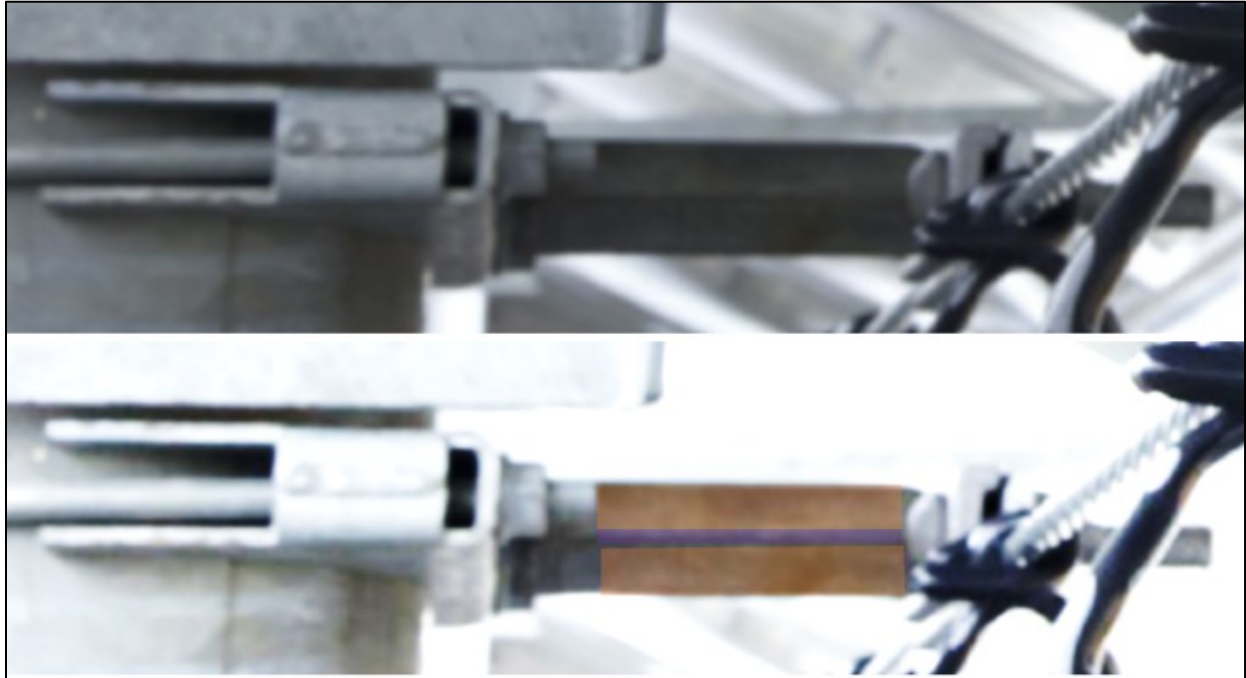
128. The CAB Website depicts a mounting body that is made out of metal, and appears to be galvanized steel which is conductive. Further, the CAB Whitepaper, which discloses the same assembly as the CAB Website, discloses that the steel messenger wire coupled to the mounting body is “grounded,” thereby teaching that the mounting body must be a conductive body. *Id.*

129. Accordingly, the CAB Website and the CAB Whitepaper disclose a mounting body that is one of a conductive body or a conductive body assembly.

9. Dependent Claim 4: The grounding system of claim 3 wherein each said mounting body has a simplified shape.

130. As discussed above, the CAB Website in view of the CAB Whitepaper renders obvious claim 3. The mounting body disclosed by the CAB Website and CAB

Whitepaper has generally planar portions, and transitional bends between the planar portions:



EX1005, 5 (excerpted with original image of mounting body, and color corrected duplication of the original image, annotated with planar portions in orange, and transitional bend in purple).

131. The '551 Patent defines “simplified shape” as “a body or assembly including generally planar portions and transitional bends or welds between the generally planar portions.” EX1001, 9:62-64.

132. Accordingly the CAB Website and CAB Whitepaper disclose a mounting body with a simplified shape.

10. Dependent Claim 5[a]: The grounding system of claim 2 wherein:

133. As discussed above, the CAB Website in view of the CAB Whitepaper discloses or renders obvious claim 2.

11. Dependent Claim 5[b]: each said mounting body is a conductive body:

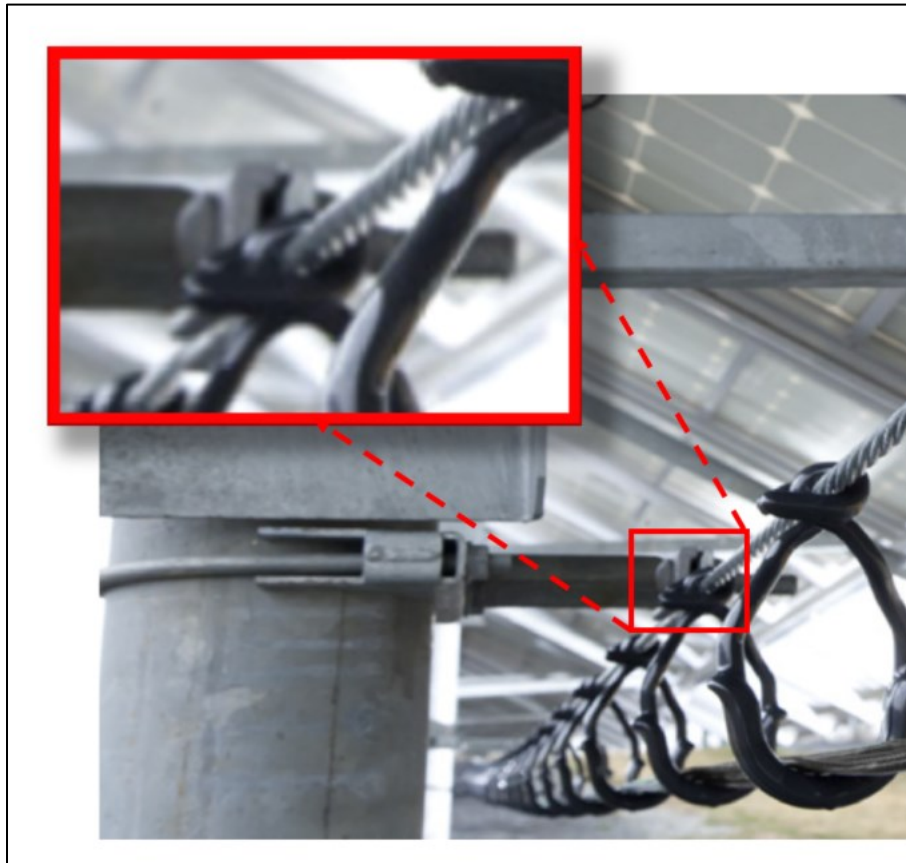
134. As discussed above, the CAB Website and the CAB Whitepaper mounting assemblies that include mounting bodies. In both the CAB Website and CAB Whitepaper, the components depicted in the mounting assemblies are made of metal, and appear to be made of galvanized steel, which is conductive and therefore a conductive body. Accordingly, the CAB Website and the CAB Whitepaper discloses each said mounting body is a conductive body.

12. Dependent Claim 5[c]: each said mounting body conductive body is a partially conductive body.

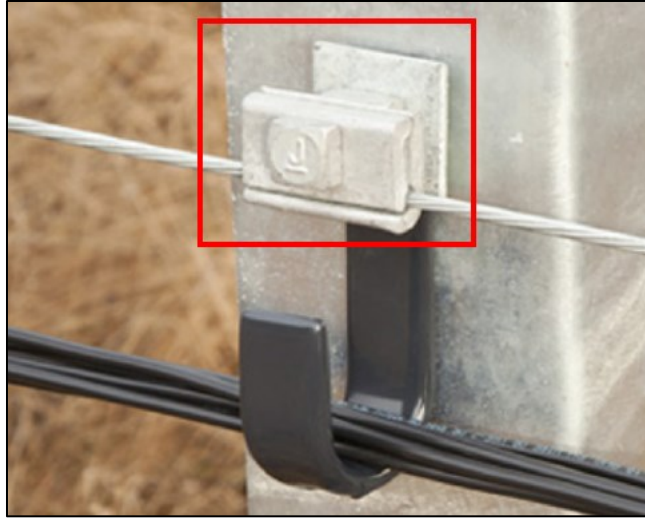
135. The '551 Patent defines “partially conductive” as any material that “conducts electricity” including “galvanized steel[.]” EX1001, 8:18-28. As discussed above, the mounting assemblies disclosed by CAB Website and CAB Whitepaper are comprised of metal components which are conductive, and accordingly both references disclose a mounting body that is partially conductive. EX1005, 5, 13, 18; EX1006, 3, 14-15. Accordingly, the CAB Website and CAB Whitepaper disclose each said mounting body conductive body is a partially conductive body.

13. Dependent Claim 6: The grounding system of claim 2 wherein each said multi-function line coupling is a clamping assembly.

136. The CAB Website (and CAB Whitepaper) depicts two different clam-shell type clamping assemblies for coupling a multi-function line:



EX1005, 5 (excerpted and annotated showing close up view of clam-shell type clamping assembly coupling multi-function line to mounting assembly).



Id., 18 (excerpted and annotated, showing clam-shell type clamping assembly coupling multi-function line to mounting assembly).

137. Accordingly, the CAB Website discloses a multi-function line coupling that is a clamping assembly.

14. Dependent Claim 7: The grounding system of claim 6 wherein each said multi-function line coupling includes one of a clam-shell assembly, a split bolt, a U-bolt, or a lay-in lug assembly.

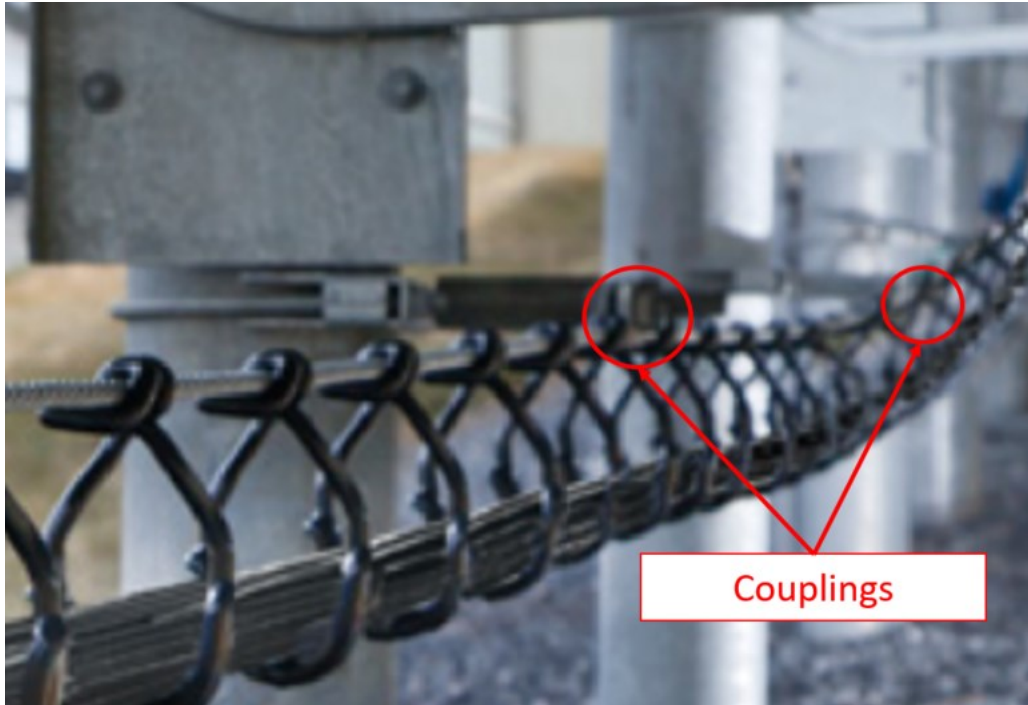
138. As discussed above, the CAB Website and the CAB Whitepaper disclose using clam-shell style multi-function line couplings. Accordingly, the CAB Website and CAB Whitepaper discloses the grounding system of claim 6 wherein each said multi-function line coupling includes one of a clam-shell assembly, a split bolt, a U-bolt, or a lay-in lug assembly.

15. Dependent Claim 8[a]: The grounding system of claim 2 wherein:

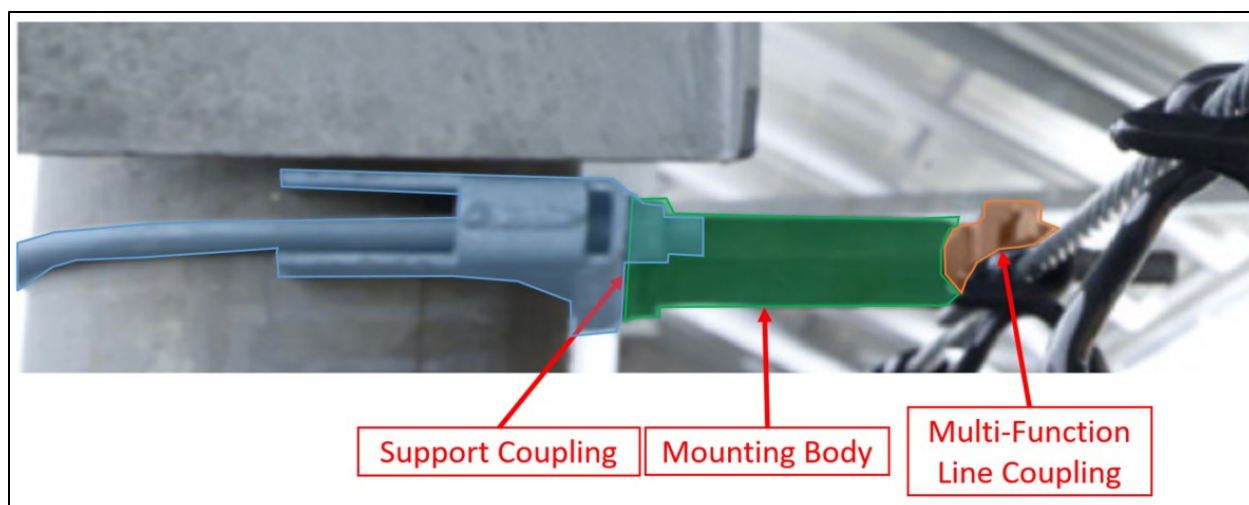
139. As discussed above, the CAB Website and CAB Whitepaper disclose or render obvious claim 2.

16. Dependent Claim 8[b]: said number of multi-function line couplings includes a plurality of multi-function line couplings:

140. As discussed above, the system disclosed in the CAB Website and CAB Whitepaper both depict a plurality of multi-function line couplings on each of the spaced conductive piles:



EX1005, 5 (excerpted and annotated);



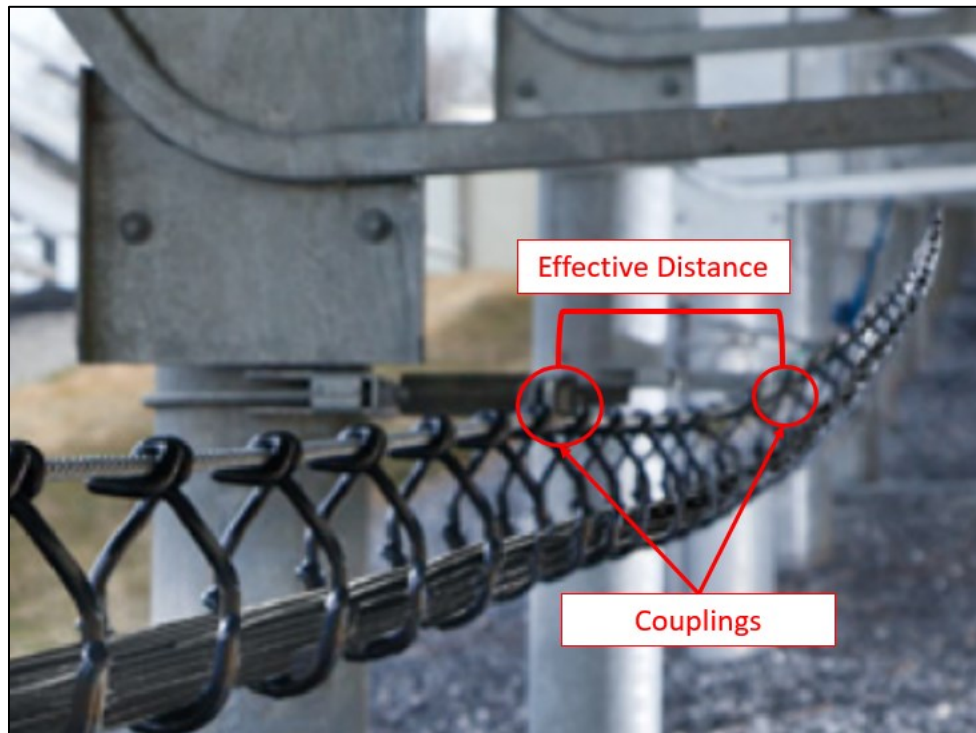
EX1005, 5 (excerpted and annotated with support coupling in blue, mounting body in green, and multi-function line coupling in orange).

141. Further, as discussed above, a POSITA at the time of the alleged invention would have been motivated to the extend the size of the mounting body disclosed by the CAB Website and CAB Whitepaper in order to facilitate coupling additional messenger wire couplings if a support assembly required more than one messenger, and would have understood that by using components made of metal, the assembly would be conductive. For example, it would have been simple to extend the length of the mounting body (depicted in green above) and affix an additional multi-function line assembly on top of the mounting body. In such configuration a POSITA would have known that (i) mounting body must support plurality of wires, (ii) there must a method of connecting messenger wire to the mounting body, such as clamps, brackets, bolt and nuts, thimble-eye connection, or anything of sort, and (iii) the

connection must be maintained by keeping in contact conductive components. Accordingly, the CAB Website and CAB Whitepaper disclose or render obvious a number of multi-function line couplings that include a plurality of multi-function line couplings.

17. Dependent Claim 8[c]: each said multi-function line coupling spaced one of a first effective distance, a second effective distance, or a third effective distance from another multi-function line coupling.

142. The CAB Website in view of the CAB Whitepaper discloses or renders this limitation obvious. The CAB Website discloses spacing multi-function line couplings approximately ten to twenty apart:



EX1005, 5 (excerpted and annotated).

143. The '551 Patent defines “first effective distance” as “between less than one foot to about one hundred feet apart,” “second effective distance” as “between one foot and about fifty feet apart,” and “third effective distance” as “between about five feet and about thirty feet apart.” EX1001, 11:2-7. Further, a POSITA at the time of the alleged invention would have been motivated to space the multi-function line couplings disclosed by the CAB Website a first, second, or third effective distance from each coupling because such distances were known in the art. For example, IEEE Standard 142 explains that current carrying cables create magnetic fields, hence when they are placed adjacently, their magnetic fields must not cross-link with one another because this will cause circulating currents between the two current carrying cables. EX1028, 90-91. Furthermore, the National Safety Code, Rule 235G specifies that vertical spacing between conductive cables shall not be less than 4 to 12 inches, depending upon the span lengths. EX1031, 1-2. Combined with IEEE specifications regarding magnetic field cross-linking, POSITAs at the time of the alleged invention understood that such vertical spacing requirements are applicable for horizontally spacing conductors on mounting brackets.

144. Accordingly, the CAB Website discloses couplings spaced one of a first effective distance, a second effective distance, or a third effective distance from another multi-function line coupling.

18. Dependent Claim 9: The grounding system of claim 1 wherein said multi-function line assembly does not include any grounding splices.

145. A POSITA at the time of the alleged invention would have understood that the grounding system disclosed by the CAB Website, and the CAB Whitepaper, would not require the addition of grounding splices because each mounting assembly disclosed by the CAB Website and CAB Whitepaper is grounded by virtue of coupling together conductive components. As discussed above, both the CAB Website and CAB Whitepaper disclose using components made of metal (in particular the components appear to be made from galvanized steel), which conduct electrical current. The components disclosed by the CAB Website and CAB Whitepaper are in contact with each other and therefore would create a path to ground via the conductive metal piles, obviating any need for a grounding splice. Accordingly the CAB Website and CAB Whitepaper disclose or render obvious the grounding system of claim 1 wherein said multi-function line assembly does not include any grounding splices.

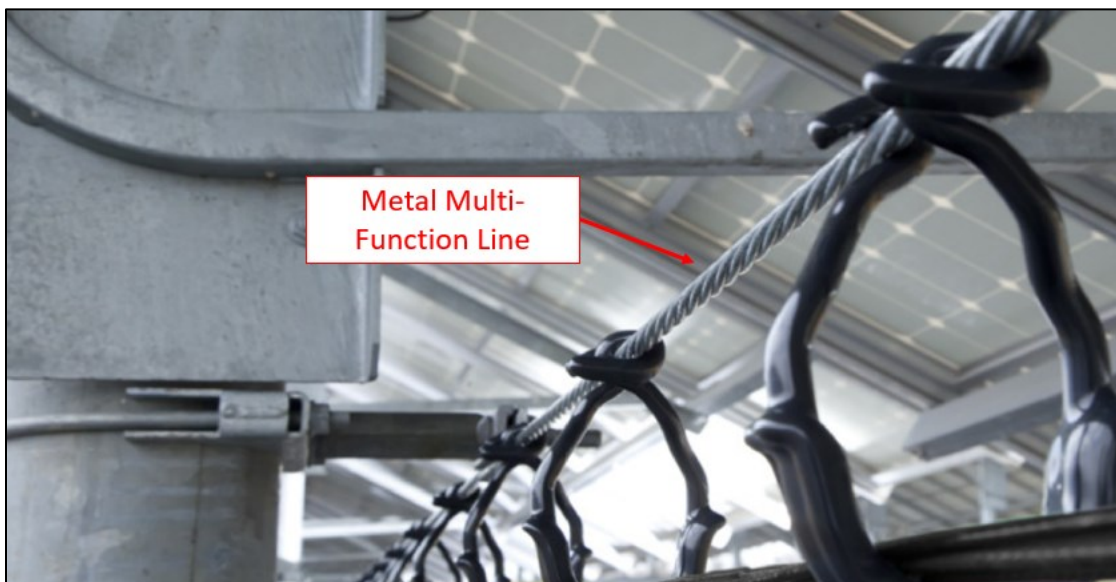
19. Dependent Claim 10: The grounding system of claim 1 wherein said multi-function line assembly does not include any medial grounding splices.

146. A POSITA at the time of the alleged invention would have understood that the grounding system disclosed by the CAB Website, and the CAB Whitepaper, would not require the addition of grounding splices because each mounting assembly disclosed by the CAB Website and CAB Whitepaper is grounded by virtue of coupling

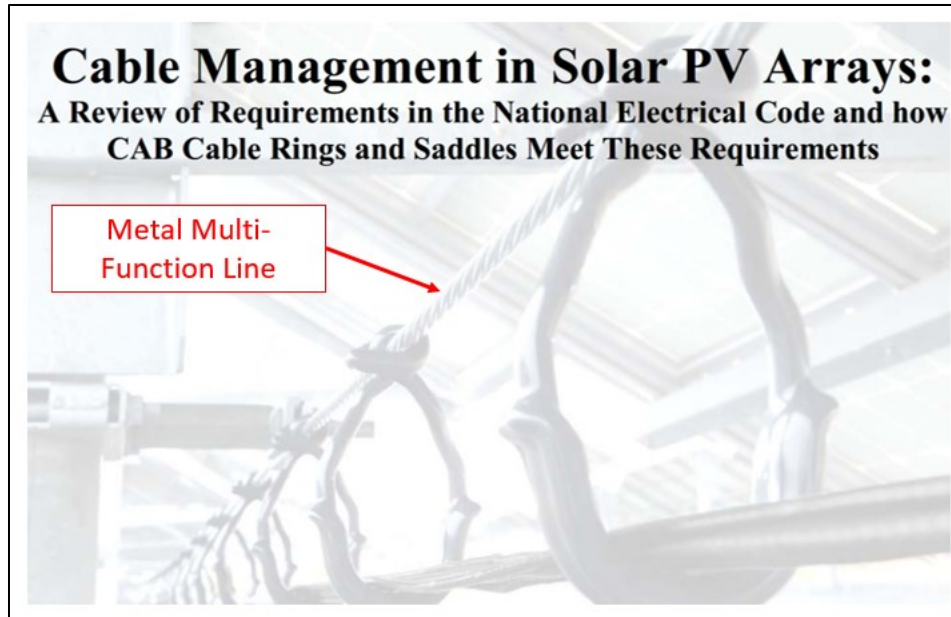
together conductive components. As discussed above, both the CAB Website and CAB Whitepaper disclose using components made of metal (in particular the components appear to be made from galvanized steel), which conduct electrical current. The components disclosed by the CAB Website and CAB Whitepaper are in contact with each other and therefore would create a path to ground via the conductive metal piles, obviating any need for a grounding splice. Accordingly, the CAB Website and CAB Whitepaper disclose or render obvious the grounding system of claim 1 wherein said multi-function line assembly does not include any medial grounding splices.

20. Dependent Claim 11: The grounding system of claim 1 wherein said multi-function line includes one of a highly conductive body or a partially conductive body.

147. Both the CAB Website and CAB Whitepaper depict metal strand multi-function lines:



EX1005, 5 (annotated);



EX1006, 3 (annotated).

148. Further, the CAB Whitepaper discloses use of a “grounded steel messenger wire” which according to the ’551 Patent is “partially conductive.”

EX1006, 14; EX1001, 8:26-28.

149. Accordingly, the CAB Website and CAB Whitepaper disclose a multi-function line that includes one of a highly conductive body or a partially conductive body.

21. Dependent Claim 12: The grounding system of claim 1 wherein said multi-function line includes strands selected from the group consisting of: copper strands, copper-clad steel strands, galvanized strands, conductive alloy strands, partially conductive, alloy strands, or composite strands.

150. As discussed above, the grounding system disclosed by the CAB Website and CAB Whitepaper teach the use of multi-function lines comprised of strands of

metal wrapped around each other. To the extent not expressly disclosed by the CAB Website or CAB Whitepaper, it would have been obvious to a POSITA at the time of the alleged invention to use a multi-function line that includes copper strands, copper-clad steel strands, galvanized strands, conductive alloy strands, partially conductive, alloy strands, or composite strands because these materials were known in the art. For example, NEC article 250.118 teaches that “copper, aluminum, or copper-clad aluminum” conductors can be used for grounding purposes. EX1007, 118-119 (Article 250.118). Accordingly the CAB Website and CAB Whitepaper disclose or render obvious the grounding system of claim 1 wherein said multi-function line includes strands selected from the group consisting of: copper strands, copper-clad steel strands, galvanized strands, conductive alloy strands, partially conductive, alloy strands, or composite strands.

22. Dependent Claim 13: The grounding system of claim 12 wherein said multi-function line assembly terminal support includes a conductive thimble-eye.

151. Conductive thimble-eye assemblies were widely used in terminal supports while maintaining the conductive path of a grounding assembly. Nearly all aerial support assemblies using messenger wires need to have a terminal support in order to prevent sagging of the messenger wire that may occur over time, even when the messenger wire is coupled to support piles along the support assembly. Indeed, the NEC specifically provides for messenger wires to be simultaneously used both as

structural support for conductors and as the equipment grounding conductor itself. For example, Chapter 3 of the NEC, which covers messenger cable supported wiring, provides that when the messenger wire is used in a support system, the same messenger wire may be used as a grounding conductor and shall be supported at dead ends (terminal supports):

396.30 Messenger.

(A) Support. The messenger shall be supported at dead ends and at intermediate locations so as to eliminate tension on the conductors. The conductors shall not be permitted to come into contact with the messenger supports or any structural members, walls, or pipes.

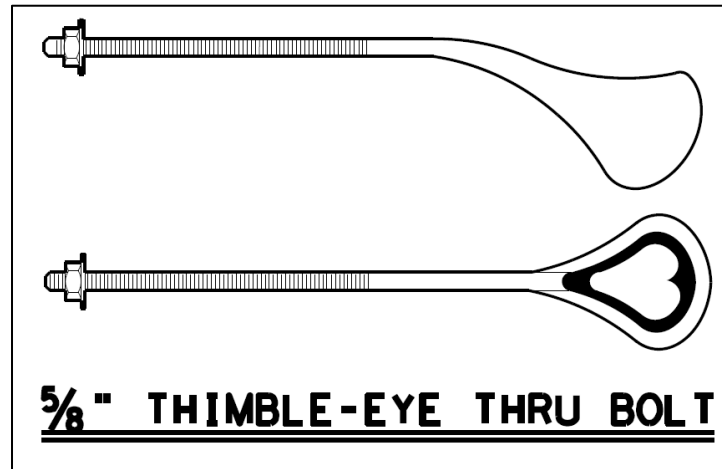
(B) Neutral Conductor. Where the messenger is used as a neutral conductor, it shall comply with the requirements of 225.4, 250.184(A), 250.184(B)(7), and 250.186(B).

(C) Equipment Grounding Conductor. Where the messenger is used as an equipment grounding conductor, it shall comply with the requirements of 250.32(B), 250.118, 250.184(B)(8), and 250.186(D).

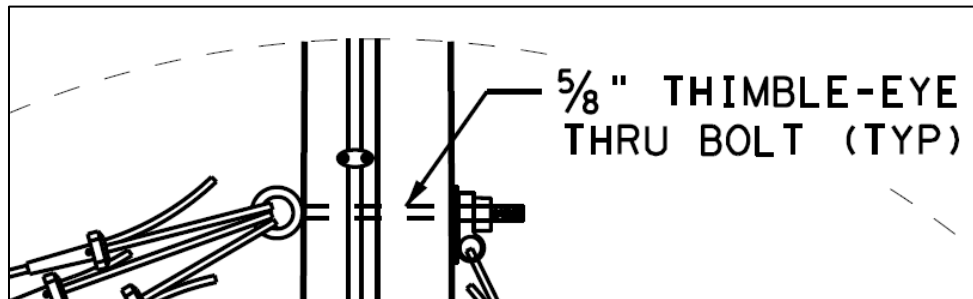
EX1007, 241 (Article 396.30).

152. The messenger wire depicted in both the CAB Website and CAB Whitepaper is taught, and therefore must be terminated at its ends. Thimble-eye termination points were widely used as simple means to maintain the taughtness of a messenger wire and prevent sagging. For instance, in 2001, the U.S. Department of Agriculture, Rural Utilities Services, recommended thimble eye bolts and/or thimble eye nuts for attaching guy wires to distribution poles. EX1036, 8. Even further, in 2012,

the Texas Department of Transportation issued recommendations on traffic electric pole assemblies which included the use of thimble-eye terminals (bolt and nut):

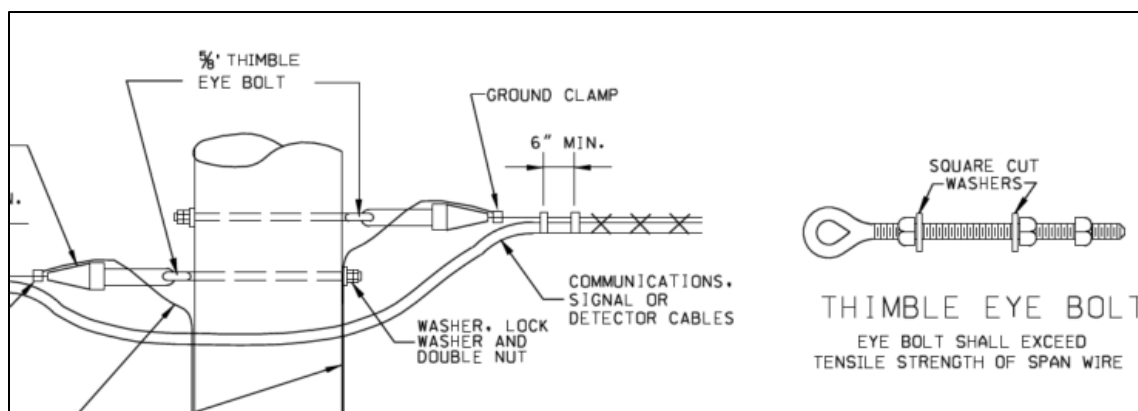


EX1033, 3.



Id.

153. Further, in 2004, the State of Tennessee Department of Transportation similarly issued guidance recommending the use of thimble-eye terminals for terminating messenger wire:



EX1034. Accordingly, the CAB Website and CAB Whitepaper disclose or render obvious the grounding system of claim 12 wherein said multi-function line assembly terminal support includes a conductive thimble-eye.

23. Dependent Claim 14: The grounding system of claim 13 wherein said multi-function line is structured to be operational with solar electrical equipment.

154. The CAB Website expressly provides that the ground system disclosed therein are used to “deliver safe, strong and durable support for all types of solar wiring.” EX1005, 3. Further, the CAB Whitepaper is entirely directed to “[c]able [m]anagement in [s]olar PV [photovoltaic] [a]rrays[.]” EX1006, 3.

155. Accordingly, it the grounding and support system depicted in the CAB Website and CAB Whitepaper are structured to be operation with solar electrical equipment. Accordingly, the CAB Website and CAB Whitepaper disclose or render obvious the grounding system of claim 13 wherein said multi-function line is structured to be operational with solar electrical equipment.

24. Dependent Claim 15: The grounding system of claim 13 wherein said multi-function line assembly does not include any grounding splices.

156. A POSITA at the time of the alleged invention would have understood that the grounding system disclosed by the CAB Website, and the CAB Whitepaper, would not require the addition of grounding splices because each mounting assembly disclosed by the CAB Website and CAB Whitepaper is grounded by virtue of coupling together conductive components. As discussed above, both the CAB Website and CAB Whitepaper disclose using components made of metal (in particular the components appear to be made from galvanized steel), which conduct electrical current. The components disclosed by the CAB Website and CAB Whitepaper are in contact with each other and therefore would create a path to ground via the conductive metal piles, obviating any need for a grounding splice. Accordingly, the CAB Website and CAB Whitepaper disclose or render obvious the grounding system of claim 13 wherein said multi-function line assembly does not include any grounding splices.

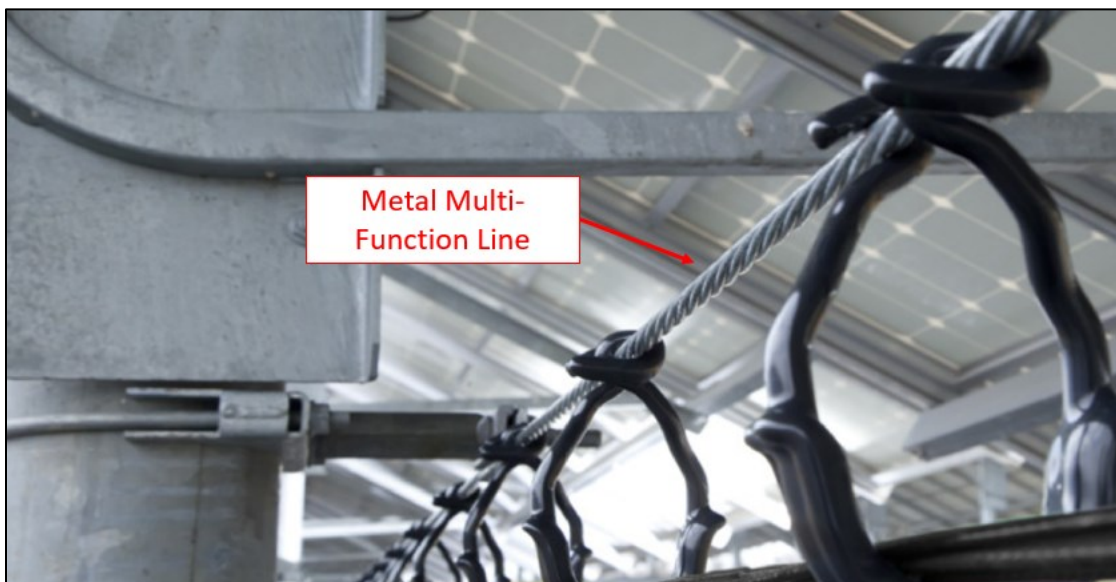
25. Dependent Claim 16: The grounding system of claim 13 wherein said multi-function line assembly does not include any medial grounding splices.

157. A POSITA at the time of the alleged invention would have understood that the grounding system disclosed by the CAB Website, and the CAB Whitepaper, would not require the addition of grounding splices because each mounting assembly disclosed by the CAB Website and CAB Whitepaper is grounded by virtue of coupling

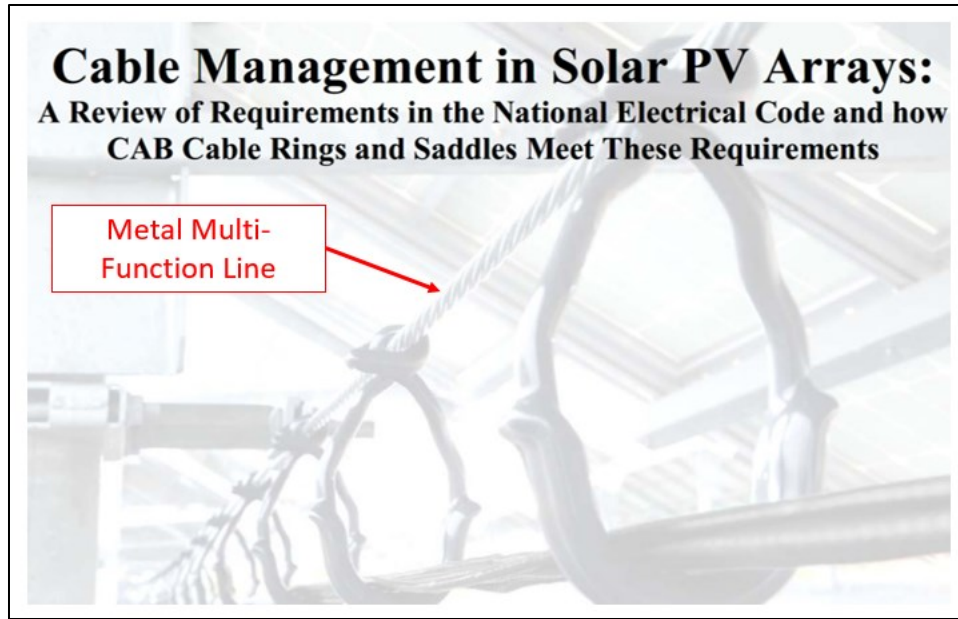
together conductive components. As discussed above, both the CAB Website and CAB Whitepaper disclose using components made of metal (in particular the components appear to be made from galvanized steel), which conduct electrical current. The components disclosed by the CAB Website and CAB Whitepaper are in contact with each other and therefore would create a path to ground via the conductive metal piles, obviating any need for a grounding splice. Accordingly, the CAB Website and CAB Whitepaper disclose or render obvious the grounding system of claim 13 wherein said multi-function line assembly does not include any medial grounding splices.

26. Dependent Claim 17: The grounding system of claim 13 wherein said multi-function line includes one of a highly conductive body or a partially conductive body.

158. Both the CAB Website and CAB Whitepaper depict metal strand multi-function lines:



EX1005, 5 (annotated);



EX1006, 3 (annotated).

159. Further, the CAB Whitepaper discloses use of a “grounded steel messenger wire” which according to the ’551 Patent is “partially conductive.”

EX1006, 14; EX1001, 8:26-28.

160. Accordingly, the CAB Website and CAB Whitepaper disclose a multi-function line that includes one of a highly conductive body or a partially conductive body.

27. Dependent Claim 18: The grounding system of claim 1 wherein said multi-function line assembly includes a conductive terminal support.

161. It would have been obvious to a POSITA at the time of the alleged invention to utilize a terminal support made of conductive material in order to provide sufficient grounding means for each of the metal components utilized in the grounding system disclosed by the CAB Website and CAB Whitepaper. In order to maintain an

effective path for the ground current to flow, a POSITA would have known that any terminal support would have needed to be conductive. This is common in any grounding systems.

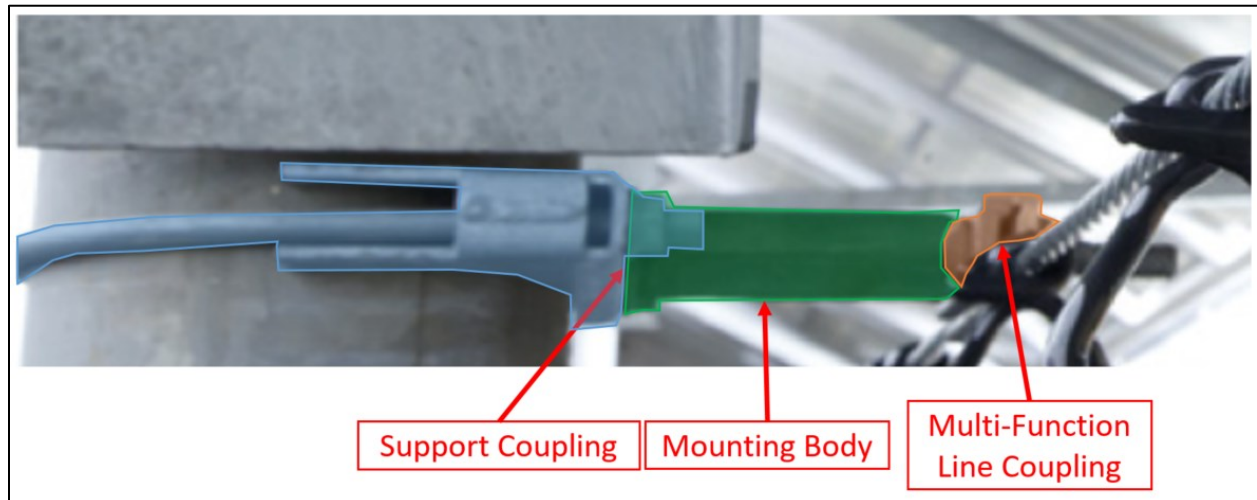
28.Independent Claim 19[a]: A mounting assembly for a grounding system structured to ground a number of cables supported by a support assembly, said support assembly including a plurality of spaced, conductive piles, said grounding system including a multi-function line assembly with a multi-function line, said mounting assembly comprising:.

162. As discussed above, both the CAB Website and the CAB Whitepaper disclose a cable support system that utilized metal components in contact with each other. Because metal conducts electrical current, by placing the metal messenger wire in contact with the metal mounting assemblies, and coupling the metal mounting assemblies to the metal steel piles, a ground path is formed. Accordingly, the CAB Website and CAB Whitepaper disclose or render obvious the grounding system of claim 1 wherein said multi-function line assembly includes a conductive terminal support.

29.Independent Claim 19[b]: a mounting body, a support coupling, and a number of multi-function line couplings.

163. As discussed above, the CAB Website and the CAB Whitepaper discloses a number of mounting assemblies, each comprising a mounting body with a multi-function line coupling thereon, with each mounting body coupled to a conductive pile via a support coupling. For example, The CAB Website depicts a mounting

assembly with a mounting body, a support coupling, and at least one multi-function line coupling:



EX1005, 5 (excerpted and annotated with support coupling in blue, mounting body in green, and multi-function line coupling in orange).

164. As can be seen above, the mounting assembly depicted in the CAB Whitepaper comprises a coupling that couples the multi-function line to the mounting body, and the mounting body is coupled to the vertical pile by the support coupling, all of which appear to be made from galvanized steel, which is a conductive material. Similarly, the CAB Whitepaper discloses the same assembly, including a support coupling, mounting body, and multi-function line coupling. Each mounting assembly on each of the plurality of spaced conductive piles in the system depicted by the CAB Website and CAB Whitepaper contains these same components. Accordingly, the

CAB Website and CAB Whitepaper disclose or render obvious a mounting body, a support coupling, and a number of multi-function line couplings.

30.Independent Claim 19[c]: each said multi-function line couplings structured to be coupled to said multi-function line.

165. As discussed above regarding claim 1 and 2, the structure of the system depicted in the CAB Website and CAB Whitepaper shows that the couplings used in the mounting assembly are structured to couple the multi-function to the mounting assembly. Accordingly, the CAB Website and CAB Whitepaper disclose or render obvious each said multi-function line couplings structured to be coupled to said multi-function line.

31.Independent Claim 19[d]: each said support coupling structured to be coupled to a conductive pile; and.

166. As discussed above regarding claim 1 and 2, the structure of the system depicted in the CAB Website and CAB Whitepaper shows that the support couplings are structured to be coupled to a conductive pile. Accordingly, the CAB Website and CAB Whitepaper disclose or render obvious each said support coupling structured to be coupled to a conductive pile.

32.Independent Claim 19[e]: wherein, when said multi-function line assembly is coupled to, and in electrical communication with said multi-function line couplings, each said multi-function line coupling defines a conductive path.

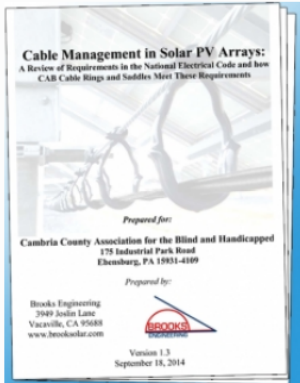
167. As discussed above regarding claim 1 and 2, the structure of the system depicted in the CAB Website and CAB Whitepaper shows that a multi-function line is

coupled to the mounting brackets and conductive piles, thereby forming a conductive path. The CAB Website depicts using metal, specifically galvanized steel messenger wire and couplings. Galvanized steel conducts electrical current, and according when the CAB Website's messenger wire is coupled to the mounting assembly, a conductive path is formed. Further, the CAB Whitepaper teaches using "a grounded steel messenger wire" which means that in order to be grounded, the messenger wire must be in contact, *i.e.* electrical communication, with the mounting assembly via the messenger wire coupling. EX1006, 14. Accordingly, the CAB Website and CAB Whitepaper render obvious a multi-function line assembly that is coupled to, and in electrical communication with said multi-function line couplings, each said multi-function line coupling defines a conductive path.

33. Motivation to Combine the CAB Website and CAB Whitepaper

168. A POSITA at the time of the alleged invention would have been motivated to combine the teachings in the CAB Website with the teachings in the CAB Whitepaper because both references are concerned with the same subject matter (cable management systems for solar arrays), discuss the same company's products, and because the CAB Website expressly references by name and date, excerpts from, and encourages CAB Website visitors to download the CAB Whitepaper:

Bill Brooks Engineering White Paper



"Cable management is critical to the safety and longevity of nearly every Solar PV System. This is primarily due to the extensive use of exposed cables in the PV array.

"Using purpose-built products like CAB Cable Rings and Saddles for exposed cable management in a PV array is well substantiated by NEC and industry installation standards.

"Multiple hanger sections, such as those in various configurations of CAB Cable Rings and Saddles, create effective separation of conductors that allow for dc, ac, and communications cables to be supported with a single ring type." – Bill Brooks, Brooks Engineering White Paper

CAB provides high quality, cost effective wire management solutions. We include here a September 2014 White Paper, published by Brooks Engineering, which reviews requirements of the 2014 updated NEC as it relates to CAB Cable Rings and Saddles.

[Click here to read this important White Paper.](#)

EX1005, 4-5.

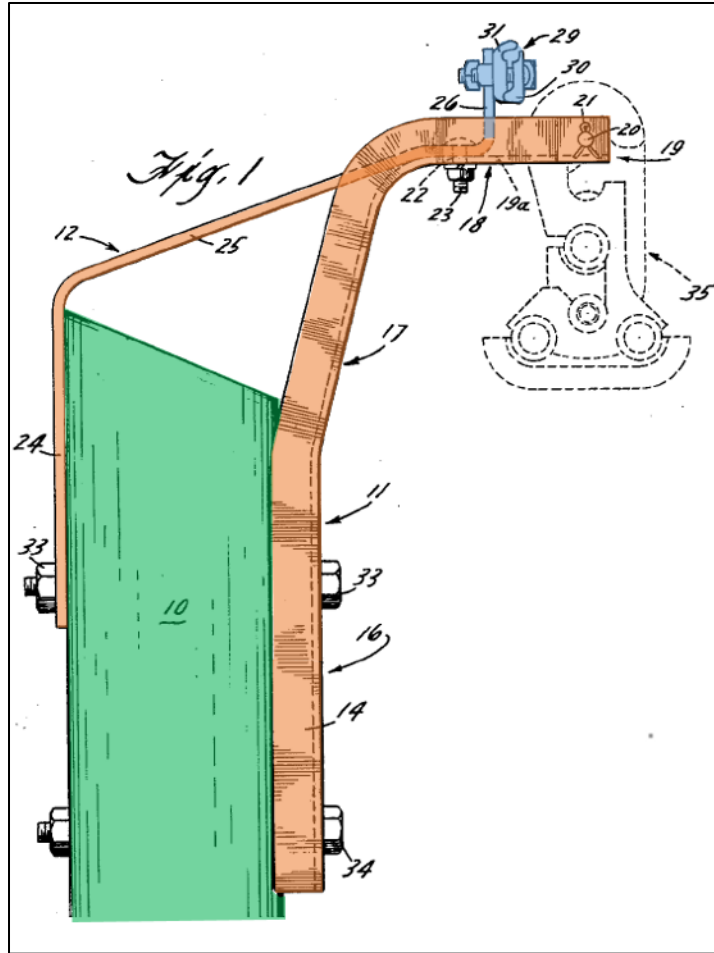
169. A POSITA at the time of the alleged invention would have a reasonable expectation of success in combining the teachings of the two references because both references are discussing the same cable management systems and corresponding components. The CAB Website provides visual schematic of the parts and brief description of them. A POSTA would be encouraged to refer to the CAB White paper to check the details of the parts and to ensure that CAB products satisfy NEC codes.

XIII. Ground 3: Claims 1-19 of the '551 patent obvious in view of Petersen alone or in combination with the knowledge of a POSITA at the time of the alleged invention.

- 1. Independent Claim 1[a]:** A grounding system structured to ground a number of cables supported by a support assembly, said support

assembly including a plurality of spaced, conductive piles, said grounding system comprising:

170. Petersen discloses “a [utility] pole top extension” that “is adapted to be attached to the top of the pole” with an “end portion 26 extend[ing] above the pole top extension” “for supportingly engaging [a] neutral messenger cable.” EX1004, 1:50-51; 2:1-8. Petersen’s pole top extension and neutral messenger cable are used to support current carrying cables. *Id.*, 2:41-44. Coupled to end portion 26 of Petersen’s assembly is “a ground clamp means 29 which is fixedly mounted ... and comprises two clamping jaw members 30 and 31 which upon tightening of suitable bolts confine and keep a neutral messenger cable 37 in tight supported engagement therewith.” *Id.*, 2:34-40. Petersen’s use of the term “ground clamp means” implies to me that the neutral messenger and pole top extension are coupled with the clamp means in order to provide a ground-path for any stray electrical current.



EX1004, Fig. 1 (excerpted and annotated with pile in green, support assembly in orange, and end portion 26 with ground clamp means 29 for neutral messenger cable 37 in blue).

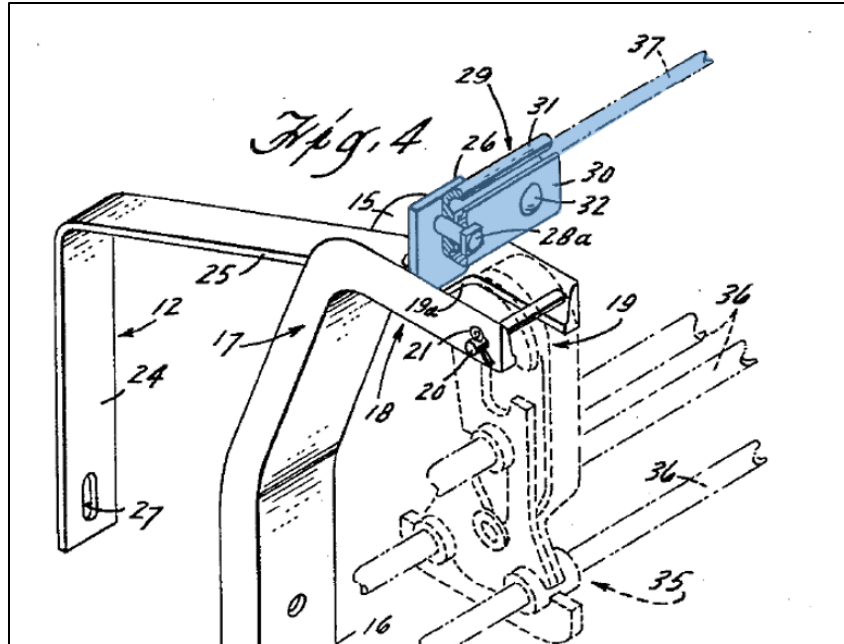
171. Accordingly, Petersen renders obvious a grounding system structured to ground a number of cables supported by a support assembly.

172. It would have been obvious to a POSITA prior to the alleged invention of the '551 Patent that Petersen's system includes more than one pile or utility pole because electric distribution systems require a plurality of piles in order to cover greater

distances. Petersen teaches that the parts of Petersen's assembly are "metallic" and therefore must be conductive in the context of electrical power systems. *Id.*, 2:56-63. To the extent Petersen does not expressly disclose conductive piles, metallic and/or conductive materials were widely used in the industry for piles in electrical distribution systems around the time of Petersen's invention because of their enhanced durability, and because metal piles weigh approximately 60% less than wood structures, galvanized steel poles are easier and less expensive to handle and install. *See* EX1030. Accordingly, Petersen discloses or renders obvious a support system including a plurality of spaced conductive piles.

2. Independent Claim 1[b]: a multi-function line assembly including a multi-function line:

173. Petersen's "neutral messenger cable 37" is subjected to tensile forces as a result of gravity and the weight current wires and/or cable hangers supported thereon, and accordingly that Petersen's neutral messenger cable 37 is a tension/support member.



EX1004, Fig. 4 (excerpted and annotated with multifunction line assembly (clamping means 29, vertical portion 26, and neutral messenger cable 37 in blue).

174. Petersen's neutral messenger cable 37 is a multi-function line. Accordingly, Petersen discloses or renders obvious a multi-function line assembly including a multi-function line.

3. Independent Claim 1[c]: a number of conductive mounting assemblies, each said conductive mounting assembly structured to be coupled to said multi-function line and to a conductive pile:

175. Petersen's pole top extension (mounting assembly) (of which there would be multiple in any energy distribution system, *i.e.*, one per pile) is comprised of "metallic parts" which are conductive. Petersen's pole top extension mounting assembly is structured to be coupled to said neutral messenger wire cable 37 (multi-function line) via portion 26 of the brace member 12 using two clamping jaw members.

EX1004, 34-40. Petersen's pole top extension mounting assembly is structured to be attached to the conductive pole with "[s]uitable through bolts 33 and 34 [which] extend through the pole and fixedly attach the brace member to the channel support member to the pole[.]" *Id.*, 2:28-33. Accordingly, Petersen discloses or renders obvious a number of conductive mounting assemblies, each said conductive mounting assembly structured to be coupled to said multi-function line and to a conductive pile.

4. Independent Claim 1[d]: wherein said multi-function line assembly is coupled to, and in electrical communication with, said number of conductive mounting assemblies:

176. Petersen discloses coupling the neutral messenger cable (multi-function line) to the pole top extension assembly (mounting assembly) via "ground clamp means 29 which is fixedly mounted by a bolt 28a." *Id.*, 2:34-36. A metallic messenger cable fixed to a metallic coupling, which is fixed to a metallic mounting assembly creates an electrical communication between the foregoing components due to their conductive properties and being in contact with one another. As a result, Petersen discloses a multi-function line assembly coupled to and in contact, *i.e.* in electrical communication, with conductive mounting assemblies. Accordingly, Petersen discloses or renders obvious a multi-function line assembly that is coupled to, and in electrical communication with, said number of conductive mounting assemblies.

5. Dependent Claim 2[a]: The grounding system of claim 1 wherein:

177. As discussed above, Petersen discloses or renders obvious claim 1.

6. **Dependent Claim 2[b]**: each said conductive mounting assembly includes a mounting body, a support coupling, and a number of multi-function line couplings; and:

178. Petersen discloses a metallic pole top extension which includes a “vertically extending end portion 26” for supporting “the neutral messenger cable.” EX1004, 2:1-8. End portion 26 of Petersen’s system acts as a mounting body because the neutral messenger cable (multi-function line) is mounted on end portion 26 via ground clamp means 29. *Id.*, Fig. 4. Further, Petersen discloses coupling the pole top extension to the pole with “[s]uitable through bolts 33 and 34 [which] extend through the pole and fixedly attach the brace member and channel support member [of the pole top extension] to the pole,” thereby supporting the pole top extension. *Id.*, 2:28-33.

179. Though Petersen discloses a single ground clamp structure to couple the messenger wire to each pole top extension, Petersen acknowledges that “many modifications ... are possible.” EX1004, 2:67-69. One such modification that could easily be made to Petersen’s system would have been the addition of a second ground clamping means 29 to facilitate an additional neutral messenger wire. As discussed above, messenger wires can only support a maximum load based on their physical characteristics such as diameter, material, and the space between piles. Because of this, it is very common for mounting assemblies to be extended to facilitate a plurality of messenger wires. Petersen’s system could be modified by welding or bolting additional brackets and/or clamps or using plurality of piles where the piles would be welded or

bolted together. Due to additional load when plurality of messenger wires are used, the piles would possibly need to be mechanically strengthened or substituted for wider-diameter piles.

180. Accordingly, it would have been obvious at the time of the alleged invention to provide additional ground clamps to facilitate coupling additional neutral messenger cables, and Petersen therefore discloses or renders obvious a conductive mounting assembly that includes a mounting body, a support coupling, and a number of multi-function line couplings.

7. Dependent Claim 2[c]: each said multi-function line coupling defines a conductive path.

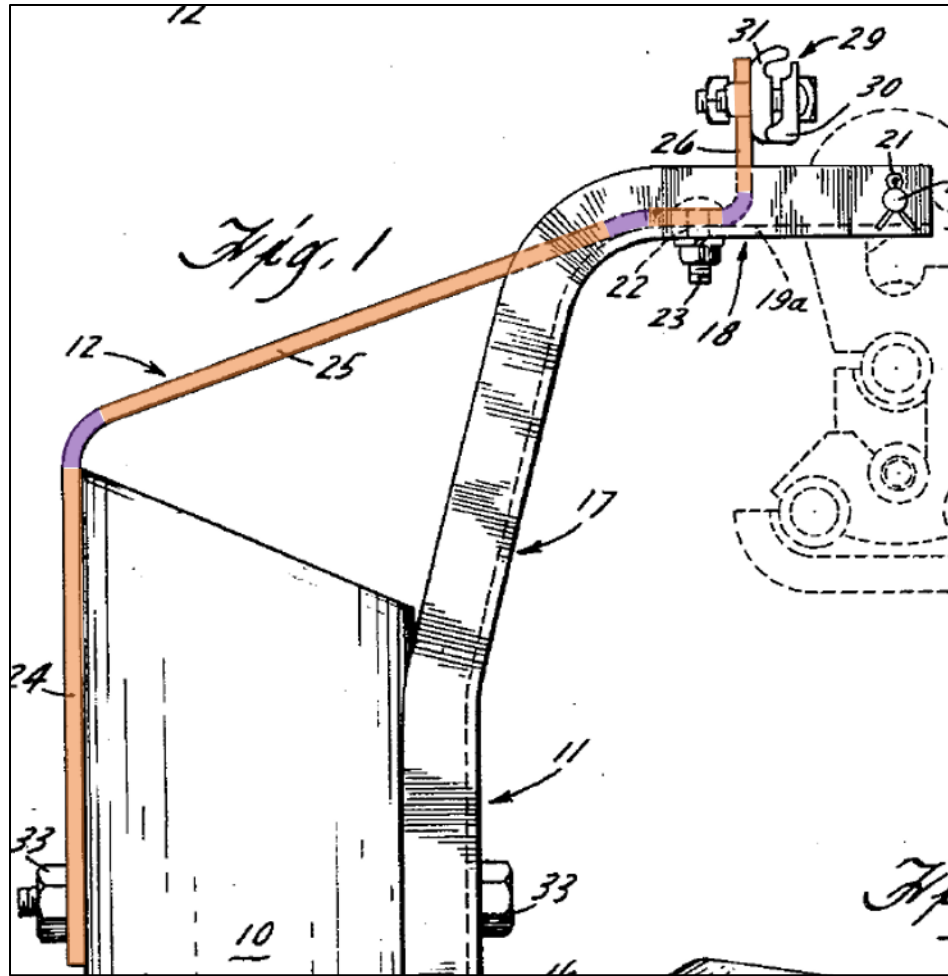
181. As discussed above, Peterson discloses that the assembly is comprised of “metallic parts” which POSITAs would have understood at the time of the alleged invention to be conductive in the context of electrical power system. When conductive components are in contact with each other, a conductive path is created. Petersen’s use of “grounding clamp means 29”, metallic pole top extension, and metallic messenger wire, on a metallic pile, all in contact with one another creates a conductive path. EX1004, 2:56-63. Therefore, Petersen discloses or renders obvious a multi-function line coupling defines a conductive path.

- 8. Dependent Claim 3:** The grounding system of claim 2 wherein each said mounting body is one of a conductive body or a conductive body assembly.

182. As discussed above, Peterson discloses that the assembly is comprised of “metallic parts” which POSITAs would have understood at the time of the alleged invention to conduct electrical current. EX1004, 2:56-63. Accordingly, Petersen discloses or renders obvious the grounding system of claim 2 wherein each said mounting body is one of a conductive body or a conductive body assembly.

- 9. Dependent Claim 4:** The grounding system of claim 3 wherein each said mounting body has a simplified shape.

183. The pole top extension disclosed by Peterson comprises brace means 12, extending from which is vertical portion 26, which includes planar portions and transitional bends between such portions:



EX1004, Fig. 1 (excerpted and annotated with planar portions of brace means 12 and vertical portion 26 in orange, and transitional bends of brace means 12 in purple).

184. The '551 Patent defines “simplified shape” as “a body or assembly including generally planar portions and transitional bends or welds between the generally planar portions.” EX1001, 9:62-64. Petersen’s pole top extension has generally planar portions, and transitional bends between such planar portions, and therefore Petersen discloses a mounting body having a simplified shape. Accordingly,

Petersen discloses or renders obvious the grounding system of claim 3 wherein each said mounting body has a simplified shape.

10.Dependent Claim 5[a]: The grounding system of claim 2 wherein:

185. As discussed above, Petersen discloses or renders obvious claim 2.

11.Dependent Claim 5[b]: each said mounting body is a conductive body:

186. As discussed above, Petersen discloses a mounting assembly with ground clamp means 29 and other components that are metallic components that are conductive. Therefore, Petersen discloses or renders obvious a mounting body is a conductive body.

12.Dependent Claim 5[c]: each said mounting body conductive body is a partially conductive body.

187. The '551 Patent defines “partially conductive” as any material that “conducts electricity” including “galvanized steel[.]” EX1001, 8:18-28. Petersen utilizes metallic components which POSITAs would have understood at the time of the alleged invention to conduct electrical current. Accordingly, Petersen discloses a partially conductive mounting body.

13.Dependent Claim 6: The grounding system of claim 2 wherein each said multi-function line coupling is a clamping assembly.

188. Petersen discloses “ground clamp means 29 which ... comprises two clamping jaw members 30 and 31 ... to keep a neutral messenger cable 37 in tight supported engagement therewith.” EX1004, 2:34-40. Accordingly, Petersen discloses

the grounding system of claim 2 wherein each said multi-function line coupling is a clamping assembly.

14. Dependent Claim 7: The grounding system of claim 6 wherein each said multi-function line coupling includes one of a clam-shell assembly, a split bolt, a U-bolt, or a lay-in lug assembly.

189. Petersen discloses “in portion 26 of the brace member 12 is a ground clamp means 29 which ... comprises two clamping jaw members 30 and 31[.]” EX1004, 2:34-40. “Clam-shell assembly” is synonymous with a “clamping assembly” as disclosed by Petersen because both assemblies have the same subparts (two planar portions that can be drawn closer together through a bias device such as a nut and bolt assembly, with room for a cable to be placed between the two planar portions).

190. Accordingly, Petersen discloses or renders obvious a multi-function line coupling that includes one of a clam-shell assembly, a split bolt, a U-bolt, or a lay-in lug assembly.

15. Dependent Claim 8[a]: The grounding system of claim 2 wherein:

191. As discussed above, Petersen discloses or renders obvious claim 2.

16. Dependent Claim 8[b]: said number of multi-function line couplings includes a plurality of multi-function line couplings:

192. As discussed above, Petersen acknowledges that “many modifications ... are possible[.]” One such modification that could easily be made to Petersen’s system would have been the addition of a second clamping means 29 to facilitate an additional neutral messenger wire. Messenger wires can only support a maximum load based on

their physical characteristics such as diameter, material, and the space between piles. Because of this, it is very common for mounting assemblies to be extended to facilitate a plurality of messenger wires. Petersen's system could be modified by welding or bolting additional brackets and/or clamps or using plurality of piles where the piles would be welded or bolted to the brackets. Due to additional load when plurality of messenger wires are used, the piles would possibly need to be mechanically strengthened, or substituted for piles with for wider-diameter piles. Accordingly, Petersen discloses or renders obvious a number of multi-function line couplings includes a plurality of multi-function line couplings.

17. Dependent Claim 8[c]: each said multi-function line coupling spaced one of a first effective distance, a second effective distance, or a third effective distance from another multi-function line coupling.

193. The '551 Patent defines "first effective distance" as "between less than one foot to about one hundred feet apart," "second effective distance" as "between one foot and about fifty feet apart," and "third effective distance" as "between about five feet and about thirty feet apart." EX1001, 11:2-7.

194. To the extent Petersen does not expressly disclose a first, second, or third effective distance, such spacing-distances would have been obvious to a POSITA at the time of the alleged invention because current carrying cables have to be spaced apart at a certain distance. For example, IEEE Standard 142 explains that current carrying cables create magnetic fields, hence when they are placed adjacently, their

magnetic fields must not cross-link with one another because this will cause circulating currents between the two current carrying cables. EX1028, 80-81. Furthermore, the National Safety Code, Rule 235G specifies that vertical spacing between conductive cables shall not be less than 4 to 12 inches, depending upon the span lengths. EX1031, 1-2. Combined with IEEE specifications regarding magnetic field cross-linking, POSITAs at the time of the alleged invention understood that such vertical spacing requirements are applicable for horizontally spacing conductors on mounting brackets. Accordingly, Petersen discloses or renders obvious each said multi-function line coupling spaced one of a first effective distance, a second effective distance, or a third effective distance from another multi-function line coupling.

18. Dependent Claim 9: The grounding system of claim 1 wherein said multi-function line assembly does not include any grounding splices.

195. As discussed above, Petersen discloses a grounding system that is comprised of metallic components in contact with one another that results in a grounding system that does not require grounding splices. A POSITA at the time of the alleged invention would have understood that no such splices are necessary in Petersen's system. Splices are usually only used when it is necessary to connect or join parts, assemblies, or elements of an electrical system that are otherwise not in electrical communication. In case of connecting grounding parts, it is obvious to POSITAs that splices would not be necessary when there is a ground path established by the

conductive components of a support assembly. Accordingly, Petersen discloses or renders obvious the grounding system of claim 1 wherein said multi-function line assembly does not include any grounding splices.

19. Dependent Claim 10: The grounding system of claim 1 wherein said multi-function line assembly does not include any medial grounding splices.

196. As discussed above, Petersen discloses a grounding system that is comprised of metallic components in contact with one another that results in a grounding system that does not require grounding splices. A POSITA at the time of the alleged invention would have understood that no such splices are necessary in Petersen's system. Splices are usually only used when it is necessary to connect or join parts, assemblies, or elements of an electrical system that are otherwise not in electrical communication. In case of connecting grounding parts, it is obvious to POSITAs that splices would not be necessary when there is a ground path established by the conductive components of a support assembly. Accordingly, Petersen discloses or renders obvious the grounding system of claim 1 wherein said multi-function line assembly does not include any medial grounding splices.

20. Dependent Claim 11: The grounding system of claim 1 wherein said multi-function line includes one of a highly conductive body or a partially conductive body.

197. As discussed above, Petersen's pole tope extension system utilized metallic components, which POSITAs would have understood at the time of the

alleged invention to include either a highly conductive, or partially conductive neutral messenger wire. Accordingly, Petersen discloses or renders obvious the grounding system of claim 1 wherein said multi-function line includes one of a highly conductive body or a partially conductive body.

21. Dependent Claim 12: The grounding system of claim 1 wherein said multi-function line includes strands selected from the group consisting of: copper strands, copper-clad steel strands, galvanized strands, conductive alloy strands, partially conductive, alloy strands, or composite strands.

198. A POSITA at the time of the alleged invention would have known that copper, copper-clad steel, galvanized metals, conductive alloys, and partially conductive alloys or composites are conductive and useful for use in grounding systems. For example the 1959 Advance Reports of the NEC, rule 250-91 states that grounding conductors can be copper, or any corrosion resistant material, which would have included copper-clad steel or copper alloys. EX1032, 250-91. Accordingly, Petersen discloses or renders obvious the grounding system of claim 1 wherein said multi-function line includes strands selected from the group consisting of: copper strands, copper-clad steel strands, galvanized strands, conductive alloy strands, partially conductive, alloy strands, or composite strands.

22. Dependent Claim 13: The grounding system of claim 12 wherein said multi-function line assembly terminal support includes a conductive thimble-eye.

199. Conductive thimble-eye assemblies were widely used in terminal supports while maintaining the conductive path of a grounding assembly. Nearly all aerial support assemblies using messenger wires need to have a terminal support in order to prevent sagging of the messenger wire that may occur over time, even when the messenger wire is coupled to support piles along the support assembly. Indeed, the NEC specifically provides for messenger wires to be simultaneously used both as structural support for conductors and as the equipment grounding conductor itself. For example, Chapter 3 of the NEC, which covers messenger cable supported wiring, provides that when the messenger wire is used in a support system, the same messenger wire may be used as a grounding conductor and shall be supported at dead ends (terminal supports):

396.30 Messenger.

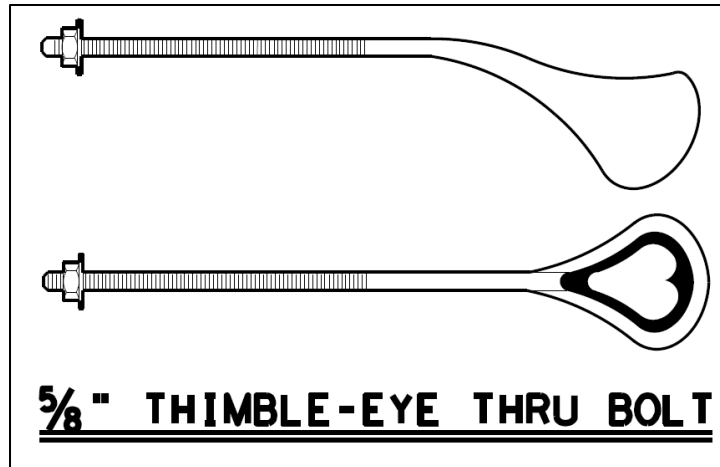
(A) **Support.** The messenger shall be supported at dead ends and at intermediate locations so as to eliminate tension on the conductors. The conductors shall not be permitted to come into contact with the messenger supports or any structural members, walls, or pipes.

(B) **Neutral Conductor.** Where the messenger is used as a neutral conductor, it shall comply with the requirements of 225.4, 250.184(A), 250.184(B)(7), and 250.186(B).

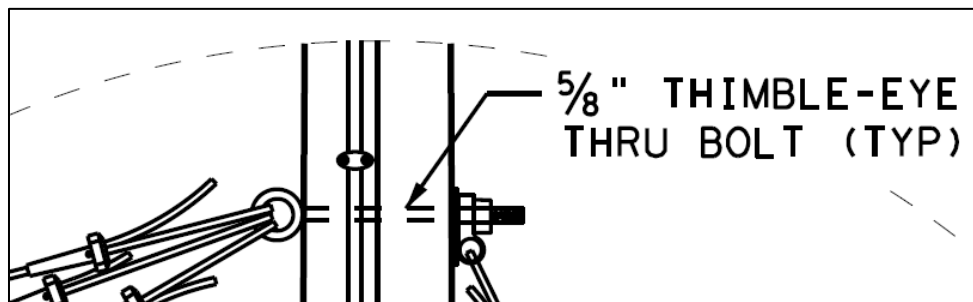
(C) **Equipment Grounding Conductor.** Where the messenger is used as an equipment grounding conductor, it shall comply with the requirements of 250.32(B), 250.118, 250.184(B)(8), and 250.186(D).

EX1007, 396.30.

200. Petersen expresses the need to keep the “neutral messenger cable 37 in tight supported engagement”, and it would have been obvious to any POSITA at the time of the alleged invention to do so with thimble-eye terminal supports as thimble eye were one widely known approaches to tying. EX1004, 2:34-40. For instance, in 2001, the U.S. Department of Agriculture, Rural Utilities Services, recommended thimble eye bolts and/or thimble eye nuts for attaching guy wires to distribution poles. EX1036, 8. Even further, in 2012, the Texas Department of Transportation issued recommendations on traffic electric pole assemblies which included the use of thimble-eye terminals (bolt and nut):

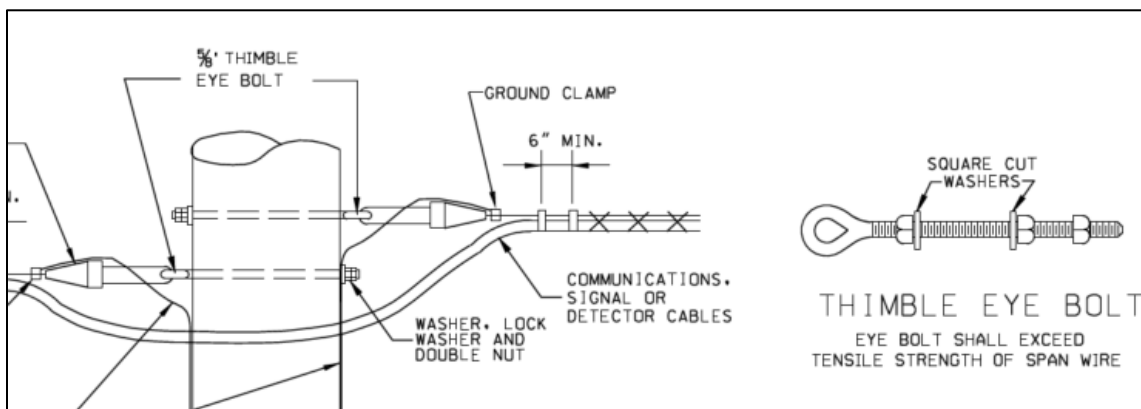


EX1033, Sheet 3.



Id.

201. Further, in 2004, the State of Tennessee Department of Transportation similarly issued guidance recommending the use of thimble-eye terminals for terminating messenger wire:



Affordable Wire Management, Exhibit No. EX1002

Case No.: IPR2024-00139

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EX1034. Accordingly, Petersen discloses or renders obvious the grounding system of claim 12 wherein said multi-function line assembly terminal support includes a conductive thimble-eye.

23. Dependent Claim 14: The grounding system of claim 13 wherein said multi-function line is structured to be operational with solar electrical equipment.

202. Petersen generally relates to efficient management of current carrying cable, and a grounded support system, which a POSITA at the time of the alleged invention would have been motivated to apply in the field of solar electrical equipment. For example, the SolarPro Magazine in their PV Array Wire Management, Issue 6.2 Feb/March 2013 addresses PV wire management, best practices, commonly used components, elements, and approaches taken by skilled persons in the solar industry. EX1035, *passim*. In particular, the SolarPro article addresses the use of USE-2 conductors which have been commonly used in the electrical power industry for over 30 years and are now being used in solar power systems. *Id.*, 2-4, 6-7, 9. Additionally, the SolarPro article describes the pros and cons of wire ties (plastic and metallic) in solar systems, which were appropriated from, and well known in, traditional electrical power distribution systems, where the UV-rated plastic ties degrade over time and metallic ties risk cutting into cable insulation. *Id.*, 2, 4, 6-9. Even further, the SolarPro article quotes solar industry experts that recommend employing NEC in solar wire management, including NEC codes that applied to traditional electrical distribution

systems long before the proliferation of solar technology. *Id.*, *passim*. Accordingly, Petersen discloses or renders obvious the grounding system of claim 13 wherein said multi-function line is structured to be operational with solar electrical equipment.

24. Dependent Claim 15: The grounding system of claim 13 wherein said multi-function line assembly does not include any grounding splices.

203. As discussed above, Petersen discloses a grounding system that is comprised of metallic components which are conductive and in contact with each other, thereby obviating any need for grounding splices. Accordingly, Petersen discloses or renders obvious grounding system of claim 13 wherein said multi-function line assembly does not include any grounding splices.

25. Dependent Claim 16: The grounding system of claim 13 wherein said multi-function line assembly does not include any medial grounding splices.

204. As discussed above, Petersen discloses a grounding system that is comprised of metallic components which are conductive and in contact with each other, thereby obviating any need for grounding splices. Accordingly, Petersen discloses or renders obvious the grounding system of claim 13 wherein said multi-function line assembly does not include any medial grounding splices.

26. Dependent Claim 17: The grounding system of claim 13 wherein said multi-function line includes one of a highly conductive body or a partially conductive body.

205. As discussed above, Petersen discloses a grounding system that is comprised of metallic components, including a metallic neutral messenger wire, which

are all conductive by virtue of their metallic compositions. Accordingly, Petersen discloses or renders obvious the grounding system of claim 13 wherein said multi-function line includes one of a highly conductive body or a partially conductive body.

27. Dependent Claim 18: The grounding system of claim 1 wherein said multi-function line assembly includes a conductive terminal support.

206. As discussed above, nearly all aerial support systems utilizing a messenger wire need some sort of a terminal support to ensure a safe and reliable connection of messenger wire to another element. In grounding systems, the terminal support must be conductive to ensure the ground path for the stray current is maintained. POSITAs at the time of the alleged invention used a variety of terminal supports, such as a bolt and nut system, joint, thimble-eye, or another wire, all of which provide a safe connection, and conducting path. Nearly all aerial support assemblies using messenger wires need to have a terminal support in order to prevent sagging of the messenger wire that may occur over time, even when the messenger wire is coupled to support piles along the support assembly. A POSITA at the time of the alleged invention would have understood that a conductive terminal support would be necessary to maintain the conductive path of a grounding assembly. Accordingly, Petersen discloses or renders obvious the grounding system of claim 1 wherein said multi-function line assembly includes a conductive terminal support.

28. Independent Claim 19[a]: A mounting assembly for a grounding system structured to ground a number of cables supported by a support

assembly, said support assembly including a plurality of spaced, conductive piles, said grounding system including a multi-function line assembly with a multi-function line, said mounting assembly comprising:

207. As discussed above, Petersen discloses a pole top extension for supporting and grounding cables, including the use of a neutral messenger wire to support cables, and provide an electrical path to ground. To the extent not expressly disclosed by Petersen, it would have been obvious to use a plurality of piles because it allows the electric power distribution system to reach greater distances, and the use of conductive metal piles comes with the benefit of easier installation, increased durability and resiliency, and obviates the need for an additional ground wire. EX1030. Accordingly, Petersen discloses or renders obvious a mounting assembly for a grounding system structured to ground a number of cables supported by a support assembly, said support assembly including a plurality of spaced, conductive piles, said grounding system including a multi-function line assembly with a multi-function line, said mounting assembly comprising.

29.Independent Claim 19[b]: a mounting body, a support coupling, and a number of multi-function line couplings

208. As discussed above, Petersen's pole top extension (mounting assembly) (of which there would be multiple in any energy distribution system, *i.e.*, one per pile) is comprised of "metallic parts" which are conductive. Petersen's pole top extension mounting assembly is structured to be coupled to said neutral messenger wire cable 37

(multi-function line) via portion 26 of the brace member 12 using two clamping jaw members. EX1004, 34-40. Petersen's pole top extension mounting assembly is structured to be attached to the conductive pole with "[s]uitable through bolts 33 and 34 [which] extend through the pole and fixedly attach the brace member to the channel support member to the pole[.]" *Id.*, 2:28-33.

209. Petersen discloses a metallic pole top extension which includes a "vertically extending end portion 26" for supporting "the neutral messenger cable." EX1004, 2:1-8. End portion 26 of Petersen's system acts as a mounting body because the neutral messenger cable (multi-function line) is mounted on end portion 26 via ground clamp means 29. *Id.*, Fig. 4. Further, Petersen discloses coupling the pole top extension to the pole with "[s]uitable through bolts 33 and 34 [which] extend through the pole and fixedly attach the brace member and channel support member [of the pole top extension] to the pole," thereby supporting the pole top extension. *Id.*, 2:28-33.

210. Though Petersen discloses a single ground clamp structure to couple the messenger wire to each pole top extension, Petersen acknowledges that "many modifications ... are possible." EX1004, 2:67-69. One such modification that could easily be made to Petersen's system would have been the addition of a second ground clamping means 29 to facilitate an additional neutral messenger wire. As discussed above, messenger wires can only support a maximum load based on their physical characteristics such as diameter, material, and the space between piles. Because of this,

it is very common for mounting assemblies to be extended to facilitate a plurality of messenger wires. Petersen's system could be modified by welding or bolting additional brackets and/or clamps or using plurality of piles where the piles would be welded or bolted together. Due to additional load when plurality of messenger wires are used, the piles would possibly need to be mechanically strengthened or substituted for wider-diameter piles. Accordingly, it would have been obvious at the time of the alleged invention to provide additional ground clamps to facilitate coupling additional neutral messenger cables. Accordingly Petersen discloses or renders obvious a mounting body, a support coupling, and a number of multi-function line couplings.

30.Independent Claim 19[c]: each said multi-function line couplings structured to be coupled to said multi-function line.

211. As discussed above, Petersen discloses a clam-shell clamping assembly structured to couple the neutral messenger wire to the pole top extension. Accordingly, Petersen discloses or renders obvious each said multi-function line couplings structured to be coupled to said multi-function line.

31.Independent Claim 19[d]: each said support coupling structured to be coupled to a conductive pile; and.

212. As discussed above, Petersen's pole top extension mounting assembly is structured to be attached to the conductive pole with "[s]uitable through bolts 33 and 34 [which] extend through the pole and fixedly attach the brace member to the channel support member to the pole[.]" EX1004, 2:28-33. Accordingly, Petersen discloses or

renders obvious each said support coupling structured to be coupled to a conductive pile.

32. Independent Claim 19[e]: wherein, when said multi-function line assembly is coupled to, and in electrical communication with said multi-function line couplings, each said multi-function line coupling defines a conductive path.

213. As discussed above, Petersen discloses a neutral messenger wire that is secured by “ground clamp means 29” which means that the neutral messenger wire is coupled with ground clamp means, and through such coupling creates a conductive ground path. Accordingly, Petersen discloses or renders obvious a multi-function line assembly that is coupled to, and in electrical communication with said multi-function line couplings, each said multi-function line coupling defines a conductive path.

XIV. Ground 4: Claims 13-17 of the ’551 patent are obvious in view of Petersen in view of MacLean, and further in view of the knowledge of a POSITA at the time of the alleged invention.

1. Dependent Claim 13: The grounding system of claim 12 wherein said multi-function line assembly terminal support includes a conductive thimble-eye.

214. As discussed above, Petersen discloses or renders obvious claim 12 and claim 1 upon which claim 12 depends. Petersen in view of MacLean disclose a multi-function line assembly terminal support that includes a conductive thimble-eye. All messenger supports must be supported where the messenger support terminates in order to maintain the messenger in taught suspension so it can adequately support current carrying cable. Indeed, the NEC specifically provides for messenger wires to

be simultaneously used both as structural support for conductors and as the equipment grounding conductor itself. For example, Chapter 3 of the NEC, which covers messenger wire supported wiring, provides that when the messenger wire is used in a support system, the same messenger wire may be used as a grounding conductor and shall be supported at dead ends (terminal supports):

396.30 Messenger.

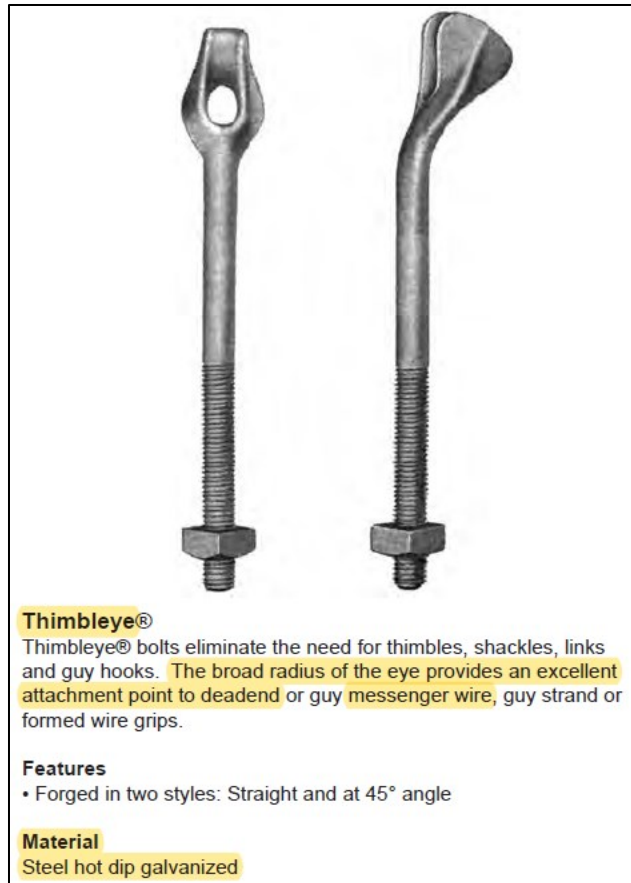
(A) Support. The messenger shall be supported at dead ends and at intermediate locations so as to eliminate tension on the conductors. The conductors shall not be permitted to come into contact with the messenger supports or any structural members, walls, or pipes.

(B) Neutral Conductor. Where the messenger is used as a neutral conductor, it shall comply with the requirements of 225.4, 250.184(A), 250.184(B)(7), and 250.186(B).

(C) Equipment Grounding Conductor. Where the messenger is used as an equipment grounding conductor, it shall comply with the requirements of 250.32(B), 250.118, 250.184(B)(8), and 250.186(D).

EX1007, 241 (Article 396.30).

215. Thimble-eye terminal supports were known in the art prior to the alleged invention as a cost effective and simple way to terminate a messenger wire. MacLean discloses a thimble-eye bolt, made of galvanized steel, that “provides an excellent attachment point *to deadened ... messenger wire*[.]” EX1027, 14 (emphasis added).



Id. (annotated).

216. A POSITA at the time of the alleged invention would have been motivated to combine the disclosures of Petersen with MacLean's thimble-eye terminal support because of the inherent need to provide a terminal support for a messenger wire support system. EX1007, 241 (Article 396.30). A POSITA would have been further motivated to look at the various components offered by MacLean because it was well known in the electrical distribution system industry has a purveyor of terminal supports, messenger wire, and other necessary components. Furthermore, a POSITA would have been motivated to purchase from MacLean a galvanized steel

thimble eye terminal support because of the strength galvanized steel provides and it is a relatively cheap material. Given that MacLean's thimble eye terminal support is made of steel, it is conductive and when in contact with the neutral messenger disclosed by Petersen, would maintain a path to ground.

217. A POSITA at the time of the alleged invention would have a reasonable expectation of success combining the teachings of Petersen and MacLean because Petersen's system teaches the use of a messenger wire, and MacLean's thimble eye terminal support "provides an excellent attachment point to deadend ... [a] messenger wire[.]" EX1027, 14. Accordingly, Petersen in view of MacLean disclose or render obvious the grounding system of claim 12 wherein said multi-function line assembly terminal support includes a conductive thimble-eye.

2. Dependent Claims 14-17

218. Claims 14-17 depend on claim 13. As discussed above, claims 14-17 are disclosed by Peterson, and therefore Peterson in view of MacLean and further in view of a POSITA's knowledge renders them obvious.

3. Motivation to Combine Petersen with MacLean

219. A POSITA at the time of the alleged invention would have been motivated to combine Petersen's system with MacLean's thimble-eye terminal support, at least because both references concern components and arrangements for electrical distribution support systems. Moreover, all messenger supports must be

supported where the messenger support terminates in order to maintain the messenger in taught suspension so it can adequately support current carrying cable. Indeed, the NEC specifically provides for messenger wires to be simultaneously used both as structural support for conductors and as the equipment grounding conductor itself. For example, Chapter 3 of the NEC, which covers messenger wire supported wiring, provides that when the messenger wire is used in a support system, the same messenger wire may be used as a grounding conductor and shall be supported at dead ends (terminal supports):

396.30 Messenger.

(A) Support. The messenger shall be supported at dead ends and at intermediate locations so as to eliminate tension on the conductors. The conductors shall not be permitted to come into contact with the messenger supports or any structural members, walls, or pipes.

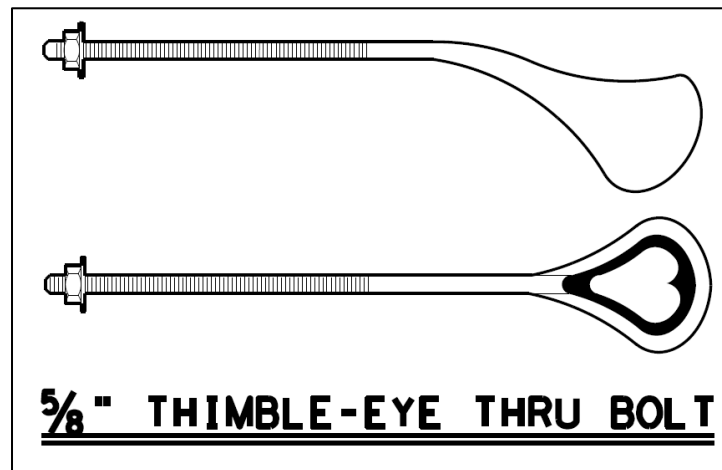
(B) Neutral Conductor. Where the messenger is used as a neutral conductor, it shall comply with the requirements of 225.4, 250.184(A), 250.184(B)(7), and 250.186(B).

(C) Equipment Grounding Conductor. Where the messenger is used as an equipment grounding conductor, it shall comply with the requirements of 250.32(B), 250.118, 250.184(B)(8), and 250.186(D).

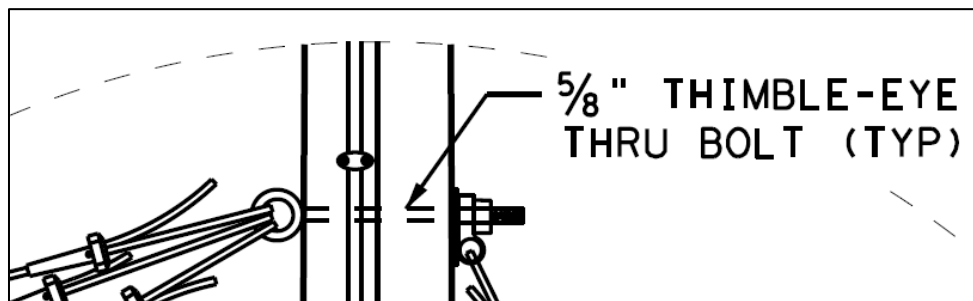
EX1007, 241 (Article 396.30).

220. Use of thimble eye terminal has been known to POSITAs for use in electrical poles. Thimble eye terminals have long been one of the most commonly employed components for terminating wires or cables. For instance, in 2001, the U.S.

Department of Agriculture, Rural Utilities Services, recommended thimble eye bolts and/or thimble eye nuts for attaching guy wires to distribution poles. EX1036, 8. Even further, in 2012, the Texas Department of Transportation issued recommendations on traffic electric pole assemblies which included the use of thimble-eye terminals (bolt and nut):

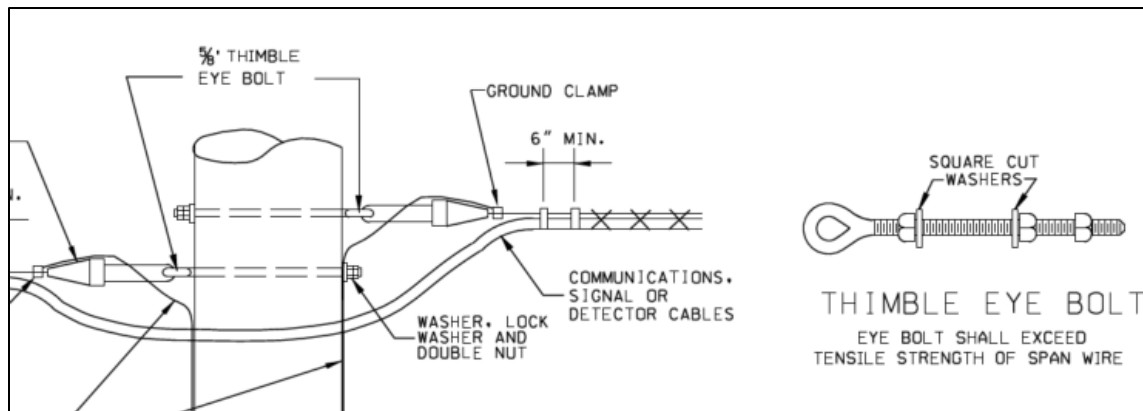


EX1033, 3.



Id.

221. Further, in 2004, the State of Tennessee Department of Transportation similarly issued guidance recommending the use of thimble-eye terminals for terminating messenger wire:



EX1034.

XV. Ground 5: Claims 13-17 of the '551 patent are obvious in view of the CAB Website in combination with the CAB Whitepaper, further in view of MacLean, and further in view of the knowledge of a POSITA at the time of the alleged invention.

1. Dependent Claim 13: The grounding system of claim 12 wherein said multi-function line assembly terminal support includes a conductive thimble-eye.

222. As discussed above, the CAB Website and CAB Whitepaper disclose or render obvious Claims 1 and 12, on which Claim 13 depends. The CAB Website and the CAB Whitepaper in view of MacLean disclose a multi-function line assembly terminal support that includes a conductive thimble-eye. All messenger supports must be supported where the messenger support terminates in order to maintain the messenger in taught suspension so it can adequately support current carrying cable. Indeed, the NEC specifically provides for messenger wires to be simultaneously used both as structural support for conductors and as the equipment grounding conductor itself. For example, Chapter 3 of the NEC, which covers messenger wire supported

wiring, provides that when the messenger wire is used in a support system, the same messenger wire may be used as a grounding conductor and shall be supported at dead ends (terminal supports):

396.30 Messenger.

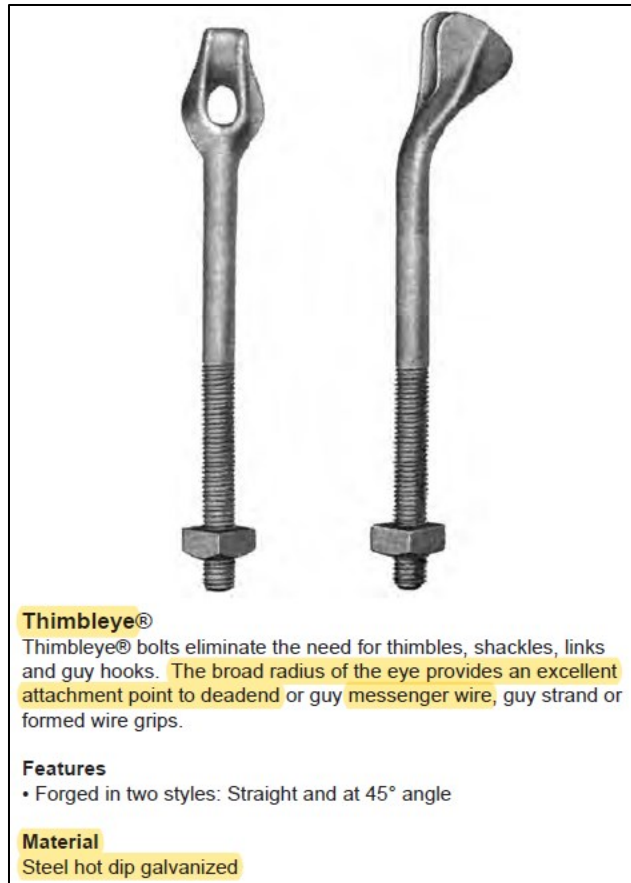
(A) **Support.** The messenger shall be supported at dead ends and at intermediate locations so as to eliminate tension on the conductors. The conductors shall not be permitted to come into contact with the messenger supports or any structural members, walls, or pipes.

(B) **Neutral Conductor.** Where the messenger is used as a neutral conductor, it shall comply with the requirements of 225.4, 250.184(A), 250.184(B)(7), and 250.186(B).

(C) **Equipment Grounding Conductor.** Where the messenger is used as an equipment grounding conductor, it shall comply with the requirements of 250.32(B), 250.118, 250.184(B)(8), and 250.186(D).

EX1007, 241 (Article 396.30).

223. Thimble-eye terminal supports were known in the art prior to the alleged invention as a cost effective and simple way to terminate a messenger wire. MacLean discloses a thimble-eye bolt, made of galvanized steel, that “provides an excellent attachment point *to deadened ... messenger wire*[.]” EX1027, 14 (emphasis added).

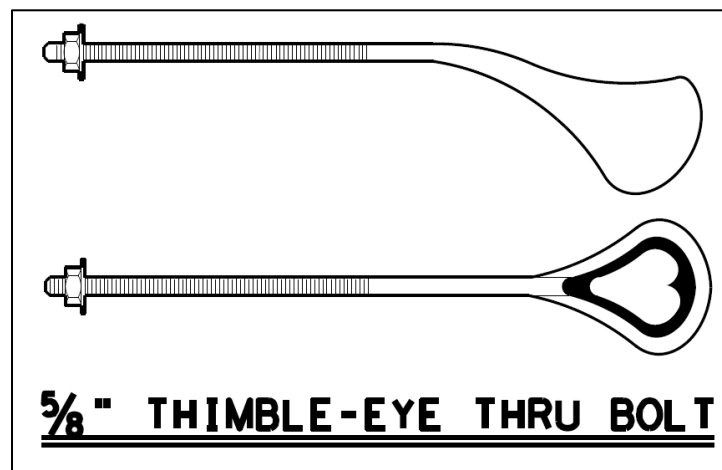


Id. (annotated).

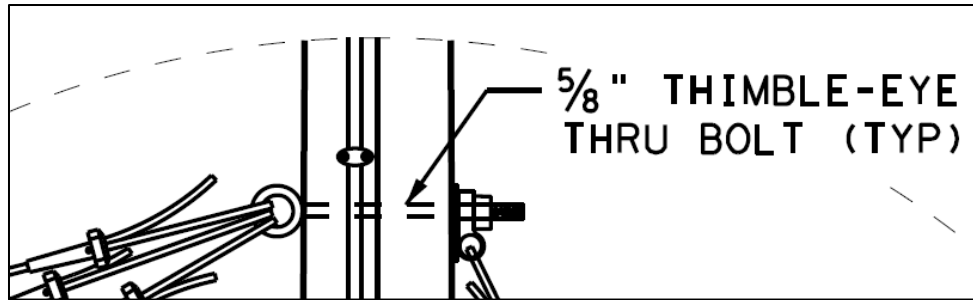
224. A POSITA at the time of the alleged invention would have been motivated to combine the disclosures of the CAB Website and CAB Whitepaper with MacLean's thimble-eye terminal support because of the inherent need to provide a terminal support for a messenger wire support system. EX1007, 241 (Article 396.30). A POSITA would have been further motivated to look at the various components offered by MacLean because it was well known in the electrical distribution system industry has a purveyor of terminal supports, messenger wire, and other necessary components. Furthermore, a POSITA would have been motivated to purchase from

MacLean a galvanized steel thimble eye terminal support because of the strength galvanized steel provides and it is a relatively cheap material. Given that MacLean's thimble eye terminal support is made of steel, it is conductive and when in contact with the messenger wire disclosed by the CAB Website and CAB Whitepaper, would maintain a path to ground.

225. Thimble eye terminals have long been one of the most commonly employed components for terminating wires or cables. For instance, in 2001, the U.S. Department of Agriculture, Rural Utilities Services, recommended thimble eye bolts and/or thimble eye nuts for attaching guy wires to distribution poles. EX1036, 8. Even further, in 2012, the Texas Department of Transportation issued recommendations on traffic electric pole assemblies which included the use of thimble-eye terminals (bolt and nut):

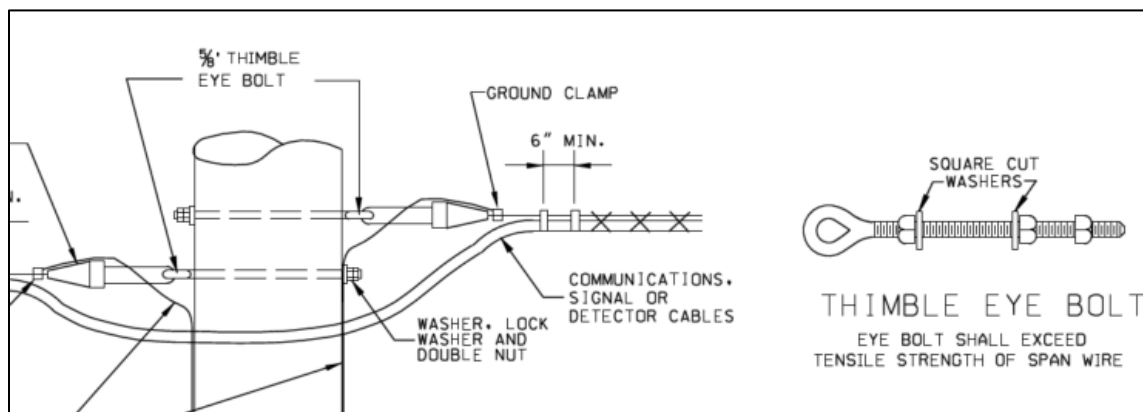


EX1033, 3.



Id.

226. Further, in 2004, the State of Tennessee Department of Transportation similarly issued guidance recommending the use of thimble-eye terminals for terminating messenger wire:



EX1034. Therefore, the use of thimble eye terminal has been known to POSITAs for use in electrical poles.

227. A POSITA at the time of the alleged invention would have a reasonable expectation of success combining the teachings of the CAB Website and CAB Whitepaper and MacLean because the system disclosed by the CAB Website and CAB Whitepaper teach the use of a messenger wire, and MacLean's thimble eye terminal support "provides an excellent attachment point to deadend ... [a] messenger wire[.]"

EX1027, 14. Accordingly, the CAB Website and CAB Whitepaper in view of MacLean disclose or renders obvious the grounding system of claim 12 wherein said multi-function line assembly terminal support includes a conductive thimble-eye.

2. Dependent Claims 14-17

228. Claims 14-17 depend on claim 13. As discussed above, claims 14-17 are disclosed by the CAB Website and CAB Whitepaper, and therefore CAB Website and CAB Whitepaper in view of MacLean and further in view of a POSITA's knowledge renders them obvious.

3. Motivation to Combine the CAB Website and CAB Whitepaper and MacLean

229. A POSITA at the time of the alleged invention would have been motivated to combine the system disclosed by the CAB Website and CAB Whitepaper with MacLean's thimble-eye terminal support with , at least because both references concern components and arrangements for electrical distribution support systems. Moreover, all messenger supports must be supported where the messenger support terminates in order to maintain the messenger in taught suspension so it can adequately support current carrying cable. Indeed, the NEC specifically provides for messenger wires to be simultaneously used both as structural support for conductors and as the equipment grounding conductor itself. For example, Chapter 3 of the NEC, which covers messenger wire supported wiring, provides that when the messenger wire is

used in a support system, the same messenger wire may be used as a grounding conductor and shall be supported at dead ends (terminal supports):

396.30 Messenger.

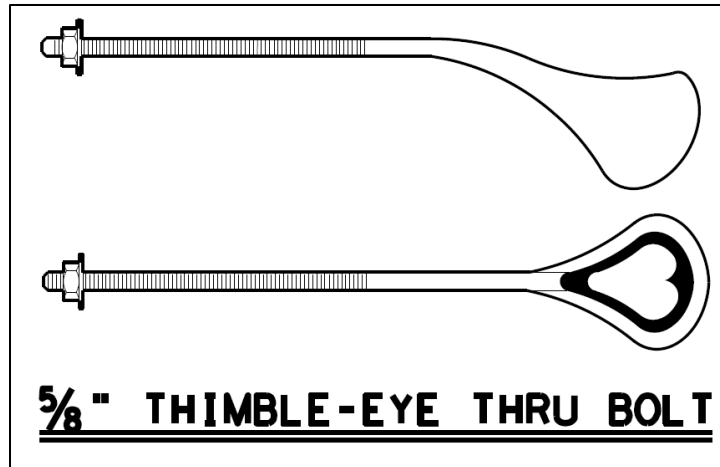
(A) **Support.** The messenger shall be supported at dead ends and at intermediate locations so as to eliminate tension on the conductors. The conductors shall not be permitted to come into contact with the messenger supports or any structural members, walls, or pipes.

(B) **Neutral Conductor.** Where the messenger is used as a neutral conductor, it shall comply with the requirements of 225.4, 250.184(A), 250.184(B)(7), and 250.186(B).

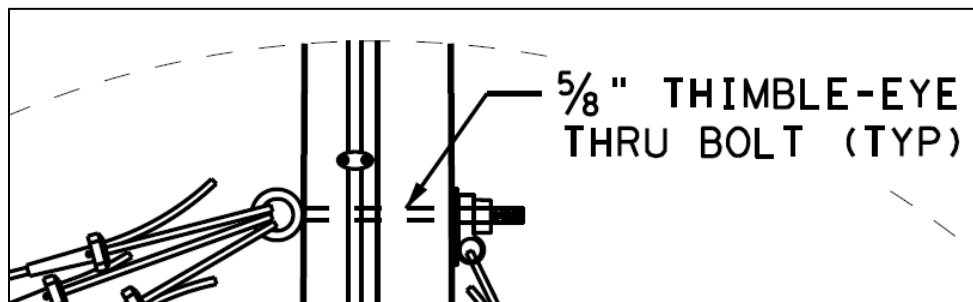
(C) **Equipment Grounding Conductor.** Where the messenger is used as an equipment grounding conductor, it shall comply with the requirements of 250.32(B), 250.118, 250.184(B)(8), and 250.186(D).

EX1007, 241 (Article 396.30).

230. Thimble eye terminals have long been one of the most commonly employed components for terminating wires or cables. For instance, in 2001, the U.S. Department of Agriculture, Rural Utilities Services, recommended thimble eye bolts and/or thimble eye nuts for attaching guy wires to distribution poles. EX1036, 8. Even further, in 2012, the Texas Department of Transportation issued recommendations on traffic electric pole assemblies which included the use of thimble-eye terminals (bolt and nut):

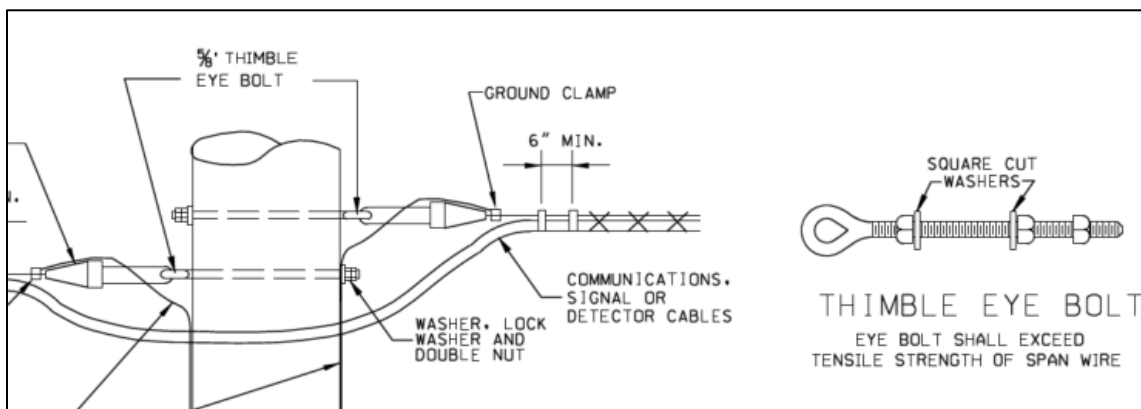


EX1033, 3.



Id.

231. Further, in 2004, the State of Tennessee Department of Transportation similarly issued guidance recommending the use of thimble-eye terminals for terminating messenger wire:



Affordable Wire Management, Exhibit No. EX1002

Case No.: IPR2024-00139

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EX1034.

XVI. Considerations of Non-Obviousness

232. As explained above, I understand that “objective indicia of non-obviousness,” also known as “secondary considerations,” are also to be considered when assessing obviousness of the claims, if such factors are present. These include commercial success of the claimed invention; long felt but unresolved needs; failure of others to solve the problem that the inventor solved; unexpected results; copying of the invention by others; and industry recognition or expressions of disbelief by experts in the field of the claimed invention. I also understand that in considering objective indicia of nonobviousness, it is not proper to look beyond the scope of the claimed subject matter.

233. In my opinion, the '551 patent did not resolve any long felt need. Rather, the '551 Patent presented known options for grounding electrical distribution systems using cable support system components. For the same reasons, I am not aware of any failure of others to solve the problem identified by the inventor; any unexpected results resulting from the chosen solution, which was known in the art; or any industry recognition or praise regarding this particular claimed invention. In fact, others succeeded in designing similar grounding structures well before the inventor of the '551 Patent.

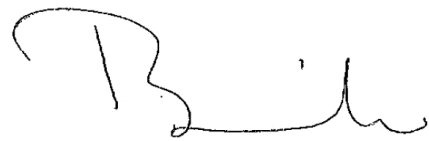
234. I am also not aware of any other secondary considerations that weigh against the obviousness of the claims, for example, commercial success or copying. Even if evidence of secondary considerations existed, in my opinion, it would be insufficient to overcome the clear obviousness of the challenged claims (claims 1-19 of the '551 Patent), as explained above.

XVII. Conclusion

235. I declare that all statements made in this declaration based on my own knowledge and experience are true to the best of my knowledge and that any statements made on information and belief are believed to be true.

236. I further declare that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: November 3, 2023

A handwritten signature in black ink, appearing to read 'Omid Beik', written over a horizontal line.

Omid Beik, Ph.D.

Appendix A: CV of Omid Beik, Ph.D.

Omid Beik, Ph.D., SMIEEE
Assistant Professor (tenure-track)
Department of Electrical Engineering
Colorado School of Mines
1500 Illinois St., Golden, CO 80401 USA
Email: beik@mines.edu; URL: <https://www.epowerhubs.com>

A. Professional Appointments

8/2023 – Present	Assistant Professor (tenure-track)	Department of Electrical Engineering, Colorado School of Mines, Golden, CO 80401 USA
10/2021 – 07/2023	Assistant Professor (tenure-track)	Department of Electrical and Computer Engineering, North Dakota State University, Fargo, ND 58102 USA
06/2019 – 09/2021	Founder & Director	Enercs Inc. (Early-stage start-up) 2900 Highway 7, Vaughan, ON L4K 0G3 Canada
03/2020 – 04/2021	Senior R&D Manager	Forte Mobility Co. Ltd. 455 Magna Drive, Aurora, ON L4G 7A9 Canada
06/2018 – 04/2019	Lead R&D Engineer	Mirus International Inc. 31 Sun Pac Blvd, Brampton, ON, L6S 5P6 Canada
03/2017 – 01/2018	Senior Engineer	Magna Powertrain Inc. 800 Tesma Way, Concord, ON, L4K 5C2 Canada

B. Education

04/2016 – 04/2017	Postdoctoral Research Fellow	Department of Electrical and Computer Engineering, McMaster University, Hamilton, ON, L8S 4K1 Canada
01/2013 – 04/2016	Ph.D.	Department of Electrical and Computer Engineering, McMaster University, Hamilton, ON, L8S 4K1 Canada
09/2011 – 12/2012	Ph.D. Student	Power Conversion Group, School of Electrical and Electronic Engineering, The University of Manchester, UK
09/2007 – 10/2009	M.Sc. (Ranked 1 st in the Class)	Department of Electrical Engineering, Shahid Beheshti University, Abbaspour School of Engineering, Tehran, Iran
09/2003 – 07/2007	B.Sc. (Ranked 1 st in the Class)	Department of Electrical and Electronics Engineering, Yazd University, Yazd, Iran

C. Journal Editorial Experience

09/2023 – 07/2024: Guest Editor, MDPI Sustainability Special Issue: Sustainable Wind Power Systems: Recent Advancements in AC/DC Collector Grids, and High-Voltage DC (HVDC) and Low-Frequency AC (LFAC) Transmission Systems.

09/2023 – 04/2024: Guest Editor, MDPI Electronics, Special Issue: Recent Advances and Applications in Electric Machines Design, Modelling, Control, and Operation.

12/2020 – Present: Editor, IEEE Transactions on Energy Conversion.

12/2020 – Present: Editor, IEEE Power Engineering Letters.

07/2020 – 07/2022: Associate Editor, IEEE Transactions on Transportation Electrification.

07/2020 – 07/2022: Associate Editor, IEEE Transportation Electrification eNewsletter.

D. Conferences Professional Volunteering

04/2026: Technical Program Chair, IEEE Green Technologies (GreenTech) Conference

11/2024: Technical Track Chair, Annual Conference of the IEEE Industrial Electronics Society (IECON)

10/2023 – 11/2023: Conference Program Committee Member, IEEE Energy Conversion Congress and Exposition (ECCE), Nashville, TN, US.

10/2022: Session Chair, IEEE Energy Conversion Congress and Exposition (ECCE), Detroit, MI, US.

03/2023: Panel Reviewer for Department of Energy (DOE), US.

08/2022: Panel Reviewer for Department of Energy (DOE), US.

01/2022 – 12/2022: Conference Advisory Committee (CONAC) Member, IEEE Canada.

05/2021: Session Chair, IEEE International Electric Machines & Drives (IEMDC), Virtual Event.

06/2018: Panel Moderator, IEEE Transportation Electrification Conference and Expo (ITEC), Long Beach, CA, US.

06/2017: Panel Organizer, IEEE Transportation Electrification Conference and Expo (ITEC), Chicago, IL, US.

06/2016: Session Chair, IEEE Transportation Electrification Conference and Expo (ITEC), Dearborn, MI, US.

E. Service

09/2023 – Present: Undergraduate Committee, Colorado School of Mines, Golden, CO, US.

2022 – 2023: Search Committee Member, Associate Vice President for Research and Faculty Development, North Dakota State University, Fargo, ND, USA.

2022 – 2023: Research & Graduate Committee, College of Engineering, North Dakota State University, Fargo, ND, USA.

09/2021 – 08/2023: Doctoral Dissertation Fellowship Review Committee, Department of Electrical and Computer Engineering, North Dakota State University, Fargo, ND, USA.

F. Publications

For a complete list of publications please visit [Google Scholar](https://scholar.google.com/citations?user=OmidBeik).

Patents

- [1] **Omid Beik**, “Electric Powered Landing Gear System,” United States Patent and Trademark Office (USPTO), US20210094517A1, Granted, Jun. 2022.
- [2] **Omid Beik**, “Electrified Landing Gear Adaptor,” United States Patent and Trademark Office (USPTO), US20200377062A1, Granted, Jun. 2022.
- [3] **Omid Beik**, “Electric Powered Landing Gear System,” European Patent Office (EPO), EP3798070B1, Granted, Mar. 2022.
- [4] **Omid Beik**, “Electric Powered Landing Gear System,” Canadian Intellectual Property Office (CIPO), CA3094627A1, Pending, Jul. 2022.

Books authored/co-authored (Published)

- [1] Mukund R. Patel, **Omid Beik**, “Spacecraft Power Systems,” 2nd edition, CRC Press, 2024.
- [2] Mukund R. Patel, **Omid Beik**, “Wind and Solar Power Systems: Design, Analysis, and Operation,” 3rd edition, CRC Press, 2021.
- [3] Ahmad S. Al-Adsani, **Omid Beik**, “Multiphase Hybrid Electric Machines: Applications for Electrified Powertrains,” Springer, 2021.
- [4] **Omid Beik**, Ahmad S. Al-Adsani, “DC Wind Generation Systems: Design, Analysis and Multiphase Turbine Technology,” Springer, 2020.

Journal Papers (Published)

- [1] M. Gholamian and **O. Beik**, "Coordinate Control of Wind Turbines in a Medium Voltage DC Grid," IEEE Transactions on Industry Applications, early access, 2023.
- [2] B. Saude, N. LaSart, J. Blair and **Omid Beik**, "Microgrid-Based Wind and Solar Power Generation on Moon and Mars," IEEE Transactions on Smart Grid, early access, 2022.
- [3] **Omid Beik**, Ahmad S. Al-Adsani, "A Wind Turbine Generator Design and Optimization for DC Collector Grids," IEEE Journal of Emerging and Selected Topics in Power Electronics, vol. 10, no. 1, pp. 484-493, Feb. 2022.

- [4] **Omid Beik**, Ahmad S. Al-Adsani, "Active and Passive Control of a Dual Rotor Wind Turbine Generator for DC Grids," IEEE Access, vol. 9, pp. 1987-1995, 2021.
- [5] Ahmad S. Al-Adsani, Michel E. AlSharidah, **Omid Beik**, "BLDC Motor Drives: A Single Hall Sensor Method and a 160° Commutation Strategy," IEEE Transactions on Energy Conversion, vol. 36, no. 3, pp. 2025-2035, Sept. 2021.
- [6] **Omid Beik**, Ahmad S. Al-Adsani, "Wind Turbine Multiphase Operational Trajectory in an All DC Wind Generation System," IET Renewable Power Generation, vol. 14, issue 15, pp. 2916 – 2923, Nov. 2020.
- [7] **Omid Beik**, Ahmad S. Al-Adsani, "Parallel Nine-Phase Generator Control in a Medium Voltage DC Wind System," IEEE Transactions on Industrial Electronics, vol. 67, no. 10, pp. 8112-8122, Oct. 2020.
- [8] **Omid Beik**, "Design Optimization of a PM Motor: A Practical Approach for Mass Production," IEEE Transactions on Energy Conversion, vol. 35, no. 4, pp. 1849-1858, Dec. 2020.
- [9] **Omid Beik**, "Operational Envelope of an Electric Transmission Auxiliary System," IEEE Transactions on Energy Conversion, vol. 35, no. 3, pp. 1513-1521, Sept. 2020.
- [10] Apparao Dekka, **Omid Beik**, Mehdi Narimani, "Modulation and Voltage Balancing of a Five-Level Series-Connected Multilevel Inverter with Reduced Isolated DC Sources," IEEE Transactions on Industrial Electronics, vol. 67, no. 10, pp. 8219-8230, Oct. 2020.
- [11] Ahmad S. Al-Adsani, Ali Jurashi, **Omid Beik**, "ICE/HPM generator range extender for a series hybrid EV powertrain," IET Electrical Systems in Transportation, vol. 10, issue 1, pp. 96-104, Mar. 2020.
- [12] Ahmad S. Al-Adsani, **Omid Beik**, "Characterization of a Hybrid PM Generator Using a 32-Phase Brushless Excitation Scheme," IEEE Transactions on Energy Conversion, vol. 34, no. 3, pp. 1391-1400, Sept. 2019.
- [13] David Schumacher, **Omid Beik**, Ali Emadi, "Standalone Integrated Power Electronics System: Applications for Off-Grid Rural Locations" IEEE Electrification Magazine, vol. 6, no. 4, pp. 73-82, Dec. 2018.
- [14] Ahmad S. Al-Adsani, **Omid Beik**, "Design of a Multiphase Hybrid Permanent Magnet Generator for Series Hybrid EV" IEEE Transactions on Energy Conversion, vol. 33, no. 3, pp. 1499-1507, Sept. 2018.
- [15] **Omid Beik**, Nigel Schofield, "High-Voltage Hybrid Generator and Conversion System for Wind Turbine Applications" IEEE Transactions on Industrial Electronics, vol. 65, no. 4, pp. 3220-3229, April 2018.
- [16] **Omid Beik**, Ali Emadi, "Toward Integrated Digital Aircraft Control Systems: For Electrified-System Optimized Size, Cost, and Efficiency" IEEE Electrification Magazine, vol. 5, no. 4, pp. 46-52, Dec. 2017.
- [17] **Omid Beik**, Nigel Schofield, "An Off-Shore Wind Generation Scheme with High Voltage Hybrid Generator, HVDC Interconnections and Transmission" IEEE Transactions on Power Delivery, vol. 31, no. 2, pp. 867-877, April 2016.
- [18] **Omid Beik**, M. R. Aghamohammadi, M. Rezaee "Generator Dynamic Performance Affected by Parameter's Uncertainty," American Journal of Applied Sciences, vol. 10, no. 6, pp. 570-578, June 2013.
- [19] **Omid Beik**, M. Hajati, M. R. Aghamohammadi, "An Analytical Method to Parameter Estimation by Dynamic Performance Evaluation" International Journal of Energy and Power, vol. 2, no. 1, Feb. 2013.
- [20] **Omid Beik**, V. Ghorbani, "Economic Evaluation of Optimal Location of FACTS Devices Using Genetic Algorithm for Voltage Drop Cost Reduction" Journal of Quarterly Energy Economics Review, vol. 5, no. 16, pp. 185-199, Spring 2008.

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- [1] M. Homaeinezhad, **O. Beik** and A. Karni, "Multiphase Multilevel NPC Converter for MVDC Electric Ship Applications," 2023 IEEE Electric Ship Technologies Symposium (ESTS), Alexandria, VA, USA, 2023, pp. 121-128.
- [2] M. Arshad, **O. Beik**, R. Pallapati and S. Hoberg, "Overview of Bison Wind Farm: An AC Collector and HVDC Transmission Grid," IEEE/IAS 59th Industrial and Commercial Power Systems Technical Conference (I&CPS), Las Vegas, NV, USA, 2023.
- [3] W. Ateeq and **O. Beik**, "Borrego Springs Microgrid Operation and Control: An Overview," IEEE/IAS 59th Industrial and Commercial Power Systems Technical Conference (I&CPS), Las Vegas, NV, USA, 2023.
- [4] **Omid Beik**, Mukund R. Patel, Sarah Talebzadeh, "Large Spacecraft Electric Propulsion Using Multiphase Generator," IEEE Aerospace Conference, Big Sky, MT, USA, Mar. 4-11, 2023.
- [5] Mahzad Gholamian, **Omid Beik**, "Coordinate Control of Wind Turbines in a Medium Voltage DC Grid" IEEE Energy Conversion Congress and Exposition (ECCE), Detroit, MI, USA, Oct. 09-13, 2022.

- [6] **Omid Beik**, Ahmad S. Al-Adsani, "Comparison of Active and Passive 9-Phase Wind Turbine Conversion System for an all DC Grid" IEEE Energy Conversion Congress and Exposition (ECCE), Vancouver, BC, Canada, Sept 10-14, 2021.
- [7] **Omid Beik**, Ahmad S. Al-Adsani, "Proposed Wind Turbine Limited- and High-Speed Operation," IEEE Electric Power and Energy Conference (EPEC), Edmonton, Canada, Nov. 2020.
- [8] **Omid Beik**, Ahmad S. Al-Adsani, "Wind Turbine Productivity and Wind Energy Assessment: An Ontario Case Study," IEEE Electric Power and Energy Conference (EPEC), Edmonton, Canada, Nov. 2020.
- [9] Ahmad S. Al-Adsani, **Omid Beik**, "Efficiency and Operational Envelop of a Hybrid PM Machine System for HEVs," The 10th IET International Conference on Power Electronics, Machines and Drives (PEMD), Nottingham, UK, April 2020.
- [10] **Omid Beik**, Rong Yang, Ali Emadi, "Design of a 5-Phase IPM Machine for Electric Vehicles" IEEE Transportation Electrification Conference and Expo (ITEC), Long Beach, CA, USA, pp. 168-172, 2018.
- [11] **Omid Beik**, Appao Dekka, Mehdi Narimani, "A New Modular Neutral Point Clamped Converter with Space Vector Modulation Control," IEEE International Conference on Industrial Technology (ICIT), Lyon, France, pp. 591-595, 2018.
- [12] Nigel Schofield, **Omid Beik**, "Wind Turbine High Voltage Generator and System," The 15th Wind Integration Workshop, Vienna, Austria, Nov. 15-17, 2016.
- [13] **Omid Beik**, Nigel Schofield, "High Voltage Generator for Wind Turbines" The 8th IET Conference on Power Electronics, Machines and Drives (PEMD 2016), Glasgow, Scotland, UK, April 19-21, 2016.
- [14] **Omid Beik**, Nigel Schofield, "Hybrid Generator for Wind Generation Systems" IEEE Energy Conversion Congress and Exposition (ECCE 2014), Pittsburgh, PA, USA, Sept 14-18, 2014.
- [15] **Omid Beik**, Nigel Schofield, Ahmad S. Al-Adsani, "Variable Speed Brushless Hybrid Permanent Magnet Generator for Hybrid Electric Vehicles" IEEE Transportation Electrification Conference and Expo (ITEC), Michigan, USA, June 15-18, 2014.
- [16] Nigel Schofield, Xin Niu, **Omid Beik**, "Multiphase Machines for Electric Vehicle Traction" IEEE Transportation Electrification Conference and Expo (ITEC), Michigan, USA, June 15-18, 2014.
- [17] **Omid Beik**, Nigel Schofield, "A Brushless Exciter Design for a Hybrid Permanent Magnet Generator Applied to Series Hybrid Electric Vehicles" The 7th IET international conference on Power Electronics, Machines and Drives (PEMD), Manchester, UK, April 8-10, 2014.
- [18] **Omid Beik**, A. Salem Nia, "Damping of Power System oscillations in Multi-machine Power Systems Using Coordinate Design of PSS and TCSC" IEEE Environment and Electrical Engineering International Conference (EEEIC), Italy, May 8-11, p.1-4, 2011.
- [19] M. R. Aghamohammadi, **Omid Beik**, "Small Signal Stability Constrained Rescheduling Using Sensitivities Analysis by Neural Network as a Preventive Tool" IEEE Transmission and Distribution (T&D) 2010, New Orleans, Louisiana, USA, April 19-22, pp. 1-5, 2010.
- [20] M. R. Aghamohammadi, **Omid Beik**, M. Rezaee "Effect of Generator Parameters Inaccuracy on Transient Stability Performance" IEEE Asia-Pacific Power and Energy Conference (APPEEC) 2010, Chengdu, China, March 28-31, pp.1-5, 2010.
- [21] A. Salem Nia, **Omid Beik**, "Impact of TCSC reliability model on HLII reliability indices of power system" Proceedings of the 9th World Scientific and Engineering Academy and Society (WSEAS) International Conference on Power Systems, Budapest, September 3-5, pp. 117-122, 2009.

Appendix B: Table of Exhibits

Exhibit	Description
1001	U.S. Patent No. 10,177,551 to Smith et al.
1002	Declaration of Dr. Beik and CV.
1003	U.S. Patent No. 10,003,298 to Grushkowitz et al. (“Grushkowitz”).
1004	U.S. Patent No. 3,001,749 to Petersen (“Petersen”).
1005	CAB Cable Rings and Saddles for Solar PV Arrays Website, Wayback Machine (February 4, 2015) (“CAB Website”).
1006	Cable Management in Solar PV Arrays: A Review of Requirements in the National Electrical Code and how CAB Cable Rings and Saddles Meet These Requirements, September 18, 2014 (“CAB Whitepaper”).
1007	National Fire Protection Association, “The National Electrical Code,” 2008 Edition.
1008	Zipse, “History of Grounding/Earthing Practices In The United States,” IEEE (PCIC-2017-25), 2017.
1009	U.S. Patent No. 231,552 to Finney.
1010	U.S. Patent No. 916,306 to Hall.
1011	U.S. Patent No. 2,201,472 to Browder.
1012	Mulqueen, “A Natural History of the Wooden Utility Pole,” California Public Utilities Commission, Policy and Planning Division, July, 2017.
1013	Water and Power Associates, “Early Power Distribution” available at https://waterandpower.org/museum/Early_Power_Distribution.html
1014	U.S. Patent No. 1,464,535 to McGivern.
1015	U.S. Patent No. 1,401,998 to Manz.
1016	U.S. Patent No. 1,448,141 to Manz.
1017	U.S. Patent No. 2,917,259 to Hill.
1018	U.S. Patent No. 3,042,351 to Du Bois.
1019	U.S. Patent No. 3,363,048 to Vaughn.
1020	U.S. Patent No. 1,754,924 to Williams.
1021	U.S. Patent No. 1,766,873 to Birch.
1022	Seo, Hun Chul, et al. “Applicability of Messenger Wire for Purpose of Lightning Protection.” <i>Journal of Electrical Engineering and Technology</i> , vol. 11, no. 1, 2016, pp. 167–174.
1023	Southwire, “Triplex Service Drop, Aluminum Conductors. Polyethylene or Crosslinked Polyethylene Insulation,” 2003.
1024	Seiler, “Hendrix Covered Conductor Manual,” Western Power, Rev 2 – August 8, 2013

1025	U.S. Patent Application Publication No. 2001/0038738 to Akasaka.
1026	Affidavit of Nathaniel E Frank-White – Authentication of EX1005 and EX1006.
1027	MacLean “Pole Line Hardware Catalog” was issued in May of 2010 (“MacLean”).
1028	IEEE Green Book 142, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems, 2007.
1029	Jung, et al., “An In-depth Analysis for Optimal Cable Tray Support Span,” Sustainable Marine Structures, Volume 02, Issue 01, January 2020.
1030	“Steel Distribution Poles,” American Galvanizers Association, 1997 accessible at https://galvanizeit.org/education-and-resources/publications/hdg-steel-distribution-poles-1997 .
1031	National Electrical Safety Code, “National Electrical Safety Code Committee, Accredited Standards Committee C2 – Interpretation Section 23 Clearances,” July 31, 2001.
1032	National Fire Protection Association, “Volume II 1959 Advance Reports Proposed National Electrical Code,” 1959.
1033	Texas Department of Transportation, Fort Worth District, “Traffic Signal Support Structures Timber Pole Assemblies,” September, 2012.
1034	State of Tennessee Department of Transportation, “Span Wire and Messenger Cable Details,” July 29, 2004.
1035	Jacoby, “PV Array Wire Management, Securing, Supporting and Protecting Conductors within the PV Array,” SolarPro, Issue 6.2, Feb./Mar. 2013.
1036	United States Department of Agriculture, Rural Utilities Service, “Bulletin 1724E-153, RD-GD-2001-39: Electrical Distribution Line Guys and Anchors.” April 25, 2001.
1037	U.S. Patent 10,177,551 File History