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NORTHERN DISTRICT OF CALIFORNIA

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UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

[DIVISION TO BE ASSIGNED]

BZ

AKEENA SOLAR, INC., a Delaware corporation; and ANDALAY SOLAR, INC., a California corporation,

Plaintiffs,

v.

ZEP SOLAR, INC., a California corporation; GLOBAL RESOURCE OPTIONS, INC. dba GROSOLAR, a Delaware corporation; and HIGH SUN TECHNOLOGY, INC., a California corporation,

Defendants.

Civil Action No. CV 09 5040

COMPLAINT FOR:

1. **PATENT INFRINGEMENT OF U.S. PATENT NO. 7,406,800; AND**
2. **DECLARATORY JUDGMENT OF NON-INFRINGEMENT OF U.S. PATENT NO. 7,592,537**

AND

DEMAND FOR JURY TRIAL

Plaintiffs AKEENA SOLAR, INC. ("Akeena") and ANDALAY SOLAR, INC. ("Andalay") (hereafter each a "Plaintiff" and collectively "Plaintiffs"), by their undersigned counsel, hereby bring this action against defendants ZEP SOLAR, INC. ("Zep"), GLOBAL RESOURCE OPTIONS, INC. dba GROSOLAR ("groSolar"), and HIGH SUN TECHNOLOGY, INC. ("High Sun Technology") (hereafter each a "Defendant" and collectively "Defendants"), and allege as follows:

THE PARTIES

1. Plaintiff Akeena is a corporation organized and existing under the laws of the State of Delaware, having its corporate headquarters and principal place of business in this district at 16005 Los Gatos Blvd., Los Gatos, California, 95032, in Santa Clara County.

2. Plaintiff Andalay is a corporation organized and existing under the laws of the State of California, having its corporate headquarters and principal place of business in this district at 16005 Los Gatos Blvd., Los Gatos, California, 95032, in Santa Clara County. Andalay is a wholly-owned subsidiary of Akeena.

3. Defendant Zep is a corporation organized and existing under the laws of the State of California that, on information and belief, has its corporate headquarters and principal place of business in this district at 161 Mitchell Blvd., Suite 104, San Rafael, California, 95945, in Marin County.

4. Defendant groSolar is a corporation organized and existing under the laws of the State of Delaware that, on information and belief, has its corporate headquarters and principal place of business at 601 Old River Road Suite 3, White River Junction, Vermont, 05001, and that has installation, warehouse, and sales offices across the United States, including in the cities of Berkeley (in Alameda County) and San Jose (in Santa Clara County), both in California and in this district.

5. Defendant High Sun Technology is a California corporation that, on information and belief, has its corporate headquarters and principal place of business in this district at 15925 Birkhofer Road, Guerneville, California, 95446, in Sonoma County.

JURISDICTION (Civil L.R. 3-5(a)) AND VENUE

6. This action is for patent infringement, arises under the Patent Laws of the United States, 35 U.S.C. § 1 *et seq.*, and seeks damages and injunctive relief. This Court has original and exclusive subject matter jurisdiction over this action pursuant to 28 U.S.C. §§ 1331 and 1338(a). This Court further has subject matter jurisdiction over this action because it is additionally an action for declaratory relief that seeks a declaratory judgment under 28 U.S.C. §§ 2201 and 2202 regarding patent non-infringement.

7. This Court has personal jurisdiction over Defendant Zep in this action because, on information and belief, Zep has its corporate headquarters and principal place of business within this judicial district, and has engaged in substantial business within this forum amounting to sufficient minimum contacts, including, but not limited to, making, using, advertising, marketing, offering to sell, importing, and/or selling products (including, at least, offering to sell products that are the subject of Plaintiffs' patent infringement allegations in this Complaint) to customers within or into California and this judicial district, as well as employing personnel and/or representatives within this judicial district.

8. This Court has personal jurisdiction over Defendant groSolar in this action because, on information and belief, groSolar has installation, warehouse, and sales offices within this judicial district (in the cities of Berkeley in Alameda County and San Jose in Santa Clara County), and has engaged in substantial business within this forum amounting to sufficient minimum contacts, including, but not limited to, making, using, advertising, marketing, offering to sell, importing, selling, and/or distributing products and services (including, at least, offering to sell products that are the subject of Plaintiffs' patent infringement allegations in this Complaint) to customers within or into California and this judicial district, as well as employing personnel and/or representatives within this judicial district.

9. This Court has personal jurisdiction over Defendant High Sun Technology because, on information and belief, High Sun Technology has its corporate headquarters and principal place of business within this judicial district, as well as a separate divisional office for an affiliate of unknown corporate status known as "High Sun Engineering" within this judicial district

in the city of San Rafael (in Marin County), and has engaged in substantial business within this forum amounting to sufficient minimum contacts, including, but not limited to, making, using, advertising, marketing, offering to sell, importing, and/or selling products (including, at least, offering to sell products that are the subject of Plaintiffs' patent infringement allegations in this Complaint, or contributing to, actively inducing, or otherwise supporting Defendant Zep's and Defendant groSolar's offering to sell same) to customers within or into California and this judicial district, as well as employing personnel and/or representatives within this judicial district.

10. Venue is proper in this judicial district pursuant to 28 U.S.C. § 1391(b)-(c) and 28 U.S.C. § 1400(b).

INTRADISTRICT ASSIGNMENT (Civil L.R. 3-5(b))

11. Because this action is an Intellectual Property Action as specified in Civil L.R. 3-2(c), it is to be assigned on a district-wide basis.

FACTUAL BACKGROUND

Plaintiffs, the Andalay System, and U.S. Patent No. 7,406,800

12. Founded in 2001, Plaintiff Akeena designs, develops, and installs quality, state-of-the-art solar power harnessing technologies for both residential and commercial use. Akeena's business centers upon the development and installation of solar power panels and systems, also referred to as photovoltaic (or PV) systems. Photovoltaics is the field of technology and research related to the conversion of solar energy (*i.e.*, sunlight) directly into electricity. Akeena is led by Barry Cinnamon (its Founder, CEO, and President), who has been involved in the solar industry since the late 1970's.

13. Plaintiff Andalay is a wholly-owned subsidiary of Akeena, and is the division responsible for Akeena's Andalay integrated solar power system (the "Andalay System"). Barry Cinnamon is the President of Andalay. The innovative Andalay System incorporates solar panels, racks, and wiring integrated together with each other and with grounding mechanisms in a cohesive manner never previously accomplished in the solar power industry. Andalay System

solar panels are modular and may stand alone, but are specially-designed to attach together as an integrated system in whatever number is desired by the customer, using integrated internal splices with coupling and securing mechanisms for connecting and securing the solar panels directly and seamlessly together in a structurally rigid fashion. All racking, grounding, and wiring connections are integrated within the solar panels. Andalay's revolutionary engineering secures the various parts within each panel, allowing its slim solar panels to be mounted closer together for smaller "footprints," with no unsightly mounting racks, dangling wires, or gaps between solar panels. The result is unparalleled reliability, in that there are fewer parts to fail, fewer roof penetrations, and fewer and shorter wire connections subject to pinching, abrasion, or decay compared to any prior solar panel technologies or devices. The Andalay System's improved design also better withstands the weather, and helps to prevent panels from loosening as a result of heating and cooling cycles. It additionally provides a smooth, streamlined aesthetic unique in the solar power industry. Because there are fewer parts to install, the Andalay System substantially reduces installation time, providing great benefit to installers. The Andalay System is designed for use in residential, commercial, and government applications, whether on-roof or ground-mounted.

14. The Andalay System is the result of pioneering and innovative work by Barry Cinnamon (Akeena's Founder, CEO, and President, as well as President of Andalay), in the design of integrated solar panel technologies. On May 18, 2004, Mr. Cinnamon (along with co-inventor Emanuel Edward Levy) caused U.S. Patent Application No. 10/849,069 (the "10/849,069 Application") to be filed, claiming an integrated module frame and racking system for solar panels. The 10/849,069 Application became public on November 24, 2005, and on August 5, 2008, U.S. Patent No. 7,406,800 (the "'800 Patent") was issued by the United States Patent and Trademark Office ("PTO") based on the 10/849,069 Application. The '800 Patent names Barry Cinnamon and Emanuel Edward Levy as inventors. A true and correct copy of the '800 Patent is attached hereto as **Exhibit 1**.

15. The technology and inventions covered by the claims of the '800 Patent are featured in the Andalay System. The Andalay System products have been marked and are being marked by Plaintiffs with the '800 Patent number in accordance with 35 U.S.C. § 287.

16. On or about May 18, 2004, Barry Cinnamon assigned the '800 Patent to Andalay. Andalay later assigned the '800 Patent to Akeena, and Akeena later re-assigned the '800 Patent back to Andalay on or about October 31, 2007. Andalay is the current assignee of the '800 Patent, although Andalay remains a wholly-owned subsidiary of Akeena.

Defendant Zep, the Zep System, the High Sun Entities, and U.S. Patent No. 7,592,537

17. On information and belief, on February 7, 2005, John Raymond West (aka Jack West, now the Co-Founder, CEO, and CTO of Defendant Zep) caused U.S. Patent Application No. 11/053,524 (the "11/053,525 Application") to be filed, claiming an interlocking photovoltaic module mounting system (*i.e.*, a solar panel mounting system) that provides a one-piece, integrated photovoltaic module frame that is directly mountable to a support structure and that can interlock with separate photovoltaic module frames. On September 22, 2009, U.S. Patent No. 7,592,537 (the "'537 Patent") was issued by the PTO based on the 11/053,525 Application. The '537 Patent names John Raymond West as inventor. A true and correct copy of the '537 Patent is attached hereto as **Exhibit 2**.

18. According to Defendant Zep's website at http://www.zepsolar.com/about.html, Zep was founded in 2009 for the purpose of commercializing an improved mounting system for solar/PV panels, which mounting system was developed by Zep Co-Founder, CEO, and CTO, Jack West (aka John Raymond West, inventor of the '537 Patent). The mounting system developed by Mr. West (as disclosed in both the '537 Patent and Zep's website at http://www.zepsolar.com) involves solar panel frames that interlock together with specialized couplings to form a grounded and rigid structural grid of solar panels. Per the '537 Patent and Zep's website, the solar panel frames can also be attached to structures using a specialized leveling foot. Defendant Zep represents itself on its website as a developer and manufacturer of the Zep System for mounting solar/PV panels. Zep is currently advertising, marketing, and offering to sell its integrated solar panel/PV mounting system (called the "Zep System") and its component mounting parts through at least its Internet website at http://www.zepsolar.com/.

19. According to the PTO's online patent assignment database at http://assignments.uspto.gov/assignments/q?db=pat&qt=pat&reel=&frame=&pat=7592537&pub=&asnr=&asnri=&asne=&asnei=&asns, Mr. West assigned the '537 Patent to Defendant High Sun Technology on or about May 18, 2009. Therefore, based on the information that is publicly available, Defendant High Sun Technology is the current owner by assignment of the '537 Patent.

20. Furthermore, on information and belief, an entity of unknown corporate status known as "High Sun Engineering" is an affiliate of Defendant High Sun Technology. High Sun Engineering's website (at http://sunengineer.com/profile.htm and http://sunengineer.com/staff.htm) names Jack West as a Co-Founder, Principal, and its Photovoltaic Systems Engineer. Accordingly, based on: 1) Mr. West's apparent common involvement as a principal in both Defendant High Sun Technology (through at least its affiliated High Sun Engineering entity) and in Defendant Zep; 2) a press release dated September 22, 2009 (available at http://www.renewableenergyworld.com/rea/partner/high-sun-engineering-7213/news/article/2009/09/zep-solar-launches-ultra-efficient-solar-mounting-system1#) describing Zep as a "spin-off" of "High Sun Engineering" and describing the Zep System as "patent pending"; 3) a press release dated October 13, 2009 (available at Defendant groSolar's website at http://grosolar.com/global-solar-news/press-releases/grosolar-and-zep-solar-to-revolutionize-residential-pv-installation/) describing the Zep System as "patented"; 4) High Sun Engineering's website at http://sunengineer.com/profile.htm, explaining that High Sun Engineering has "spun-off" Zep and proclaiming the October 2009 launch of Zep's products as "our" products; 5) an e-mail from counsel for Zep to counsel for Plaintiffs dated September 28, 2009, stating, among other things,"[W]e wanted to bring to your attention the fact that Zep Solar has a recently issued US patent -- #7,592,537 -- which has a priority date of Feb 5, 2004"; and 6) an e-mail from Jack West to Barry Cinnamon (President of both Plaintiffs Akeena and Andalay) dated October 12, 2009 concerning the '537 Patent, which stated, "Zep's legal team is ready for a fight if that is what is needed," Defendant Zep, on information and belief, also apparently holds all substantial rights in the '537 Patent.

21. By describing its Zep System as "patent pending" technology, and more recently, "patented" technology in the press releases described above, Zep has disseminated information asserting that its Zep System incorporates the technology and inventions of the '537 Patent.

Defendant groSolar, and Distribution of the Zep System

22. According to a press release dated October 13, 2009 that is available on Defendant groSolar's website at http://grosolar.com/global-solar-news/press-releases/grosolar-and-zep-solar-to-revolutionize-residential-pv-installation/, groSolar is a distributor, installer, and integrator of solar energy solutions for residential and commercial solar panel installations, and groSolar describes itself as the largest 100%-U.S.-owned distribution and installation company in the solar industry with offices and warehouses across the U.S.

23. Based on that same press release available on Defendant groSolar's website at http://grosolar.com/global-solar-news/press-releases/grosolar-and-zep-solar-to-revolutionize-residential-pv-installation/, on or about no later than October 13, 2009, Defendant groSolar and Defendant Zep announced a partnership between their companies whereby groSolar will distribute and install the Zep System. According to that same press release and to Defendant Zep's website at http://www.zepsolar.com/spi_2009.html, Defendant groSolar's booth at the upcoming Solar Power International 2009 convention and trade show (scheduled for October 27-29, 2009 in Anaheim, California per the Solar Power International 2009 website at http://s36.a2zinc.net/clients/sepa/sepa2009/public/FloorPlan.aspx?ID=163&sortMenu=105005, to which a link is provided on Zep's website at http://www.zepsolar.com/spi_2009.html) will feature Zep's products and live installation demonstrations of solar panels using Zep's products. Defendant Zep is therefore poised to capitalize on groSolar's national sales, distribution, and installation network to propagate its Zep System, and the two companies are actively promoting their partnership involving the Zep System.

FIRST CLAIM FOR RELIEF

Patent Infringement of U.S. Patent No. 7,406,800

(Against Defendants Zep and groSolar)

24. The allegations of paragraphs 1-23 above are hereby re-asserted and re-alleged and incorporated herein by reference in support of this First Claim for Relief.

25. Plaintiff Andalay is the owner, by assignment, of the '800 Patent, and is a wholly-owned subsidiary of Plaintiff Akeena. The '800 patent is valid and was duly and legally issued by the PTO on August 5, 2008. A true and correct copy of the '800 Patent is attached hereto as **Exhibit 1**.

26. Defendants Zep and groSolar have been, and are now, directly, indirectly, contributorily, and/or by inducement, infringing one or more claims of the '800 Patent, literally and/or under the doctrine of equivalents, as proscribed by 35 U.S.C. § 271 *et seq.,* by, without permission or authority from Plaintiffs,: 1) making, using, offering to sell, importing, and/or selling; 2) contributing to each others' and/or third parties' making, using, offering to sell, importing, and/or selling of; and/or 3) actively inducing each other and/or third parties to make, use, offer to sell, import, and/or sell, within the United States or into the United States, devices and/or systems and/or components of devices and/or systems (including the Zep System), embodying the patented invention(s) claimed by the '800 Patent.

27. Defendant Zep's and Defendant groSolar's offers to sell the infringing Zep System include offers disseminated through: 1) Zep's website at http://www.zepsolar.com, including, but not limited to, at http://www.zepsolar.com/purchase.html (providing an order reservation form and information on how Zep products may be purchased from Defendant groSolar, as well as information on how to make direct sales inquires of Zep), at http://www.zepsolar.com/products.html#Zep_System_LM (advertising Zep's specific products), and at http://www.zepsolar.com/spi_2009.html (regarding Zep's intention to show and demonstrate its products at Defendant groSolar's booth at the Solar Power International 2009 convention and trade show expo); 2) groSolar's website at http://grosolar.com, including, but not limited to, at http://grosolar.com/global-solar-news/press-releases/grosolar-and-zep-solar-to-

revolutionize-residential-pv-installation/ (presenting a press release dated October 13, 2009 announcing groSolar's partnership with Zep for the distribution of the Zep System, Zep's intention to provide demonstrations of its products at groSolar's booth at the Solar Power International 2009 convention, and Defendant Zep's and Defendant groSolar's plans for Zep to have the first shipments of its products available through groSolar in the first quarter of 2010) and at http://grosolar.com/calendar/ (providing a link to the website of the Solar Power International 2009 convention and trade show expo, at which a map to groSolar's Booth 309 may be found at http://s36.a2zinc.net/clients/sepa/sepa2009/public/floorplan.aspx and at which further information regarding groSolar as an exhibitor may be found at http://s36.a2zinc.net/clients/sepa/sepa2009/public/Booth.aspx?IndexInList=23&FromPage=ExhibitorList.aspx&ParentBoothID=&ListByBooth=true&BoothID=104494); 3) the website of High Sun Engineering (a company co-founded by Zep Co-Founders Jack West and Christina Manansala that is, on information and belief, an affiliate of unknown corporate status of Defendant High Sun Technology, and from which Zep itself was spun off) at http://sunengineer.com/profile.htm (explaining that Zep is a spin-off of High Sun Engineering, and stating, "Zep Solar, Inc. proudly announces the October 2009 launch of our innovative rail-free PV mounting system inventions. Our products will greatly reduce materials, labor, space, and transportation energy, making photovoltaic power more attainable. You can check us out at www.zepsolar.com."); 4) a full-page, color advertisement at page 31 of the October/November 2009 issue of the solar power industry magazine entitled "*SOLARPRO*," advertising and describing the Zep System and the live demonstrations to take place at the Solar Power International 2009 convention at Booth 309 (*i.e.*, Defendant groSolar's booth); 5) a demonstration and display of the Zep System to a representative (or representatives) of the magazine entitled "*SOLARPRO*" that took place in San Rafael, California, as described at pages 30 and 32 of the October/November 2009 issue of that magazine; 6) a press release by Zep dated September 22, 2009 describing the Zep System and its upcoming launch at the Solar Power International 2009 convention; and 7) a "tweet" by Jeff Wolfe (Co-Founder, CEO, and Chairman of the Board of Defendant groSolar according to groSolar's website at http://grosolar.com/the-grosolar-team/) at https://twitter.com/Jeff_groSolar, dated October 4,

2009 at 10:01 PM, in which Mr. Wolfe states, "@solarfeeds (Coming soon!) RT Rail-free solar panel mounting http://ow.ly/15SSbf," with the "http://ow.ly/15SSbf" text being a link to the Solar Feeds News and Commentary Network that announces Zep's rail-free solar panel mounting products and their introduction at the upcoming Solar Power International trade show.

28. By reason of Defendant Zep's and Defendant groSolar's direct, contributory, and/or active inducement of infringement, Plaintiffs have suffered and are suffering damages, including, but not limited to, impairment of the value of the '800 Patent, loss of customer base and market share (including lost sales of the Andalay System), and loss of prestige in the solar/PV technology industry, in an amount yet to be determined, but that will be proven at trial.

29. Defendant Zep's and Defendant groSolar's acts of infringement described above are causing irreparable injury and harm to Plaintiffs, and will continue to cause irreparable injury and harm unless enjoined by this Court. Plaintiffs have no adequate remedy at law to compel Defendants Zep and groSolar to cease their wrongful misappropriation. Unless the Court grants an injunction, Plaintiffs will be compelled to prosecute a multiplicity of actions, one each time Defendants Zep and groSolar infringe the '800 Patent. The harm to Plaintiffs is irreparable because it is extremely difficult to ascertain the amount of compensation that will afford Plaintiffs adequate relief if Defendants Zep and groSolar are not enjoined at this time.

30. On information and belief, Defendants Zep and groSolar have had knowledge of the '800 Patent since at least around the time of its issue date of August 5, 2008, and certainly since on or about late September of 2009 when counsel for Plaintiffs sent a letter to Jack West (CEO of Defendant Zep) on September 23, 2009 and a separate letter to Jeffery Wolfe (CEO of Defendant groSolar) on September 25, 2009, in which Plaintiffs specifically informed Defendants Zep and groSolar of the '800 Patent and of their infringement of the '800 Patent. Despite the issuance of the '800 Patent and Defendant Zep's and Defendant groSolar's receipt of the late-September 2009 letters by counsel for Plaintiffs, Defendants Zep and groSolar continue to engage in the infringing activities described hereinabove. Defendant Zep's and Defendant groSolar's acts of infringement therefore have been, and are being, committed with notice and knowledge of Plaintiffs' patent rights and, upon information and belief, Defendant Zep's and

Defendant groSolar's infringement has been willful and carried out without the exercise of due care by Defendants Zep and groSolar. Accordingly, Plaintiffs are entitled to receive treble damages pursuant to 35 U.S.C. § 284 based on each of Defendant Zep's and Defendant groSolar's willful infringement, and this is an exceptional case entitling Plaintiffs to an award of their reasonable attorneys' fees incurred in connection with this action pursuant to 35 U.S.C. § 285.

SECOND CLAIM FOR RELIEF

Declaratory Judgment of Non-Infringement of U.S. Patent No. 7,592,537

(Against Defendants Zep and High Sun Technology)

31. The allegations of paragraphs 1-30 above are hereby re-asserted and re-alleged and incorporated herein by reference in support of this Second Claim for Relief.

32. Plaintiffs' products, systems, and services do not infringe, either directly or indirectly (*i.e.*, contributorily or by active inducement), any valid and enforceable claim of the '537 Patent, either literally or under the doctrine of equivalents. A true and correct copy of the '537 Patent is attached hereto as **Exhibit 2**.

33. A valid and justiciable controversy regarding the '537 Patent exists between Plaintiffs, on the one hand, and Defendants Zep and High Sun Technology, on the other hand, based on the following facts. On September 23, 2009, Plaintiffs, through their counsel, sent a letter to Jack West (Co-Founder, CEO, and CTO of Defendant Zep, who is also apparently a Co-Founder, Principal, and Photovoltaic Systems Engineer at High Sun Engineering, an entity of unknown corporate status that is, on information and belief, an affiliate of Defendant High Sun Technology), providing explicit notice of the '800 Patent and of Zep's infringement of the '800 Patent. In response to that letter, counsel for Zep sent an e-mail to counsel for Plaintiffs on September 28, 2009, stating, among other things,"[W]e wanted to bring to your attention the fact that Zep Solar has a recently issued US patent -- #7,592,537 -- which has a priority date of Feb 5, 2004." Additionally, on October 12, 2009, Barry Cinnamon (President of both Plaintiffs Akeena and Andalay) received an e-mail from Jack West concerning the '537 Patent, which stated, "Zep's legal team is ready for a fight if that is what is needed." Plaintiffs reasonably interpret these

communications from Zep as assertions of contentions by Zep that Plaintiffs infringe the '537 Patent. Plaintiffs further reasonably interpret those communications (as well as a press release dated September 22, 2009 referring to the Zep System as "patent pending" and an October 13, 2009 press release referring to the Zep System as "patented") as assertions and evidence that Zep has all substantial rights in the '537 Patent necessary to seek to enforce the '537 Patent against alleged infringers. Furthermore, Defendant High Sun Technology is the current owner by assignment of the '537 Patent, according to the PTO's online patent assignment database at http://assignments.uspto.gov/assignments/q?db=pat&qt=pat&reel=&frame=&pat=7592537&pub=&asnr=&asnri=&asne=&asnei=&asns. Defendant High Sun Technology therefore also apparently holds all substantial rights in the '537 Patent necessary to seek to enforce the '537 Patent as against Plaintiffs for alleged infringement, which Plaintiffs reasonably perceive to be a threat for the same reasons set forth above based on the apparent affiliations and commonality of interests between Defendant High Sun Technology, Defendant Zep, and '537 Patent inventor Jack West.

34. Accordingly, an actual controversy under 28 U.S.C. §§ 2201 and 2202 exists between Plaintiffs, on the one hand, and Defendants Zep and High Sun Technology, on the other hand, as to whether Plaintiffs have infringed and/or are infringing the '537 Patent. Plaintiffs seek a judgment that they have not infringed and do not infringe any claim of the '537 Patent.

PRAYER FOR RELIEF

WHEREFORE, Plaintiffs Akeena and Andalay pray for:

A. Judgment that Defendants Zep and groSolar have directly infringed, contributorily infringed, and actively induced infringement of U.S. Patent No. 7,406,800 in violation of 35 U.S.C. § 271(a)-(c) (through Plaintiffs' First Claim for Relief);

B. A preliminary injunction and a permanent injunction pursuant to 35 U.S.C. § 283 prohibiting Defendants Zep and groSolar and their officers, agents, servants, employees, and attorneys, and those persons in active concert or participation with them, from any further acts of infringement of U.S. Patent No. 7,406,800 (through Plaintiffs' First Claim for Relief);

C. Judgment awarding damages adequate to compensate Plaintiffs for Defendant Zep's and Defendant groSolar's infringement of U.S. Patent No. 7,406,800 pursuant 35 U.S.C. § 284 in an amount to be determined at trial, including, but not limited to, compensation for lost profits, loss of sales, price erosion, loss of market share, costs, and interest, but in no event less than a reasonable royalty (through Plaintiffs' First Claim for Relief);

D. Judgment pursuant to 35 U.S.C. § 285 awarding Plaintiffs treble damages based on Defendant Zep's and Defendant groSolar's willful infringement of U.S. Patent No. 7,406,800, in an amount to be determined at trial (through Plaintiffs' First Claim for Relief);

E. Judgment that this is an exceptional case pursuant to 35 U.S.C. § 285 and awarding Plaintiffs their reasonable attorneys' fees and costs from Defendants Zep and groSolar (through Plaintiffs' First Claim for Relief);

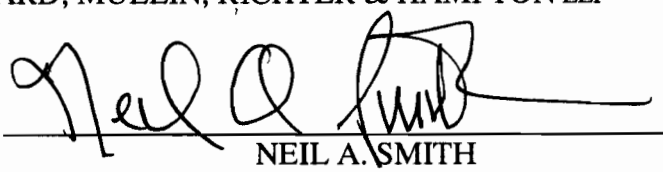
F. Judgment declaring that Plaintiffs have not directly infringed, have not contributorily infringed, and have not induced acts of infringement by others of U.S. Patent No. 7,592,537 (through Plaintiffs' Second Claim for Relief);

G. Judgment awarding Plaintiffs their costs of suit from all Defendants pursuant to Federal Rule of Civil Procedure 54(d) and other applicable law (through Plaintiffs' First and Second Claims for Relief); and

H. Such other and further relief as the Court deems just and proper.

Dated: October 22, 2009

SHEPPARD, MULLIN, RICHTER & HAMPTON LLP

By 

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Attorneys for Plaintiffs
AKEENA SOLAR, INC. and
ANDALAY SOLAR, INC.

DEMAND FOR JURY TRIAL

In accordance with Federal Rule of Civil Procedure 38(b), Plaintiffs Akeena Solar, Inc. and Andalay Solar, Inc. hereby demand a jury trial on all issues triable of right by a jury.

Dated: October 22, 2009

SHEPPARD, MULLIN, RICHTER & HAMPTON LLP

By _____

NEIL A. SMITH
MICHAEL A. MOLANO
NATHANIEL BRUNO

Attorneys for Plaintiffs
AKEENA SOLAR, INC. and
ANDALAY SOLAR, INC.

Exhibit 1

US007406800B2

(12) **United States Patent**
Cinnamon et al.

(10) **Patent No.: US 7,406,800 B2**
(45) **Date of Patent: Aug. 5, 2008**

(54) **MOUNTING SYSTEM FOR A SOLAR PANEL**

(75) Inventors: **Barry Cinnamon**, Saratoga, CA (US); **Emanuel Edward Levy**, Saratoga, CA (US)

(73) Assignee: **Andalay Solar, Inc.**, Saratoga, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 656 days.

(21) Appl. No.: **10/849,069**

(22) Filed: **May 18, 2004**

(65) **Prior Publication Data**

US 2005/0257453 A1 Nov. 24, 2005

(51) **Int. Cl.**
E04D 13/18 (2006.01)
E04B 2/00 (2006.01)
H01L 31/042 (2006.01)

(52) **U.S. Cl.** **52/173.3**; 52/586.1; 136/244

(58) **Field of Classification Search** 52/200, 52/22, 173.3, 251, 586.1, 586.2, 582.1, 656.1, 52/665, 726.2; 136/244; 126/704, 623
See application file for complete search history.

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Assistant Examiner—Anthony N Bartosik
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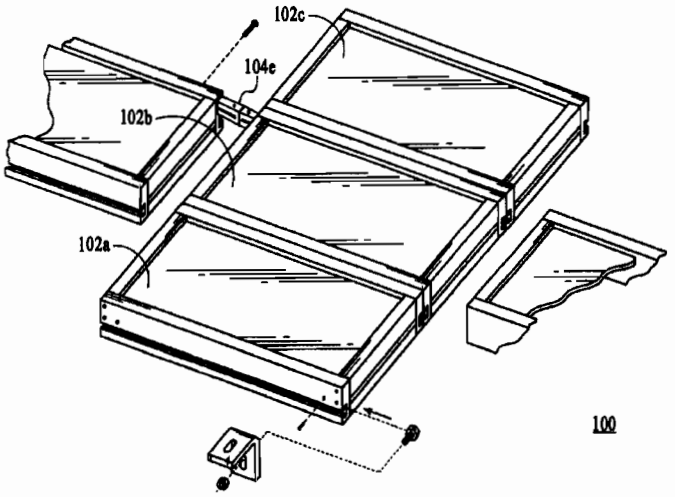
(57) **ABSTRACT**

An integrated module frame and racking system for a solar panel is disclosed. The solar panel comprises a plurality of solar modules and a plurality of splices for coupling the plurality of solar modules together. The plurality of splices provide a way to make the connected modules mechanically rigid both during transport to the roof and after mounting for the lifetime of the system, provide wiring connections between modules, provide an electrical grounding path for the modules, provide a way to add modules to the panel, and provide a way to remove or change a defective module. Connector sockets are provided on the sides of the modules to simplify the electrical assembly of modules when the modules are connected together with splices.

12 Claims, 7 Drawing Sheets



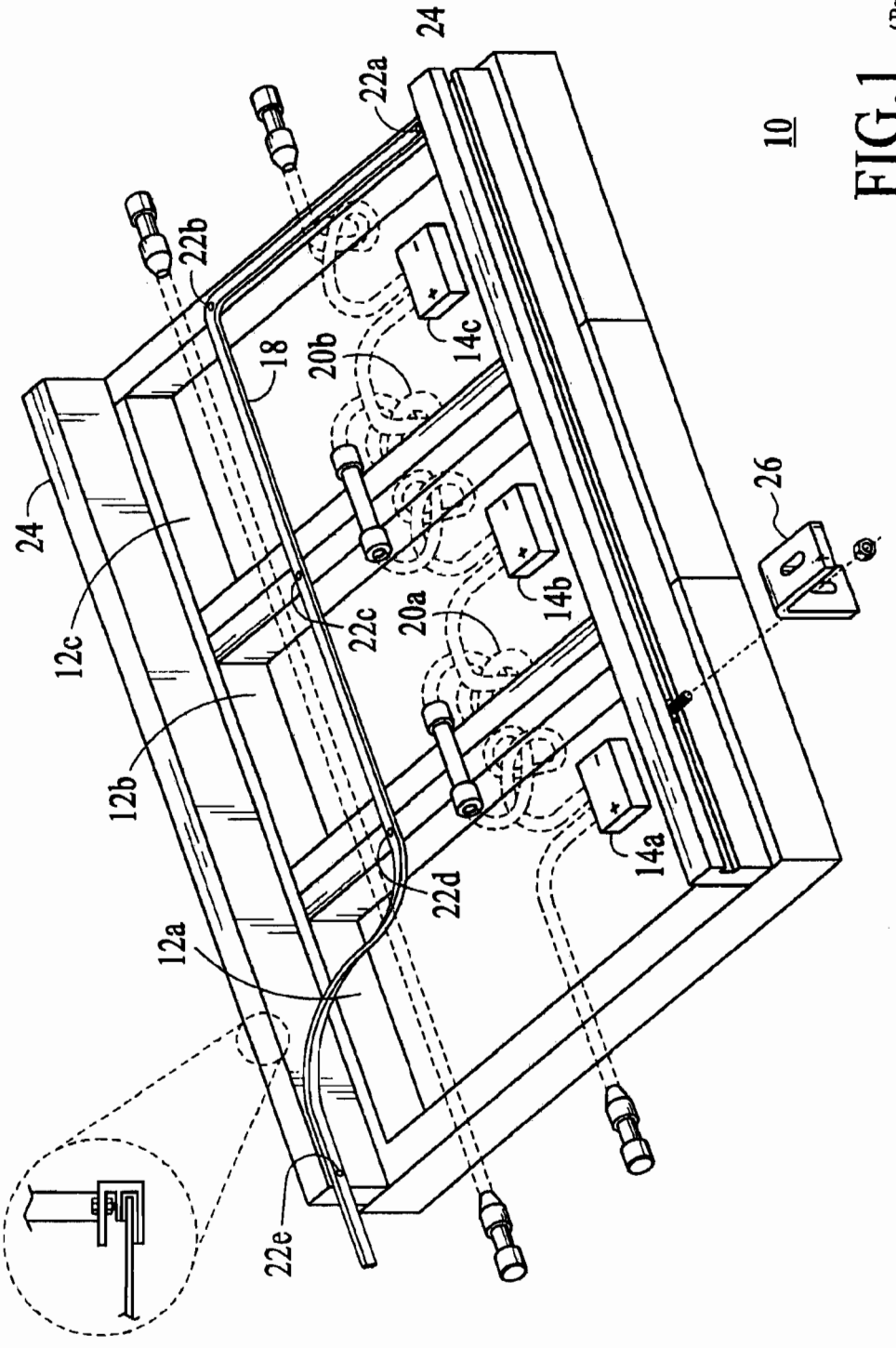


FIG. 1 (Prior Art)

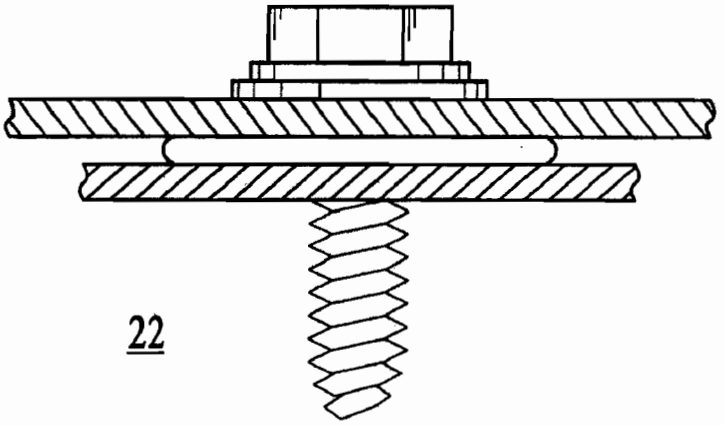


FIG.1A (Prior Art)

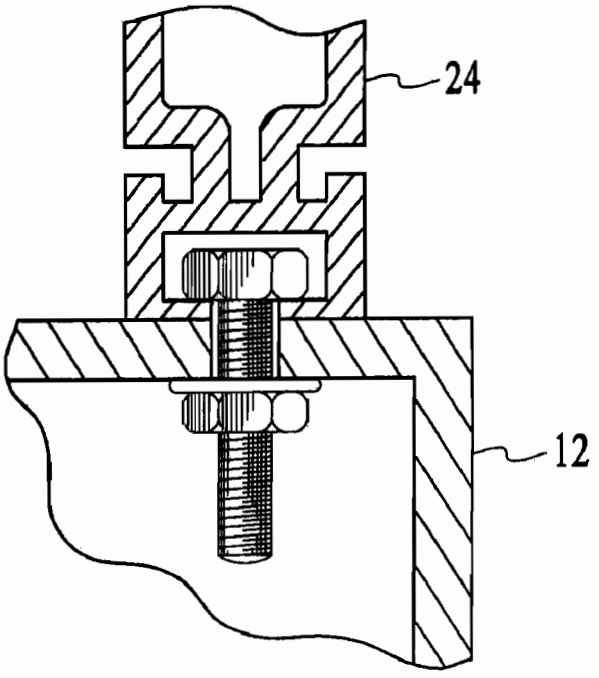


FIG.1B (Prior Art)

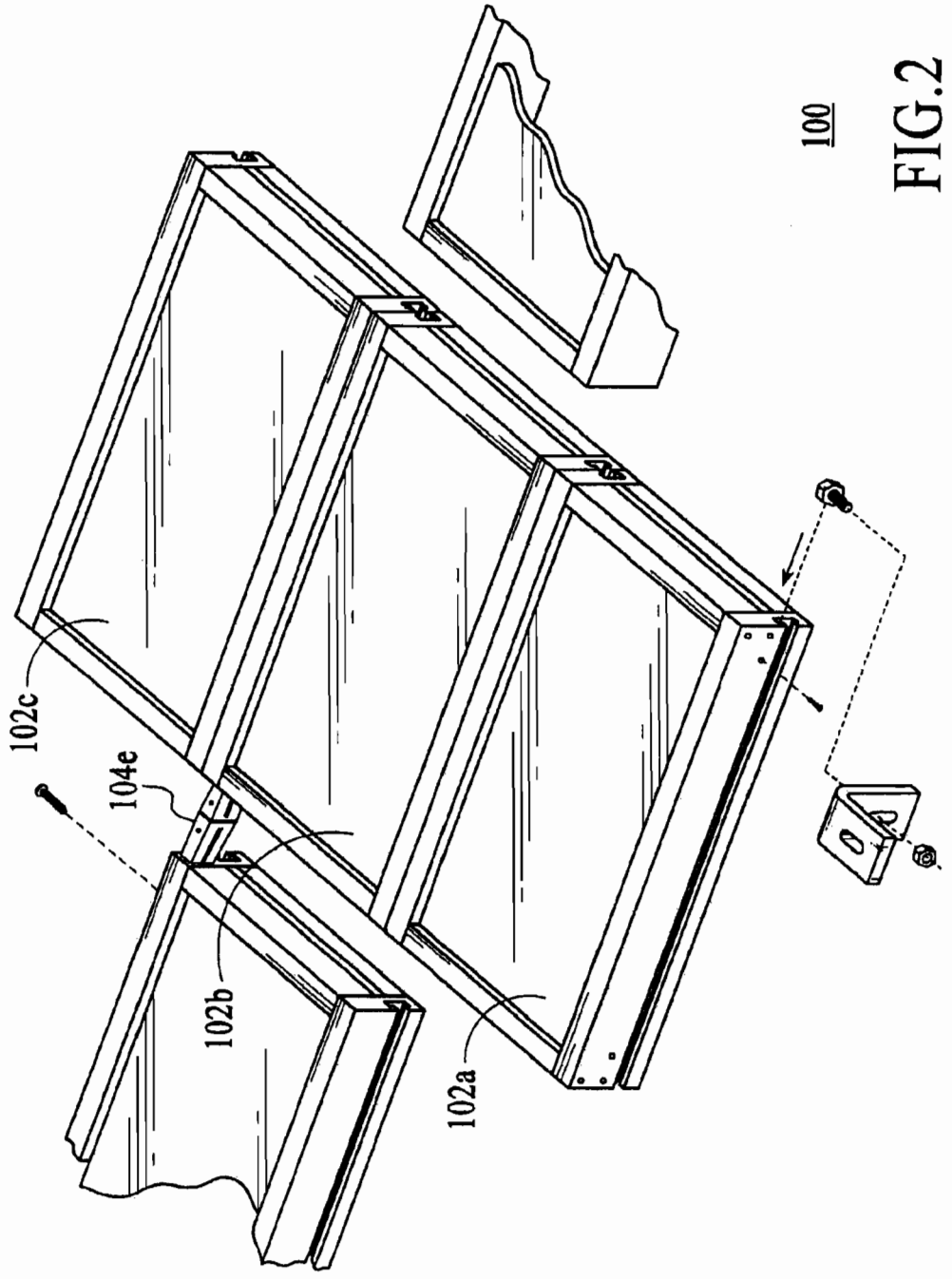


FIG.2

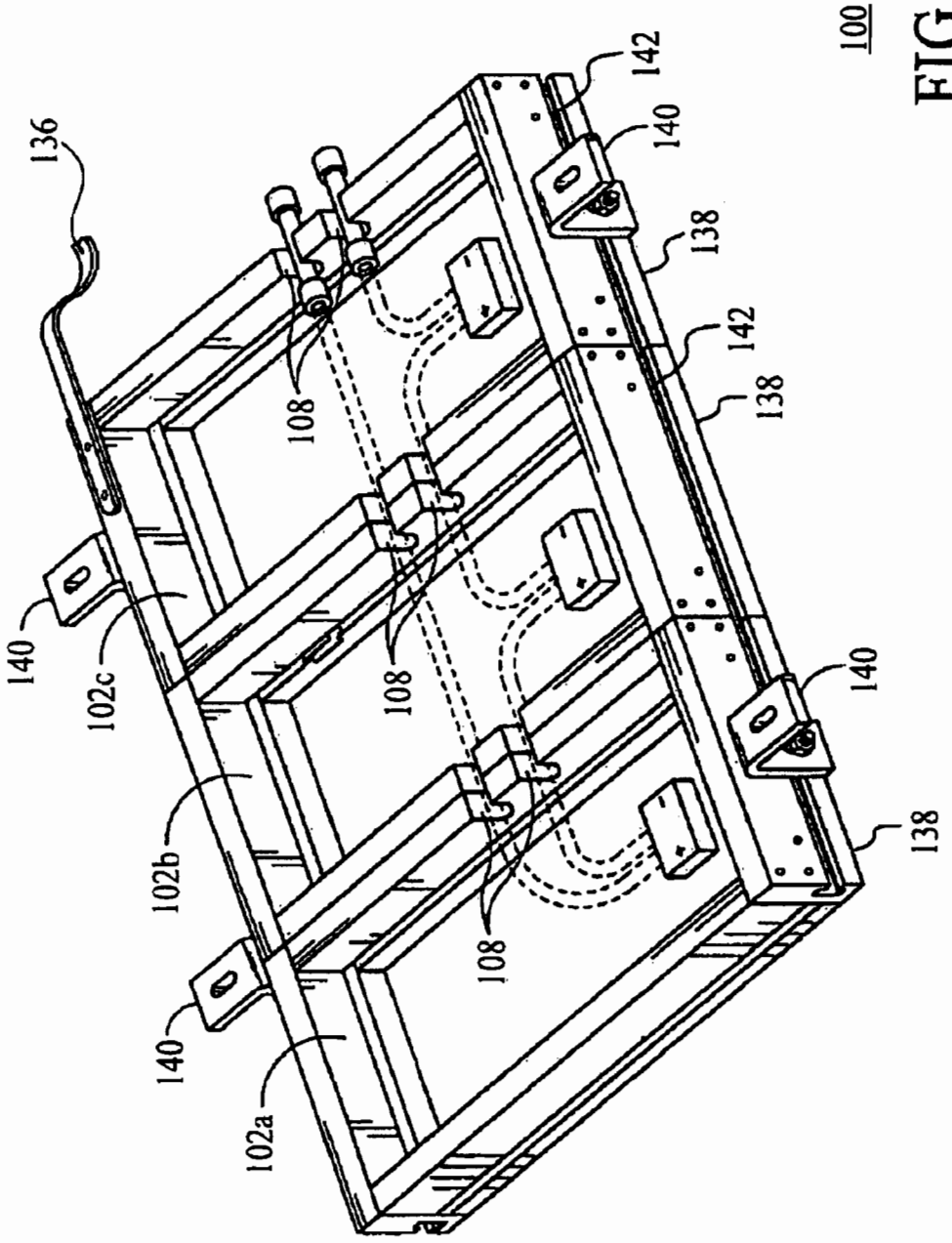

100
136
142
140
138
142
138
108
108
108
140
102c
140
102b
138
140
102a

FIG.2A

FIG.2B

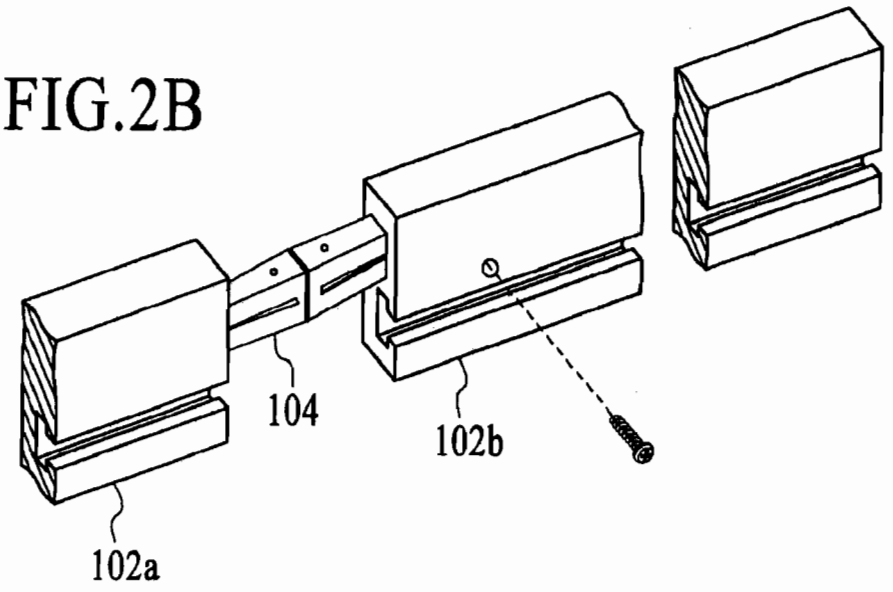
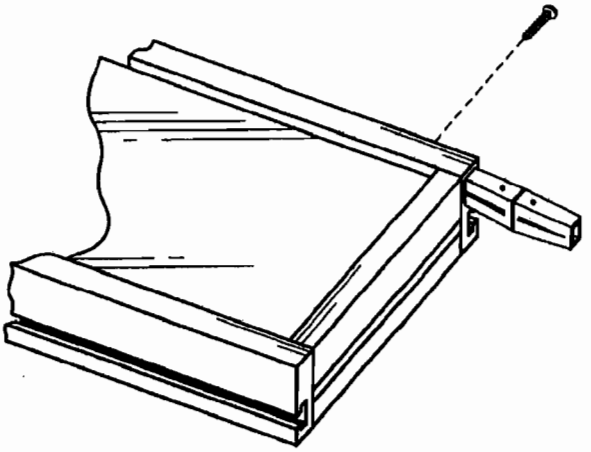


FIG.2C



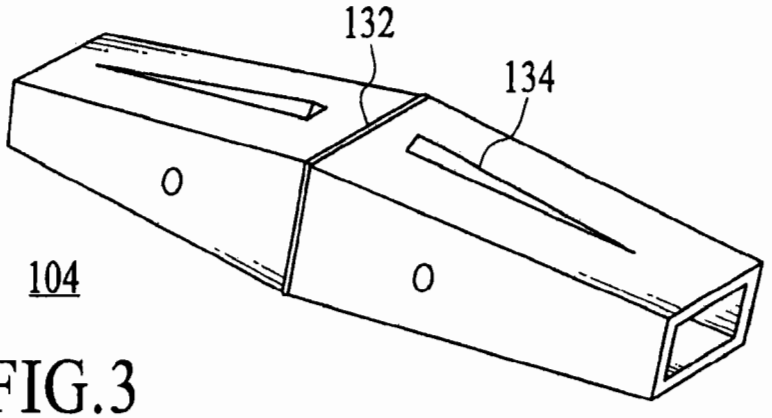


FIG.3

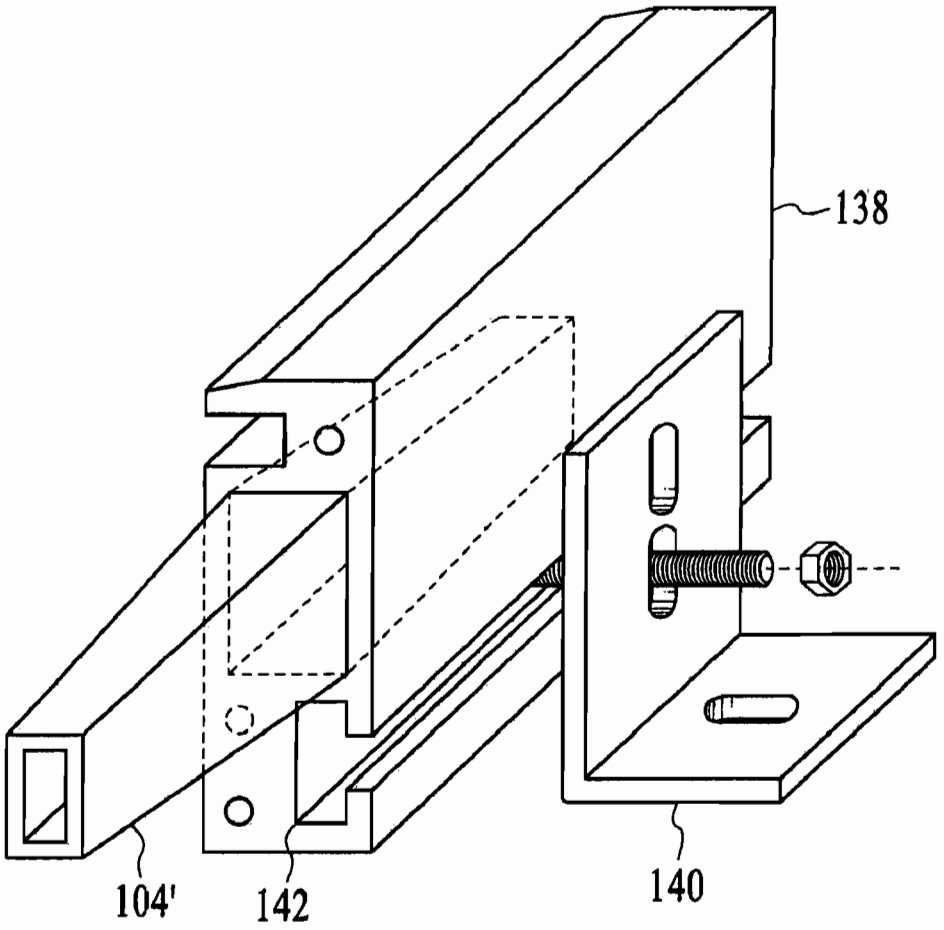


FIG.4

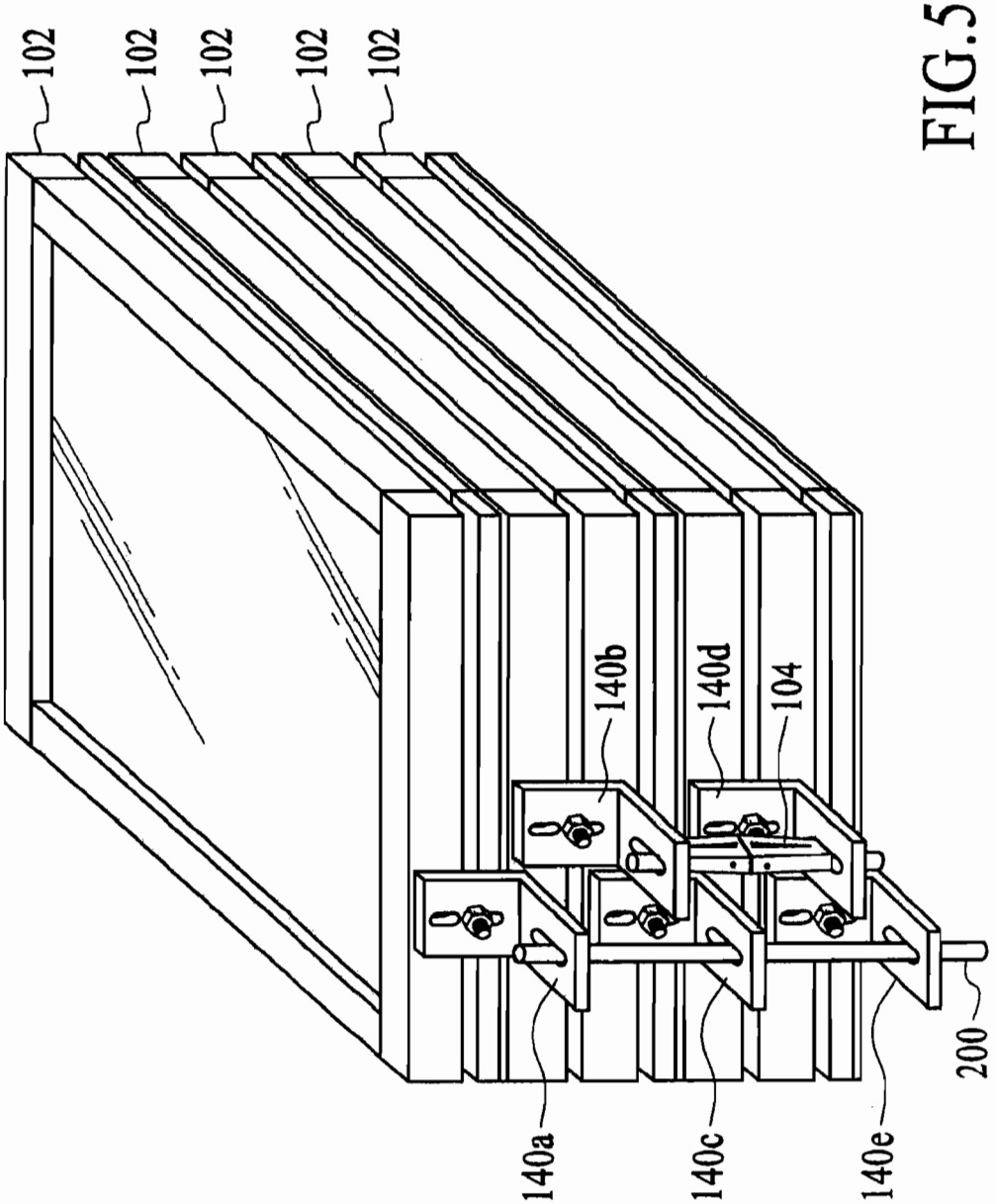


FIG.5

MOUNTING SYSTEM FOR A SOLAR PANEL

FIELD OF THE INVENTION

The present invention relates generally to solar panels and more particularly to an assembly and mounting system for a solar panel.

BACKGROUND OF THE INVENTION

Solar electric systems are the most environmentally friendly way of generating electricity. To provide such solar electric systems, typically there is a solar panel, which comprises a plurality of solar modules, which are coupled together. The solar panels are typically assembled directly on the roof of a building, assembled on the ground and then mounted on a roof of a building, or installed on a dedicated ground or pole mounted frame. FIG. **1** illustrates a conventional solar panel assembly **10**. The solar panel in this embodiment comprises three solar modules, **12A-12C**. However, one of ordinary skill in the art recognizes there could be any number of modules and they could be in any configuration to form a solar panel.

Each of the solar panel modules **12A-12C** includes a junction box **14A-14C** which receives cables **16**, which are applied in serial fashion from one module to the next. Also included within each of these modules **12A-12C** is an electrical ground wire assembly **18**, which is used to ground the modules and the underlying frame at the appropriate points. In addition, each of the modules includes extra wiring from nearby modules that must be wrapped and tied down in between, as shown at **20A** and **20B** to ensure that the wires do not get damaged. FIG. **1A** is a view of the grounding screw for the solar panel. The screw or bolt assembly **22**, which must be provided in several places, attaches the ground wire assembly **18** to each piece of equipment in the assembly at least once, in this case five (5) places, on each of the solar modules **12A-12C** and underlying frame, thereby creating a grounded assembly.

Referring back in FIG. **1**, there are two metal rails **24** that extend in parallel with and along the length of the solar modules **12A-12C**. These rails form the underlying support structure for the solar modules. The rails are attached to the roof so that the entire solar panel can be mounted in a single rigid geometric plane on the roof, thereby improving the durability and aesthetics of the installation. In some cases the rails are mounted to the roof first (attached to the roof with L shaped brackets and lag bolts to the underlying rafters), and then the modules are attached to the rails with bolt-fastened clips. In other cases, as shown in FIG. **1B**, the rails are attached to the modules first (in this case with hex nuts and bolts or in other cases clips), and then the entire module-rail assembly (or panel) is attached to the roof with L shaped brackets **26** (FIG. **1**) and lag bolts to the underlying rafters. These rails **24** are also electrically grounded as indicated above.

For ventilation and drainage purposes it is beneficial to mount the panel above the roof with a small air gap between the roof surface and underside of the modules and rails. For wiring and grounding purposes for roof-assembled panels it is beneficial to have access below the modules so that wires can be connected and tied. For single geometric plan purposes it is beneficial to provide some vertical adjustability of the mounting point to account for variability (waviness) in roof surfaces. For these reasons the roof mounting bracket (whether it is an L shaped bracket or different design) generally provides some vertical adjustability (typically 1-3 inches). Moreover, roof attachments must be made to a secure underlying surface, generally a rafter. These rafters may not be consistently spaced. Therefore, the mounting rails typically include some kind of adjustable groove so that the mounting point from the rail to the roof attachment (L bracket) can be directly over a secure mounting point—wherever this point may be.

The conventional solar panel **10** requires many individual operations to construct and mount in order to provide a reliable and high performance solar electric system. Mounting on uneven roof surfaces requires many small parts and adjustments. Making sure there is airflow and drainage requires the panel to be raised off the roof slightly, but aesthetic considerations require the panel to be close to the roof. Each module in the panel must be wired together, extra wiring must be tucked away securely, and every conductive component must be electrically grounded. All the required parts and steps increase the cost of the system, which ultimately negatively affects the payback of the system. In addition, conventional solar modules are shipped in cardboard boxes on palettes, requiring additional shipping costs and substantial unpacking and cardboard disposal costs.

Accordingly, what is desired is a solar module which is more self contained, including all the mounting and wiring hardware, without requiring all of the individual operations, minimizing the number of electrical grounding steps required, and minimizing the amount of wiring and cables that need to be managed. Finally, the system should be one that minimizes the number of parts and tools that an installer would need to assemble and install the panel. This system should be easily implemented, adaptable to various environments and cost-effective. The present invention addresses such a need.

SUMMARY OF THE INVENTION

An integrated module frame and racking system for a solar panel is disclosed. The solar panel comprises a plurality of solar modules and a plurality of splices for coupling the plurality of solar modules together. The plurality of splices provide a way to make the connected modules mechanically rigid both during transport to the roof and after mounting for the lifetime of the system, provide wiring connections between modules, provide an electrical grounding path for the modules, provide a way to add modules to the panel, and provide a way to remove or change a defective module. Connector sockets are provided on the sides of the modules to simplify the electrical assembly of modules when the modules are connected together with splices.

A solar panel in accordance with the present invention is optimized for fast and reliable installation. In addition, the fewer parts and simpler assembly technique reduces the potential for installation error. In addition, multiple modules for the panel can be supported during transport. In addition, modules and panels can be assembled closer together, improving space usage and improving aesthetics. Furthermore, individual modules can be added to and connected with existing solar panels. In addition, the use of an integrated mounting rail allows the panel to be mounted closer to the roof, improving aesthetics. Further, a minimal number of parts are utilized for the entire assembly. Finally, solar modules can be securely stacked and shipped with pre-installed mounting brackets, reducing shipping, packing and unpacking costs.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a conventional solar panel assembly.

FIG. **1**A is a view of a grounding screw for the solar panel.

FIG. **1**B is a view of a module attached to a rail.

FIG. **2** illustrates a perspective view of a mounting system for a solar panel in accordance with the present invention.

FIG. **2**A is a diagram of a back view of the solar panel in accordance with the present invention.

FIG. **2**B shows an east-west splice that allows connection of a module or panel to the side (typically east or west) of an existing module.

FIG. **2**C shows a north-south splice that allows connection of a module or panel above or below (typically north or south) of an existing module.

FIG. **3** illustrates a splice in accordance with the present invention.

FIG. **4** illustrates a groove on the module panel and a surface mounting bracket for securing the module panel to the roof.

FIG. **5** illustrates a shipping stack of solar modules with pre-installed mounting brackets, through attachment rod and splice storage.

DETAILED DESCRIPTION

The present invention relates generally to solar panels and more particularly to a mounting system for solar panels. The following description is presented to enable one of ordinary skill in the art to make and use the invention and is provided in the context of a patent application and its requirements. Various modifications to the preferred embodiment and the generic principles and features described herein will be readily apparent to those skilled in the art. Thus, the present invention is not intended to be limited to the embodiment shown but is to be accorded the widest scope consistent with the principles and features described herein.

A system and method in accordance with the present invention provides for an integrated module frame and racking system for a solar panel. The solar panel in accordance with the present invention is optimized for fast installation on a structure with a particular emphasis on completing all installation activities from the top of the module (without wiring, grounding and attachments from below). This optimization includes all steps in assembling and installing the solar panel. Furthermore utilizing the integrated frame and racking system multiple modules for the panel can be supported during transport. In addition by utilizing the integrated system in accordance with the present invention individual modules can be added to and connected with existing solar panels and can be mounted in a more aesthetically pleasing way. Finally, a minimal number of parts are utilized for the entire assembly.

To describe the features of the present invention in more detail, refer now to the following description in conjunction with the accompanying drawings.

FIG. **2** illustrates a perspective view of a mounting system for a solar panel **100** in accordance with the present invention. As is seen, there are three modules **102**A-**102**C shown that are coupled together that include several features that allow for a modularized and integrated system for the solar panel **100**. Firstly, there is a splice that mechanically connects one module to another and provides the electrical grounding connection between the solar modules. The mechanical strength of the splice and attachment technique to the module frame allows each module frame to function in the same rigid way as the underlying frame rail in a conventional solar panel assembly. In addition, there are cable connector grooves between modules that minimize the amount of wiring activities that are required for connecting the modules together. Finally, the system includes only requiring one electrical grounding connection to the entire panel; module to module and module to rail grounding connections are not needed. To describe the feature of the invention in more detail refer now to the following description in conjunction with the accompanying figures.

FIG. **2**A is a diagram of a back view of the solar panel **100** in accordance with the present invention. As has been abovementioned the solar panel **100** includes a plurality of modules **102**A-**102**C. However, one of ordinary skill in the art readily recognizes that the panel **100** could include any number of modules in both the X and Y directions and could be in any configuration and its use would be within the spirit and scope of the present invention. The solar panel **100** requires significantly fewer parts to assemble and is more easily constructed than the conventional solar panel **10** of FIG. **1**. Referring now to FIG. **2**B, as is seen there is an east-west (e-w) splice **104** shown internal to two modules **102**A and **102**B that connect the modules **102**A and **102**B. The splice **104** provides several useful features for the panel **100**, including mechanical rigidity between modules, a grounding path between modules, an alignment method between modules, a securing method between modules and a compression method between modules.

Also north-south splices between rows can be effectively utilized. FIG. **2**C shows a north-south splice **104**E that allows connection of a module or panel above (typically north) or below an existing module. This splice **104**E provides alignment between rows, rigidity between rows and provides a grounding connection. Use of this north-south splice **104**E reduces mounting points on the mounting surface.

In a preferred embodiment, the splice is a rigid removable connecting piece that protrudes from the side or top of the module when inserted in one module. Additionally, the splice is generally hidden when installed, by virtue of mounting inside the module frame hollow section or side groove. The splice allows for a very close fit between modules, thereby improving space utilization. Also, the splice has conductive capability (including the non-conductive main part with conductive wires or surface). The splice has a slightly arched profile to counteract module sag after installation (similar to the arch on a bridge). It should also be understood, that although the splice in this embodiment is internal to the solar modules, one of ordinary skill in the art readily recognizes that the splice could be external and its use could be within the spirit and scope of the present invention.

FIG. **3** illustrates a splice **104** in accordance with the present invention. The splice **104** is tapered to allow for easy initial assembly line up and a final tight fit between the modules **102**A and **102**B. In a preferred embodiment it is precisely located in the panel **100** in a centerline fashion. In a preferred embodiment the splice **104** is a tapered conductive metal to provide a grounding path between modules, and includes a sharp edge to improve grounding to each module. The splice **104** is also grooved for easy screw insertion from the top or the side of the module **102**. The splice **104** precisely aligns the modules **102** and allows the assembler to compress the connector sockets **108**, thereby completing an electrical connection between the two adjacent modules. The electrical connection between the two adjacent modules by the splice **104** eliminates the need to run a grounding wire between each module. As is seen only one other grounding wire is required for an entire panel assembly as long as all solar modules are connected with a splice. The splice provides sufficient rigidity between modules so that the entire panel can be transported

and lifted to a roof, or installed directly on a roof or other surface in a secure and long lasting fashion.

In a preferred embodiment, each splice would utilize a screw for attachment to secure the two modules together. Other mechanisms for securing the two modules together include but are not limited to a cam type compression device, a press fit or toothed barb device, a spring clip attachment, a through pin and an expandable section at each end. For a three module solar panel, as illustrated in exploded view, a total of four splices and eight self-threading screws are utilized to provide the solar panel. Accordingly, a minimal number of parts are required for the assembly of the panel. The splice also includes a plurality of raised features, which couple the modules together. The first raised feature **132** acts as a stop for the splice. The second raised feature **104** acts as a grounding path for the splice.

Referring back to FIG. **2**, a plurality of connector sockets **108** are provided in each of the modules **102**. These connector sockets **108** provide the following advantages:

The connector sockets **108** can be labeled (+/−) and then sized to only accept the proper cable connection, thereby minimizing wiring problems. The connector sockets **108** are located on the modules (on the left/right or E-W sides, and/or on the top/bottom or N/S sides) to prevent improper wiring based on cable lengths and connector socket size/configuration. The connector sockets **108** are on frame sides to allow for easy and reliable module interconnection. The connector sockets **108** on frame sides allow for pre-installed home run return wire paths. The connector sockets **108** on frame sides allow for interconnection of strings. The connector sockets **108** on frame sides allow for concealed wire connections after modules are mounted. Finally, the overall design improves wire management and grounding.

Optimally a cable holder **136** can be used in this solar panel. Referring back to FIG. **2**A, a cable holder **136** is coupled to a side portion of a module to hold cables that may be stored in the panel. Typically the cable holder **136** is a cable clip that holds the stored cable in place.

FIG. **4** illustrates a groove **142** on the metal plate **138** of the module. The groove allows for securing the panel (composed of one or more modules) to a structure, such as a roof, with the mounting bracket. The grooves **142** on the sides of each of the metal plate are aligned when the modules are connected with splices, thereby creating a continuous groove along the entire panel to allow for the connection of the solar panel to a roof or the like. In so doing the solar panel can be rigidly mounted on a structure in a single plane. The continuous groove allows attachment to an available secure point (typically a rafter) at any horizontal location. Typically the grooved portion will comprise an extrusion on a metal plate **138** shown in FIG. **4** that is part of the module thereby creating a full and roughly continuous extension in the panel. This groove **142** can be installed on both the sides (east-west) and top/bottom (north-south) of the modules, allowing the module to be installed in a variety of different orientations.

The mounting bracket **140** attaches securely to the roof and then attaches to the grooved metal plate **138** with a bolt. This bracket **140** may include provisions to mount the panel at a variable height to account for variations in surfaces. Alternatively, this bracket **140** may be mounted to the roof with a threaded bolt or other variable height mounting point. The solar panels can be mounted on a horizontal, vertical or sloped structure or surface utilizing the mounting bracket.

Finally, solar modules can be securely stacked and shipped with pre-installed mounting brackets, reducing shipping, packing and unpacking costs. FIG. **5** illustrates a shipping stack of solar modules with pre-installed mounting brackets, through attachment road and splice storage.

FIG. **5** illustrates how multiple modules are securely stacked for shipment on a single palette. Mounting brackets **140**A-**140**E are pre-installed on sides of modules **104**, thereby reducing field-installation labor. Note that, depending on rafter location, these brackets **140**A-**140**B are easily loosened and moved during installation. A metal rod **200** is installed in holes in the mounting brackets **140**A-**140**B, thereby preventing module shifting during shipment.

In this illustration, mounting brackets are offset so that every-other bracket is aligned, although using a different bracket configuration all the brackets can be in one vertical plane or installed at different locations on the module frame. Splices are slid over the metal rod for storage during shipping. In this embodiment, a stack of 16 modules would have 32 mounting brackets pre-installed on module frames, and 32 splices stored on four metal securing rods.

SUMMARY

An integrated module frame and racking system for a solar panel is disclosed. The solar panel comprises a plurality of solar modules and a plurality of internal splices for coupling the plurality of solar modules together. The plurality of internal splices provide a way to make the connected modules mechanically rigid both during transport to the roof and after mounting for the lifetime of the system, provide wiring connections between modules, provide an electrical grounding path for the modules, provide a way to add modules to the panel, and provide a way to remove or change a defective module. Connector sockets are provided on the sides of the modules to simplify the electrical assembly of modules when the modules are connected together with splices.

A solar panel in accordance with the present invention is optimized for fast and reliable installation. In addition, the fewer parts and simpler assembly technique reduces the potential for installation error. In addition, multiple modules for the panel can be supported during transport. In addition, modules and panels can be assembled closer together, improving space usage and improving aesthetics. Furthermore, individual modules can be added to and connected with existing solar panels. In addition, the use of an integrated mounting rail allows the panel to be mounted closer to the roof, improving aesthetics. Finally, a minimal number of parts are utilized for the entire assembly.

Although the present invention has been described in accordance with the embodiments shown, one of ordinary skill in the art will readily recognize that there could be variations to the embodiments and those variations would be within the spirit and scope of the present invention. For example, although the splice is preferably made of a conductive material such as aluminum, it could be made utilizing a non-conductive material which has a conductive capability added to its surface and its use would be within the spirit and scope of the present invention. Accordingly, many modifications may be made by one of ordinary skill in the art without departing from the spirit and scope of the appended claims.

What is claimed is:

1. A solar panel comprising: a plurality of solar modules wherein each solar module has a frame; and a plurality of splices for coupling the frames of the plurality of solar modules together by inserting each end of each splice into two adjacent solar module frames; wherein the plurality of splices provides rigidity to the frames of the plurality of solar modules coupled together, wherein each of the splices comprises: a body for coupling two solar modules together; a coupling

mechanism on the body for causing a press-fit coupling of two solar modules; and a secure mechanism for securing the body to at least one of the two solar modules.

2. The solar panel of claim **1** wherein the plurality of splices provides a grounding path for the modules.

3. The solar panel of claim **1** wherein the coupling mechanism comprise one or more raised features on the body.

4. The solar panel of claim **1** wherein the secure mechanism comprises one or more screws.

5. The solar panel of claim **1** wherein each of the solar modules include a plurality of connector sockets placed such that improper wiring based on cable length is prevented and placed such that at least one connector socket of one solar module is aligned with the connector socket of another solar module when coupled together.

6. The solar panel of claim **1** wherein each of the solar modules include a plurality of connector sockets designed so that improper wiring is prevented by the shape of the connector socket.

7. The solar panel of claim **1** wherein each of the modules include a groove extending along the solar module; the groove for receiving a bracket, the bracket for securing the solar panel to a structure.

8. The solar panel of claim **1** wherein each of the solar modules is a solar thermal module.

9. The solar panel of claim **1** wherein the splice is internal to the solar modules.

10. The solar panel of claim **1** wherein a first raised feature provides a stop for the splice and a second raised feature providing a grounding path for one or more of the splices.

11. The solar panel of claim **1**, wherein each splice has a tapered body.

12. The solar panel of claim **1** wherein mounting brackets are pre-installed on each of the modules and used to securely stack modules and other installation components for shipment.

* * * * *

Exhibit 2

US007592537B1

(12) **United States Patent**
West

(10) **Patent No.: US 7,592,537 B1**
(45) **Date of Patent: Sep. 22, 2009**

(54) **METHOD AND APPARATUS FOR MOUNTING PHOTOVOLTAIC MODULES**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 603 days.

(21) Appl. No.: **11/053,524**

(22) Filed: **Feb. 7, 2005**

Related U.S. Application Data

(60) Provisional application No. 60/542,463, filed on Feb. 5, 2004, provisional application No. 60/568,513, filed on May 5, 2004.

(51) **Int. Cl.**
H02N 6/00 (2006.01)

(52) **U.S. Cl.** **136/251**

(58) **Field of Classification Search** 136/243–265
See application file for complete search history.

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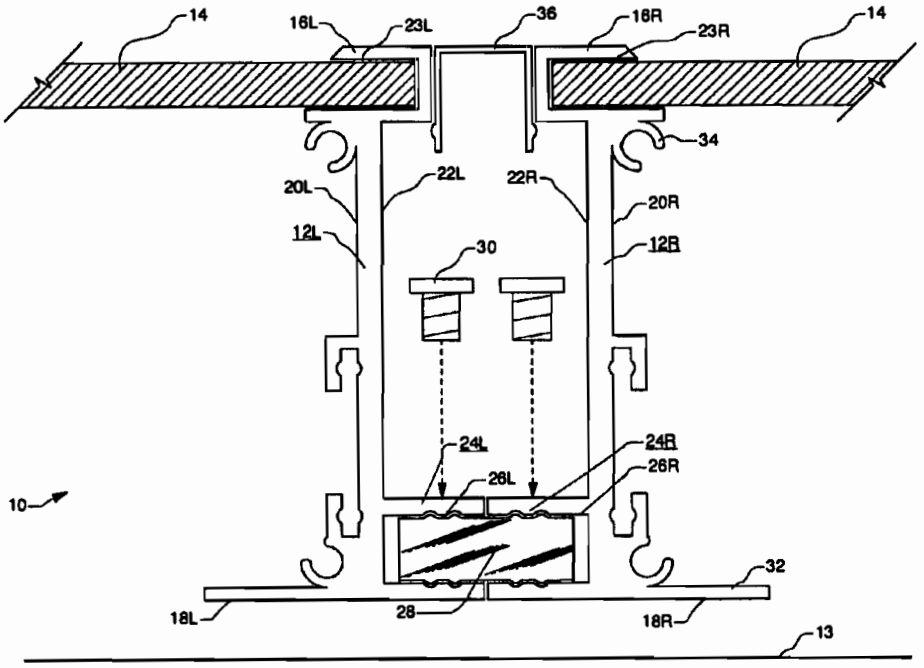
Primary Examiner—Alexa D. Neckel
Assistant Examiner—Miriam Berdichevsky
(74) *Attorney, Agent, or Firm*—Larry D. Johnson

(57) **ABSTRACT**

An interlocking photovoltaic module mounting system that provides a one piece, integrated photovoltaic module frame portion that is directly mountable to a support structure and interlocks with separate adjoining photovoltaic module frame portions. The apparatus includes a frame member for enclosing the perimeter of a photovoltaic module, having an inside surface and outside surface, with the inside surface including a recess for capture of the panel. The frame member outside surface includes at least one interlocking means for affixation to the complementary outside surface of an adjacent frame-member. The frame member includes a height-adjustable foot portion for supporting the frame member on a roof, so that adjacent frame members may be interlocked to form an array, and the foot portion may be adjusted to level the formed array on the roof.

23 Claims, 7 Drawing Sheets



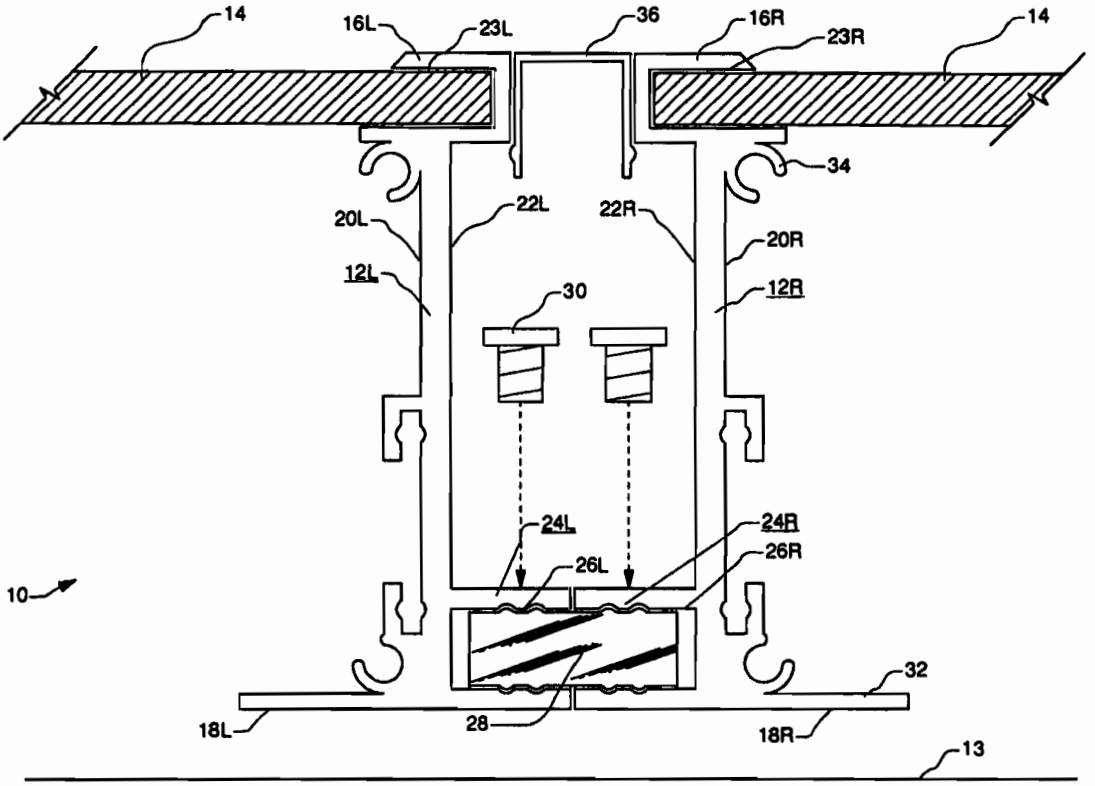

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FIG. 1

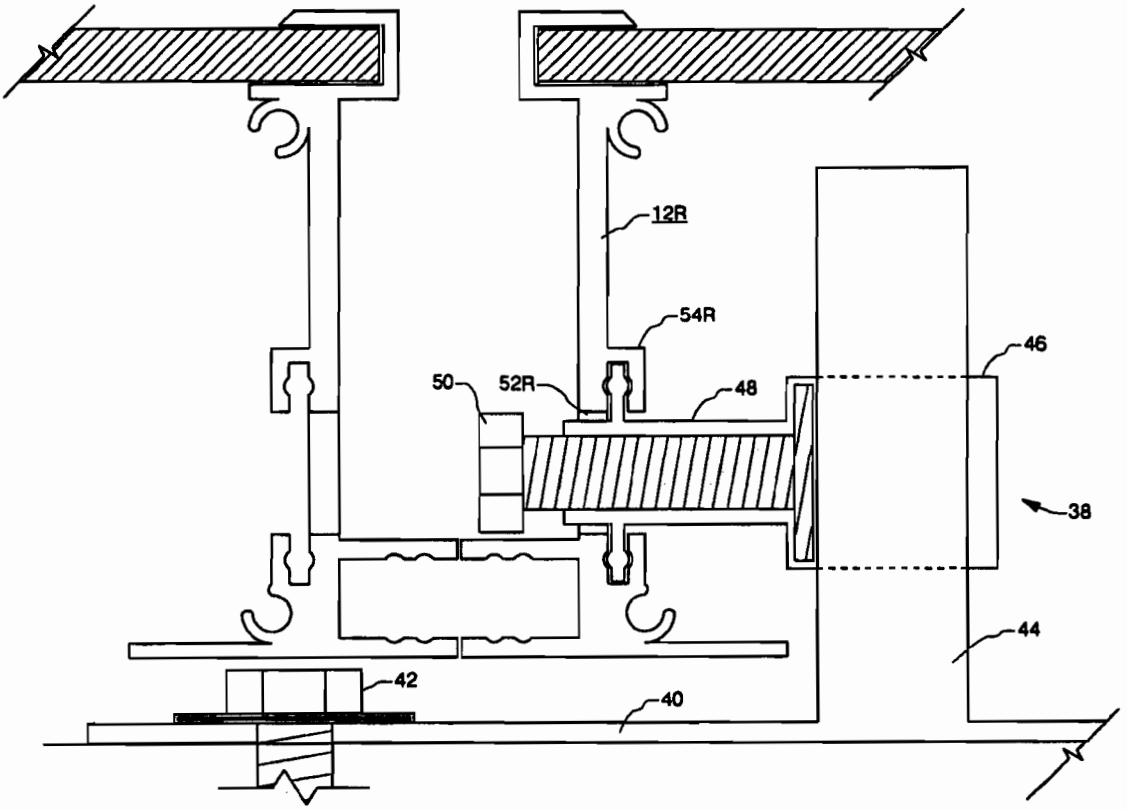

FIG. 2

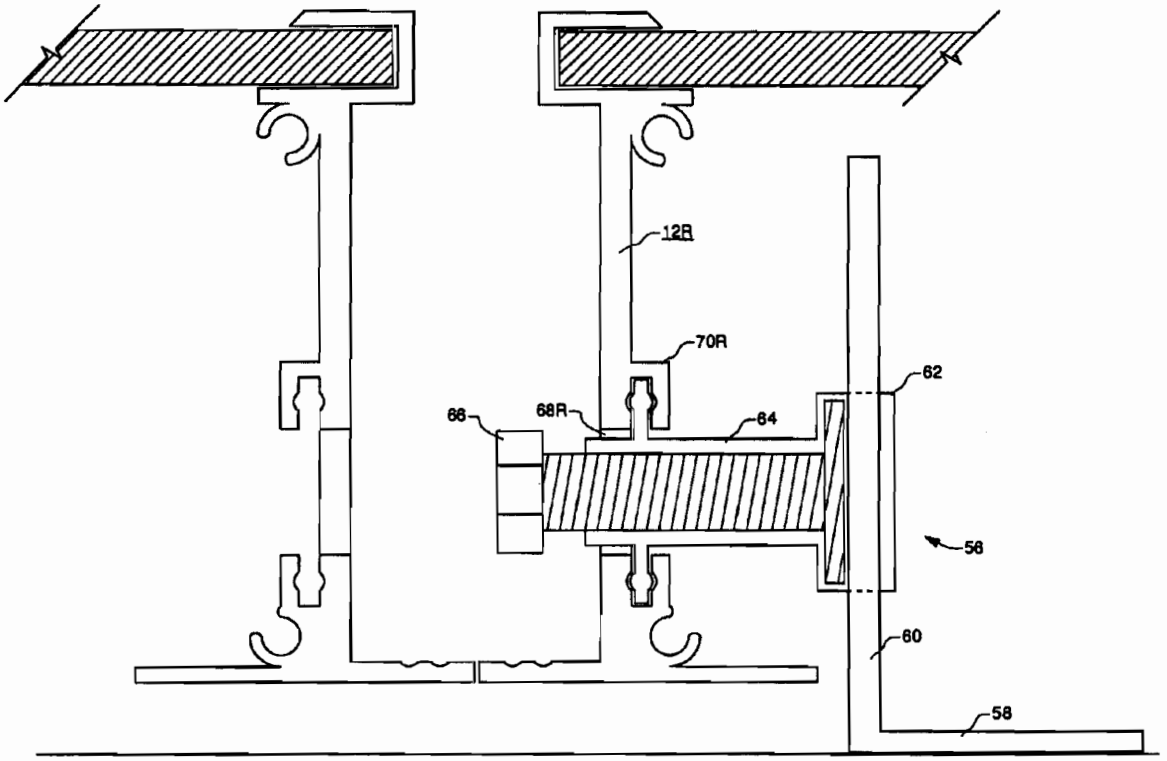

FIG. 3

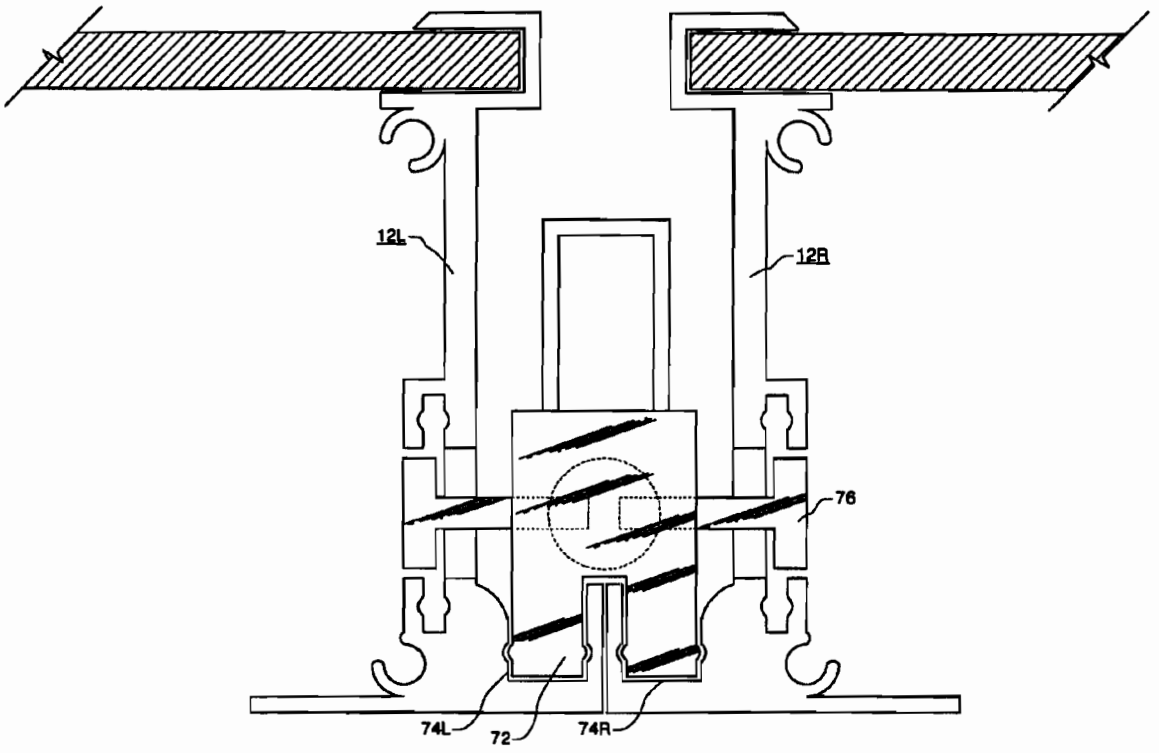

FIG. 4

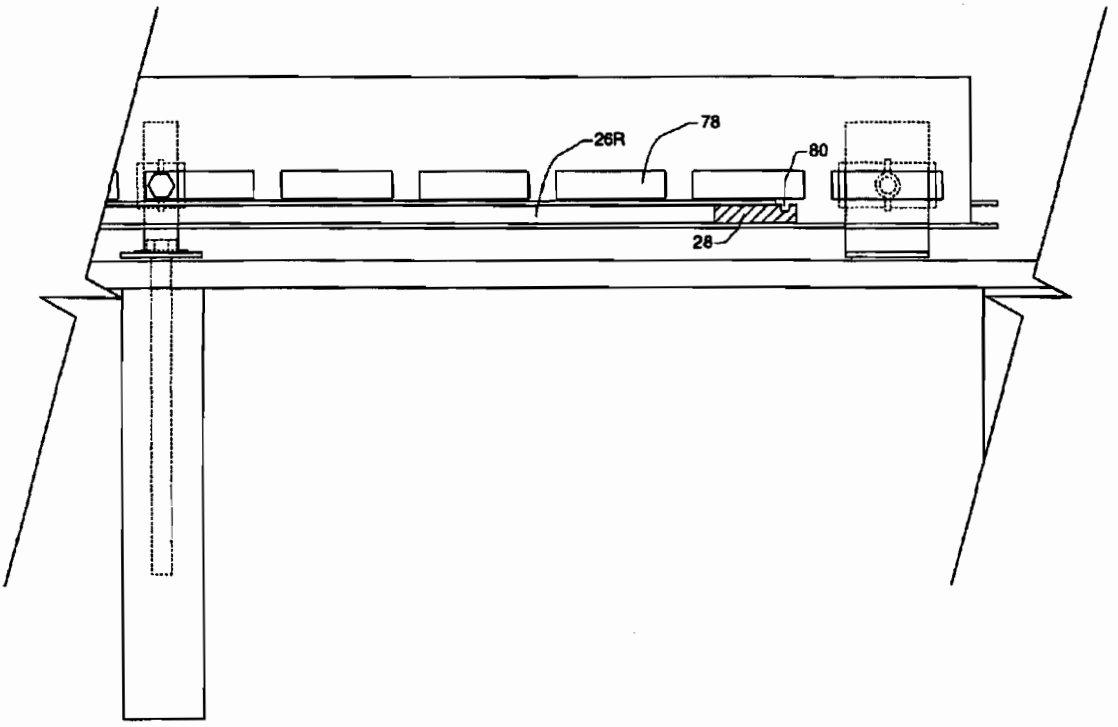

FIG. 5

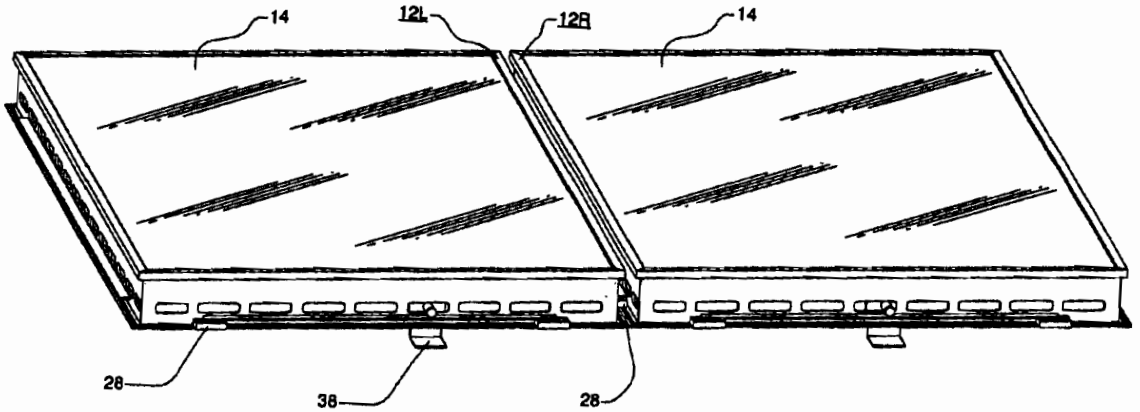

FIG. 6

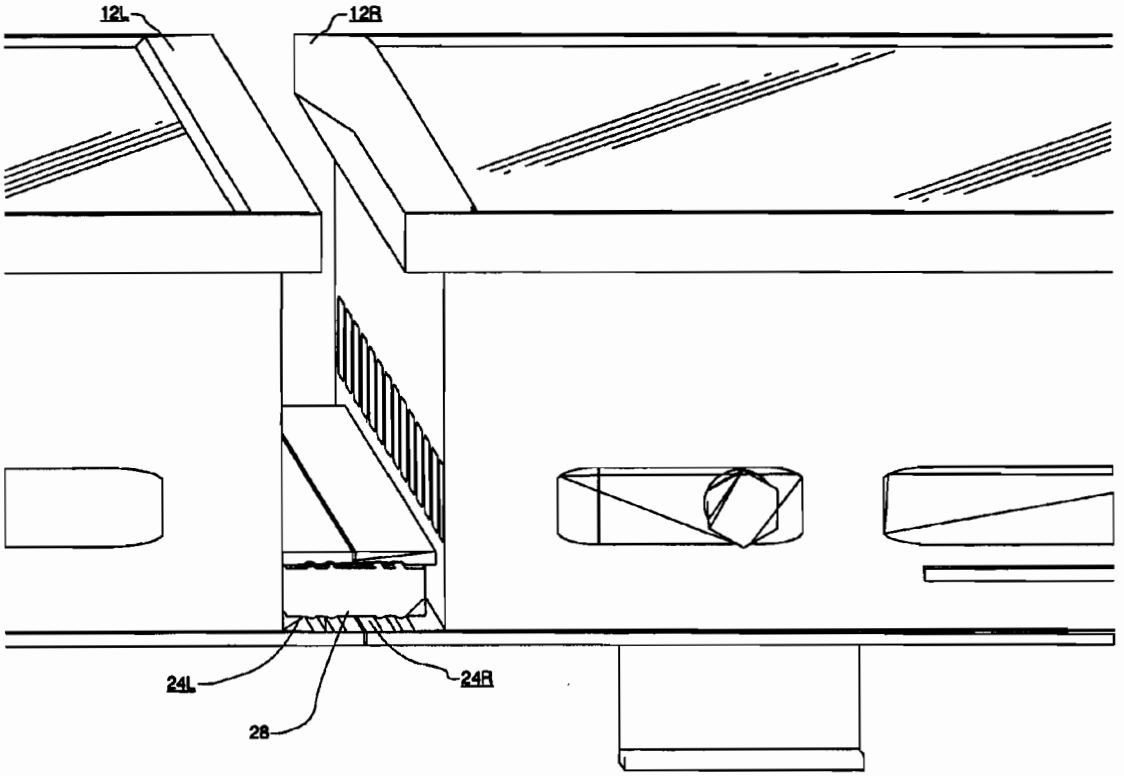

FIG. 7

METHOD AND APPARATUS FOR MOUNTING PHOTOVOLTAIC MODULES

CROSS REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of the filing date of U.S. Provisional Patent Application Ser. No. 60/542,463, filed 5 Feb. 2004, and U.S. Provisional Patent Application Ser. No. 60/568,513, filed May 5, 2004.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

REFERENCE TO A MICROFICHE APPENDIX

Not applicable.

TECHNICAL FIELD

The present invention relates generally to photovoltaic modules and associated frames and mounting hardware, and more particularly to an interlocking photovoltaic module mounting system that provides a one piece, integrated photovoltaic module frame that is directly mountable to a support structure and interlocks with separate adjoining photovoltaic module frames.

BACKGROUND INFORMATION AND DISCUSSION OF RELATED ART

Photovoltaic (PV) modules and related mounting hardware are well known and in widespread use. The most common mass-produced PV modules in use today include a laminated portion, or PV laminate, and a frame portion, and are designed specifically to convert light into electricity. The PV laminate portion is for encapsulating solar cells in a substantially flat, weather-tight envelope comprising a laminated construction of various layers including but not limited to glass, clear plastic, encapsulant material (like EVA), active photovoltaic material, interconnecting conductors between solar cells, and a protective backsheet (like PVF film). Photovoltaic laminates are commonly manufactured today in rectilinear shapes like squares, rectangles, triangles, and trapezoids and, due to their fragile nature, are usually completely enclosed by a permanent, substantially rigid, glued-on frame portion which holds and protects the delicate edges of the PV laminate portion and provides a means of attaching the PV laminate to other objects without damaging the PV laminate. The combination of the PV laminate portion and the glued-on frame portion is referred to herein as a PV module or framed PV module. The present invention relates to integral glued-on frames for standard PV laminates as are currently being produced, and to the associated mounting hardware which attaches to the integral frames for the purpose of securing the PV module to a roof or support structure.

Since PV cells are typically optimized to produce electricity most efficiently from direct sunlight, most PV modules are mounted outdoors on roofs or support structures. There are two primary methods utilized to reliably mount PV cells in the sun: (a) attach a standard framed PV module to a building, vehicle, or structure, or (b) integrate an unframed, PV laminate into a standard type of building material like a roofing product (shingle, tile, etc.), curtain wall, or a skylight framing system such that the PV laminate forms a part of the weather-tight skin of the building.

The latter approach is commonly referred to as "Building Integrated PV" and is not the subject of this invention. While there have been a number of recent developments in the field of building integrated photovoltaics, there are still very few installations because of their complex building design issues, higher costs, difficult ventilation issues (PV cells operate more efficiently with adequate air flow for cooling), problematic servicing issues (when a cell, laminate, or wiring connection fails), and inability to work well in retrofit applications.

Physical mounting issues associated with the installation of standard, framed photovoltaic modules include the following:

Alignment: Most photovoltaic systems are mounted on roofs and or structures which are not truly flat or straight despite the original design on paper (due to inherent deflection and flaws in materials). PV module alignment (in all three dimensions) is the biggest issue that photovoltaic installers face. The glass on photovoltaic modules heavily amplifies the normal dips and peaks that exist on roofs and structures. If the PV array is not straight, it is very noticeable from the ground. Typical variance is 2" maximum in any one section of a roof, though over a large roof, it may sag by up to 4". Alignment issues have typically been dealt with during installation by attaching multiple framed PV modules to several struts or channels and then attaching the struts or channels to separate foot-type pieces which include adjustable height provisions like slots or holes at different heights. Since this technique results in significantly less adjustability points than if the alignment features were built into the PV module frame, the result is that PV installers frequently spend hours just working on the alignment and generally have to eventually settle for an array which is only partially aligned and in many cases substantially non-planar.

Grounding: The 2002 National Electric Code Article 690.43 allows grounding modules by either a grounding conductor (as is typically done) or by making electrical contact with a metal rack or support structure. Given the importance of grounding for lightning protection and personnel safety, most respectable installers run large #6 ground wires to every module—a very time consuming and tedious task which still doesn't properly ground the array unless ground wires are also run to all struts and metal supports (hardly ever done because it requires threading each strut). Using the mounting structure as the ground is generally not done, primarily because it is somewhat vague in the code and installers don't know how to make lasting "electrical contact" on a structure exposed to the weather (for example, standard, self-tapping screws are not allowed). This is a major problem area because most photovoltaic arrays are not properly grounded.

Wiring: The most common wiring mistake that happens is a missed or improperly connected electrical connector between two modules (almost all photovoltaic modules now come with quick-connect, plug-type connectors for simplified and fast wiring). Even though the development of plug-type connectors have improved intermodule wiring, getting back into the middle of an array to physically reach the wiring and fix a problem can be a time-consuming process, particularly with some mounting systems. In many cases the entire row of PV modules plus all of the large ground wires plus wire strapping must be removed just to locate the problem area. Most roof mounted PV modules are mounted within 6" of a roof surface and in the same plane, so if wiring is beneath the modules or inside the module frames, it is not easily accessible once installed.

Connecting to rafters: It is generally accepted that photovoltaic modules should be secured to the rafters, or other primary structural members (purlins, joists, etc.) for struc-

tural integrity and prevention of leaks, as opposed to screwing modules down to the sheathing. A single, typical aluminum framed PV module can expand and contract under normal temperature fluctuations by as much as 1/16" and a whole 60' long array by as much as 1". If the array is only secured into the roof sheathing, then expansion and contraction over time will break the seal and create roof leaks. This issue is typically handled by use of additional struts or channels (since module edges or mounting holes rarely line up with rafters).

Collection of debris: If there are trees around, then debris (and sometimes small animals) will collect beneath modules. Some contractors prefer mounting modules higher to allow easy access for cleaning.

Water damming: Anything long and horizontal directly mounted right down on a roof is a potential leak site because water will dam up there. Roof mounted PV modules must be off of the roof, or building integrated PV s must be utilized.

Module temperature: Photovoltaic modules become less efficient the hotter they get. It is therefore required to provide some airflow beneath the modules if more efficient operation is desired. While airflow is not generally a problem on ground mounted structures and racks, roof mounted PV arrays generally perform much better when elevated off of the roof surface (as opposed to being mounted directly down on the roof surface).

Penetrations: Despite the incredible reliability of advanced roof sealants, PV contractors always want to minimize the number of penetrations that have to be drilled through the roofing surface since they are the ones who are liable for roof leaks. This is typically addressed by the use of additional struts or channels which serve to span multiple PV modules thereby minimizing the number of penetrations required.

Ease of installation: Though most people agree that PV systems provide the most environmentally sound method of producing electricity, the high capital cost of PV systems still prevents most people from being able to afford them.

Aesthetic mounting issues associated with the installation of photovoltaic modules include the following:

Module height: The generally agreed upon aesthetic that most homeowners and architects subscribe to assumes that photovoltaic modules should be either not viewable from the street, or if they are, they should be close to the roof and stand out as little as possible. Given this scenario, any ability to see beneath modules is not good, and insistence on optimum orientation (for example turning and/or tilting modules toward south when in the northern hemisphere on a roof or structure which does not face south) should be avoided. Generally speaking, the PV array should be as close to the same plane as the surface to which it is being mounted. Stated differently: the photovoltaic array should look like one large skylight. While some systems are capable of locating PV modules close to the roof, they generally require some offset from the roof and thus do not look like a skylight. This issue is slightly complicated because heating, debris, and water damming concerns all require an offset, while aesthetic concerns dictate a minimization of height.

Gaps between modules: The tighter the spacing, the better in order to minimize the view of the roof between PV modules and attain a skylight-like appearance.

Hiding other gear: Mounting hardware (like rails, hold-downs, or feet), junction boxes, conduit, wiring, and balance-of-system gear is unsightly, and should be neatly tucked away somewhere out of sight, especially from the street.

Module and frame color: Most homeowners and architects prefer black or dark bronze since these colors tend to draw the least amount of attention to themselves.

Numerous attempts have been made to address these problems, but most have been in the context of costly and cumbersome non-integral mounting hardware, such as improved PV strut systems with specialized "hold-down" pieces that connect the frame portions of PV modules to the strut or by utilizing building integrated techniques. Though the additional hardware developments have provided solutions to enough of the problems to become the dominant technique, many of the issues discussed remain unaddressed. Building integrated solutions also solve some of the problems but come with a host of new problems as discussed above.

Prior art examples include U.S. Pat. No. 6,672,018 to Shingleton which discloses a PV laminate mounting method and clip wherein a solar collector array is formed of a plurality of PV laminates mounted on a frame made of support beams which may be sheet metal channel members. A butyl tape or other glazing material is applied between the back laminate of the solar panel and the beam. Clips are used to clamp the panels to the support beams. The clips have an upper portion that is generally T-shaped in profile, and a retainer in the form of a channel nut or bar, with a threaded hole that receives a bolt or similar threaded fastener. The retainer biases against the inwardly directed flanges of the channel support beam. Electrical wires and mechanical fasteners are concealed within the support beams.

While this design does eliminate costly and unnecessary materials, it creates a new series of problems: fragile edges of the laminate are exposed and likely to break during normal-installation and/or roof maintenance, the system does not provide any means for vertical adjustability and will therefore include rows of PV laminates at differing heights which will compromise the aesthetic appeal, use of adhesive directly on the laminate means that removal of a single or multiple laminates may be difficult or impossible in some cases, thereby greatly reducing the maintenance capabilities of the system, and since PV systems are typically designed to last at least 30 years, the use of an adhesive which is exposed to the weather and under extreme daily temperature fluctuations is of questionable long term reliability.

U.S. Pat. No. 6,606,830 to Nagao et al. describes a building integrated photovoltaic roof including a roof base member provided on a partition wall which partitions a building into an indoor portion and an outdoor portion, a solar cell module provided on the roof base member, and electric wiring with one end portion being electrically connected with the solar cell module. The end portion of the electric wiring is drawn to the outside from between the roof base member and the solar cell module and at an outdoor-sided position than an indoor side face of the partition wall.

U.S. Pat. No. 6,465,724 to Garvison et al. teaches a photovoltaic module framing system with integral electrical raceways wherein a multi-purpose photovoltaic module framing system is provided which combines and integrates the framing system with the photovoltaic electrical system. The frame includes at least one rail which receives fasteners to directly mount the module on or to a roof, wall, rack, beam, or other structure. The frame has portions to space the PV module above a roof, so as to form a gap between the module and the roof to channel water, as well as to provide an air passage to cool the module. The frame includes portions that hold the PV laminate and for mechanically mounting the frame to a support structure. The PV modules are also overlapping interleaving side rails between intermediate PV modules and outboard PV modules. The overlapping, interleaving side rails can have a regular or inverted C-shaped or bracket shaped cross section with: (a) overlapping upper side flanges, which extend laterally outwardly from upper portions of the mod-

ules, (b) overlapping lower side flanges, which provide feet that extend laterally outward from lower portions of the modules, and (c) an intermediate side bight which provides a side crossbar that extends between and integrally connects the overlapping upper and lower side flanges. The bottom exterior surfaces of the feet can abut against and engage the shingles of an asphalt shingle roof. The multi-purpose frames also have integral electrical raceways which conceal and protect most electrical components and wires. The reliable frames are specially constructed and arranged to permit easy access to output wires and do not require junction boxes. Ground clips can be directly connected to the convenient framing system.

While this attempt does solve a number of the problems outlined, it has the following major faults which have significantly impeded adoption: (a) the lag bolts go through predefined holes which means that the lag bolts in most cases will have to be screwed into the sheathing, missing rafters and therefore causing roof leaks; (b) there is no vertical adjustability so the sides which abut each other will be not be level with each other in most cases (since roofs are not flat) dramatically diminishing the aesthetic appeal of the PV array; (c) design is not backwardly compatible with the common inward facing flange integral frame and thus requires contractors to completely re-tool and learn a totally different product which impedes adoption of the invention; (d) can't remove a module from the middle if it breaks without painstakingly removing the whole row; (e) it requires three different types of extrusions per PV module which means triple the cost for tooling to manufacture the unit as compared to a design with only one type of extrusion; and (f) design only allows for PV modules mounted in portrait orientation (long dimension of the module running perpendicular to the roof ridge), yet most roofs can actually fit more PV modules in landscape orientation since the long dimension of the module is now parallel with the long dimension of the roof (most roofs are longer side to side than they are from ridge to gutter). Regarding the maintenance issues, if you do have to remove modules for service, you have to literally rip up all of the now dried roof sealant and pull lag bolts out of the sheathing—a very time consuming process. Or worse yet, if a module or wiring connection is suspected to be faulty right after initial installation (the most likely time to discover a problem), then modules will have to be removed exposing wet sealant and causing a mess. To avoid the sealant problems mentioned above, the only option would be to use an inferior type of sealant like butyl tape which no experienced PV contractor would want to do because of roof leak liability.

U.S. Pat. No. 6,414,237 to Boer discloses solar collectors, articles for mounting solar modules, and methods of mounting solar modules, including a solar collector comprising at least one solar module; at least one solar module frame which supports the solar module; and at least one solar module bracket comprising a profile channel engagement hook, the profile channel engagement hook comprising a neck portion and a foot portion, the foot portion having a foot portion cross-sectional area in a first plane which is larger than a cross-sectional area of the neck portion in a second plane parallel to the first plane. There is also provided a profile channel attached to or integral with a support structure, the profile channel having at least one opening, the profile channel engagement hook engaging the opening such that the neck portion extends through the opening. There are also provided methods of making such solar collectors and methods of mounting such solar collectors on support structures.

U.S. Pat. No. 6,336,304 to Mimura et al. describes a building integrated photovoltaic roof in which an upper-end engaging portion of a downstream roof panel is seam-jointed with a lower-end engaging portion of an upstream roof panel, wherein at least the lower-end engaging portion has flexural rigidity enough to disengage the seam joint.

U.S. Pat. No. 6,269,596 to Ohtsuka et al. teaches a building integrated photovoltaic roof member and mounting method thereof wherein roof members are those fixed to the roof, each roof member being a combination solar cell and roof member having a solar cell element and a metal reinforcing member, wherein a metal member is provided below the combination solar cell and roof member or a metal member is provided along an adjacent portion between adjacent combination solar cell and roof members, wherein the metal member is electrically conductive to metal reinforcing members of plural combination solar cell and roof members and wherein the metal member is electrically grounded. Provided based on this structure are the roof members easy to install and excellent in the external view and electric safety.

U.S. Pat. No. 6,242,685 to Mizukami et al. discloses a structure and method of installing photovoltaic modules wherein a photovoltaic module has a cathode and anode acting as electrodes for collecting an output power. When the photovoltaic module is installed on a roof of a building for example, the cathode is located at a position higher than the anode.

U.S. Pat. No. 4,636,577 to Peterpaul describes a building integrated photovoltaic module for directly mounting to a roof surface comprising a plurality of solar panels and a low profile, elongated frame including a generally flat, rectangular base having a plurality of substantially planar surfaces for supporting the under surfaces of the solar panels. The panels are removably sealed to the frames at the under surfaces thereof, rendering the upper surfaces fully free and unencumbered for receipt of incident solar radiation. The frame includes, integrally therewith, upstanding walls adjacent opposite edges of the panel supporting surfaces, defining raceway channels for concealed passage of electrical wires connected to the solar panels. The channels and walls have provision for overlapping interlocking with similarly fabricated frames for ease of installation, weather-proofing and high-density panel mounting.

U.S. Pat. No. 4,392,009 to Napoli teaches a solar power module comprising an array of solar cells arranged on a flat panel, the panel being supported by a substantially rigid, easily assembled frame comprising spaced apart side channels that each interlock with adjacent end channels to form a single photovoltaic module.

U.S. Pat. No. 4,336,413 to Tourneux discloses a building integrated photovoltaic generating panel easily adaptable to a roof. The panel is equipped with a peripheral frame formed by the assembly of straight light alloy shapes. The particular form of these shapes makes possible the laying of adjacent panels with overlapping of the edges of the latter similar to roof tiles.

U.S. Pat. No. 4,246,892 to Waiche describes a solar thermal energy collector panel, having an absorber plate and a frame within which the absorber plate is mounted. The absorber plate is comprised of a plurality of absorber plate sections each having interlocking structure formed along both of their lateral edges. This interlocking structure forms a tubular passage when the interlocking structure of the adjacent absorber plate sections are matingly locked together. An elongated tubing member whose external diameter is slightly larger than the internal diameter of the tubular passage is frictionally captured within each of the tubular passages. The absorber plate sections are formed of extruded metal and they have a plurality of corrugated surface portions that provide the

absorber plate sections with greater surface exposure and improved absorption angles to the sun throughout the day. The thickness of the absorber plate sections is the greatest where the interlocking structure of the adjacent absorber plate sections are matingly locked together, thereby providing a greater mass for heat conduction transfer from the absorber plate sections to the elongated tubing member. The interlocking structure formed on the lateral edges of the absorber plate sections comprise a fin portion whose configuration is basically that of a cylindrical tube that has been cut in half longitudinally. A recess is formed adjacent one edge of the fin portion and a protrusion is formed adjacent the opposite edge of the fin portion. The frame has a back plate, side frame members, end frame members, and a glass top panel.

The foregoing patents reflect the current state of the art of which the present inventor is aware. Reference to, and discussion of, these patents is intended to aid in discharging Applicant's acknowledged duty of candor in disclosing information that may be relevant to the examination of claims to the present invention. However, it is respectfully submitted that none of the above-indicated patents disclose, teach, suggest, show, or otherwise render obvious, either singly or when considered in combination, the invention described and claimed herein.

Furthermore, it is clear from the lack of prior art and number of problems which still remain unaddressed, that a definite need exists for a simple, cost-effective widely adaptable PV module mounting system which is integrated into the PV module frame design and which provides improved alignment capability, simplified and more reliable grounding, wiring which is hidden from view yet always accessible without removing a PV module, ability to always connect to the rafters, minimization of required penetrations in the roof, greater ease of installation, backward compatibility with inward facing flange framing systems, ability to connect PV module frame directly on top of a roof or mounting structure without the need for costly struts and hardware or expensive building integrated PV technologies, ability to remove any PV module in the array without having to remove others or pull out primary penetrating bolts, ability to easily add and remove optional items like debris screens and cosmetic flashings and caps, and improved appearance.

BRIEF SUMMARY OF THE INVENTION

The method and apparatus for mounting photovoltaic modules of this invention provides a simple, cost-effective, complete mounting strategy for installing photovoltaic modules on most common roofs, structures, vehicles, and surfaces. The present invention provides an interlocking photovoltaic module mounting system that provides a one piece, integrated photovoltaic module frame portion that is directly mountable to a support structure and interlocks with separate adjoining photovoltaic module frame portions. The inventive apparatus includes a frame member for enclosing the perimeter of a photovoltaic laminate and which is made of substantially similar construction on all four sides; the frame member having a top portion, bottom portion, inside surface, and outside surface, the inside surface including a recess for capture of the laminate. The frame member outside surface includes at least one interlocking means for adjoining a first frame member of a first PV module with a second frame member on an adjacent, second PV module to form a planar array.

A preferred embodiment of the invention includes an interlocking mechanism comprising at least one C-shaped channel portion on the outside surface of the PV module frame member with the opening oriented parallel to the plane of the substantially flat top solar cell covering, and which interlocks with an identical adjoining C-shaped channel portion of an adjoining PV module frame member through the use of a separate male coupling member which is inserted into the C-shaped portions of the two adjoining modules. The adjacent C-shaped channel portions do not overlap each other. The male coupling member may also serve as a means for providing electric ground continuity between PV modules.

The frame member bottom portion may also include at least one height-adjustable mounting foot portion which is also adjustable in a direction perpendicular to the primary structural elements which are supporting the PV array, such as the rafters of a roof, and which provides a means for attaching the frame member to a structural member, and at least one height adjustable leveling foot portion which provides a means for supporting the frame member and adjustably, vertically aligning individual PV modules with adjoining PV modules to form a substantially planar PV array.

The inventive system thus provides an interlocking, self-grounding, and self-aligning framing structure for each module, which provides three-dimensional adjustability, allows simple connection to the rafters, minimizes penetrations in the roof, allows access to wiring interconnects without removing modules, does not require expensive strut hardware, utilizes a non-overlapping, interlocking mechanism which allows for all PV modules in an array to rest in the same plane instead of having consecutive modules at slightly different angles due to the overlapping nature of an interleaved connection, and which in some embodiments allows removal of single PV modules from the middle of the array.

The inventive system also provides an attractive appearance by having a low profile, with no gaps between modules, and no visible hold-downs or hardware, plus optional cosmetic flashings for screening visible edges of the array and optional cosmetic caps for covering the small gaps that may occur, or in one embodiment, for bridging between two adjacent PV modules to cover the wiring. Additional benefits are further described herein.

It is therefore an object of the present invention to provide a new and improved frame apparatus for photovoltaic modules.

It is another object of the present invention to provide a new and improved interlocking photovoltaic module mounting system.

A further object or feature of the present invention is a new and improved interlocking, self-grounding, and self-aligning framing structure for photovoltaic modules.

An even further object of the present invention is to provide a novel method for mounting photovoltaic modules.

Other novel features which are characteristic of the invention, as to organization and method of operation, together with further objects and advantages thereof will be better understood from the following description considered in connection with the accompanying drawing, in which preferred embodiments of the invention are illustrated by way of example. It is to be expressly understood, however, that the drawing is for illustration and description only and is not intended as a definition of the limits of the invention. The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming part of this disclosure. The invention resides not in any one of these features taken alone, but rather in the particular combination of all of its structures for the functions specified.

There has thus been broadly outlined the more important features of the invention in order that the detailed description

thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form additional subject matter of the claims appended hereto. Those skilled in the art will appreciate that the conception upon which this disclosure is based readily may be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

Further, the purpose of the Abstract is to enable the U.S. Patent and Trademark Office and the public generally, and especially the scientists, engineers and practitioners in the art who are not familiar with patent or legal terms or phraseology, to determine quickly from a cursory inspection the nature and essence of the technical disclosure of the application. The Abstract is neither intended to define the invention of this application, which is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

Certain terminology and derivations thereof may be used in the following description for convenience in reference only, and will not be limiting. For example, words such as "upward," "downward," "left," and "right" would refer to directions in the drawings to which reference is made unless otherwise stated. Similarly, words such as "inward" and "outward" would refer to directions toward and away from, respectively, the geometric center of a device or area and designated parts thereof. References in the singular tense include the plural, and vice versa, unless otherwise noted.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

FIG. **1** is a side elevation cross-sectional view of a first embodiment of an interlocking photovoltaic module mounting system of this invention, illustrating two adjacent interlocked photovoltaic module frames;

FIG. **2** is a side elevation cross-sectional view of the interlocking photovoltaic module frames of FIG. **1**, this section take at a mounting foot;

FIG. **3** is a side elevation cross-sectional view of the interlocking photovoltaic module frames of FIG. **1**, this section take at a leveling foot;

FIG. **4** is a side elevation cross-sectional view of an alternate embodiment of an interlocking mechanism for photovoltaic module frames of this invention;

FIG. **5** is an end elevation view of a single photovoltaic module frame as installed on a roof;

FIG. **6** is a perspective view of two adjacent interlocked photovoltaic module frames; and

FIG. **7** is an enlarged perspective view of two adjacent interlocked photovoltaic module frames illustrating the interlocking mechanism.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. **1** through **7**, wherein like reference numerals refer to like components in the various views, there is illustrated therein a new and improved apparatus for mounting photovoltaic modules to a roof, generally denominated **10** herein.

FIG. **1** is a side elevation cross-sectional view of a first embodiment of an interlocking photovoltaic module mounting system **10** of this invention, illustrating two adjacent interlocked photovoltaic module frames **12**L, **12**R above a roof **13**. Each frame member encloses the perimeter of a photovoltaic laminate **14**. Each frame is made of substantially similar construction on all four sides, and each includes a top portion **16**L, **16**R, bottom portion **18**L, **18**R, inside surface **20**L, **20**R, and outside surface **22**L, **22**R. Inside surfaces **20**L, **20**R include a recess **23**L, **23**R for capture of the laminate **14**. The frame member outside surfaces **22**L, **22**R include at least one interlocking mechanism **24**L, **24**R for adjoining frame **12**L to adjacent frame **12**R to form a planar array of laminates **14**.

Interlocking mechanism **24**L, **24**R may consist of C-shaped or female channel portions **26**L, **26**R on the outside surfaces **22**L, **22**R of each the PV module frame members with the opening oriented parallel to the plane of the substantially flat top solar cell **14**, through the use of a separate male coupling member **28** which is inserted into the C-shaped portions of the two adjoining modules. The male coupling member **28** may also serve as a means for providing electric ground continuity between PV modules, as by tapping the coupling member **28** with the optional grounding screws **30**.

The frame members may be constructed as an extrusion, with all portions run full length except the top of the female channel portion at the ends, and various slots and holes which may be punched out after the extrusion is run. The frame members may include an inward flange **32** for backward compatibility with existing mounting systems. Screw holes **34** may be used to connect frame pieces together at the module corners.

The frames may include an optional cosmetic cap **36** for covering the small gaps that may occur, or in one embodiment, for bridging between two adjacent PV modules to create a wireway.

FIG. **2** is a side elevation cross-sectional view of the interlocking photovoltaic module frames **12**L, **12**R, this section illustrating a mounting foot **38**. Mounting foot **38** includes lateral portion **40** which may be secured to a roof with lag bolt **42**, and vertical (cylindrical) portion **44**, which is captured by foot sleeve **46** of mounting foot bracket **48**. Bolt **50** threads into bracket **48** and compresses against the vertical portion **44** of the mounting foot **38** to secure the mounting foot in position and at the desired height. Mounting foot bracket **48** is preferably inserted through slot **52**R of frame **12**R, and secured there by twist lock clip **54**R.

FIG. **3** is a side elevation cross-sectional view of the interlocking photovoltaic module frames **12**L, **12**R, this section illustrating a leveling foot **56**. Leveling foot **56** includes lateral portion **58** (which is preferably not physically secured to the roof), and vertical portion **60**, which is captured by foot sleeve **62** of leveling foot bracket **64**. Bolt **66** threads into bracket **64** and compresses against the vertical portion **60** of the leveling foot **56** to secure the leveling foot in position at the desired height. Leveling foot bracket **64** is preferably inserted through slot **68**R of frame **12**R, and secured there by twist lock clip **70**R.

FIG. **4** is a side elevation cross-sectional view of an alternate embodiment of an interlocking mechanism for photovoltaic module frames of this invention. Here, U-clip coupling strip **72** engages vertically-oriented channels **74**L, **74**R to secure the adjacent modules together. Spring loaded pins **76** extend into the frames **12**L, **12**R, and may be released by

pulling a handle at the top. A hook on the end of the coupling strip allows removal of the strip from an access port.

FIG. **5** is an end elevation view of a single photovoltaic module frame as installed on a roof. This view illustrates the plurality of slots **78** available for mounting and leveling foot brackets, as well as for inter-module wiring access. This view also illustrates a slot **80** on coupling strip **28** which may be engaged by a screwdriver or other tool to move the strip into or out of engagement with the female channel portion **26**R.

FIG. **6** is a perspective view of two adjacent interlocked photovoltaic module frames. This view serves to illustrate the coplanar nature of the laminates **14** in adjoining frames **12**L and **12**R to form a planar array of laminates.

FIG. **7** is an enlarged perspective view illustrating interlocking mechanism **24**L, **24**R adjoining frame **12**L to adjacent frame **12**R. The interlocking mechanism may be a removable coupler such as a double male interlock, as illustrated, or may consist of any other releasable interlock that permits connection of adjacent frames on all four sides of a module such that the supported laminates are coplanar.

Inventive features of the present apparatus include, but are not limited to, the following:

Self-locking—all modules frames securely interlock together to form a completely connected array structure. In the preferred embodiment of the invention this interlocking is achieved by a female channel integrated into all four sides of the photovoltaic module frame which mates with a removable male coupling strip. The coupling strip is releasable from the top via a break in the extrusion thereby allowing removal of any single module without requiring removal of previous modules in the row, unlike previous attempts at interlocking functionality which used an overlapping technique instead of the coupling technique described herein. Another embodiment of the invention achieves release of the coupling strip from the top by utilizing spring loaded pins and a release handle.

Self-grounding—interlocking mechanisms provide a solid "electrical contact" (as required by the NEC) which is protected from the weather so it will last. One simple ground wire to one module grounds the whole array and its support structure. Another embodiment includes provision for a ground screw to tap the coupling strips if required for certain jurisdictions.

Self-aligning—as modules are snapped into place, they are automatically aligned on the side where the interlock is being made. Small leveling legs are provided on the opposing side of each module to fine tune the vertical alignment before securing it to the roof or structure. Straight, substantially planar arrays are simple even on dramatically swooping roofs.

Accessible yet hidden wiring—as each module goes down, the quick-connect electrical connectors are plugged together then tucked into a slot which is accessible from the top—allowing future repair of each module interconnection without removing any modules (note: installers can carefully crawl out on top of the modules to fix wiring on a module out in the middle). Thus, all wiring is still accessible, yet carefully hidden from view. Another embodiment includes a snap-on cover which hides the wiring.

Strutless design—while a separate optional piece can be added to allow connection to all standard struts on the market, the inventive apparatus is capable of mounting photovoltaic modules to most roof surfaces and structures without the need for expensive and time consuming strut at all.

Minimizes penetrations—while all other direct mount, strutless mounting systems require more penetrations than a strut mount, the inventive apparatus distributes the load more evenly across the whole array area and typically requires less penetrations. This unlikely result is obtained by reallocating two critical mounting hardware functions: 1) resisting the downward pull of gravity, and 2) resisting the upward pull of wind. All other mounting systems combine these two functions into a single portion, most commonly a foot-type portion. A preferred embodiment of the inventive apparatus however separates these two functions into two different types of feet: leveling feet which are not fastened to the roof or structure and primarily resist gravity, and carefully spaced mounting feet which are fastened to the roof and primarily resist windloads.

Works on most roof types—The inventive apparatus is compatible with all common roofs and surfaces found including: composition shingle, tile, shake, tar & gravel, membrane, standing seam, trellis or other wooden structure, ground mount metal structure, and many others. A preferred embodiment includes the use of circular foot members which allow standard circular pipe flashings to be used.

Flexible orientation—The inventive apparatus works with Landscape and Portrait orientations and photovoltaic module rows can be installed in any order. However, the inventive apparatus does favor Landscape orientation which allows for fewer penetrations and, in most cases on sloped roofs, will yield a slightly higher kW/s.f. of roof area. Strut mounts, on the other hand, tend to favor portrait orientation which frequently results in less modules for the same roof. This happens because most roofs are wider east to west than they are tall (from ridge to gutter), so orienting the long dimension of the photovoltaic module parallel with the long dimension of the roof surface increases the likelihood of a better fit.

Rafter connection—unlike any other mounting system available, the inventive apparatus includes simple integral adjustability in X, Y, and Z so connection to rafters is always possible. Set one dimension, then quickly adjust the other two with a single, easily accessible bolt. Fumbling with nuts, washers, and lock washers or losing hardware as it rolls down the roof, as is typically the case when mounting PV modules, is not required since a single wrench operates all integral bolts.

Adjustable height—a preferred embodiment allows module height off of the roof or structure to be fully adjustable (no discreet holes) from 0" to approximately 2.5" (depending on module frame depth) so that the correct height for each situation can be chosen depending on the water damming, aesthetic, and debris issues on site.

No gaps—Interlocking frames eliminate all gaps between modules and wire access ports are not discernible from the ground because there is a black frame right behind them.

Easier obstacle avoidance—unlike strut systems which require ending the strut and starting a new row every time you run across a roof vent or skylight, the inventive apparatus easily accommodates small obstructions by simply leaving out a module.

Snap-on options—Cosmetic flashings can be snapped right into the frames along visible sides of the array to eliminate problematic viewing angles beneath the modules, or in heavily treed areas, debris screens can be snapped on forming a complete skirt around the array. Other embodiments include snap-on pre-stressed sheet metal pieces to receive conduit, snap-on junction boxes and wiring combiner boxes, and snap-on caps between PV modules to cover wiring.

Backward compatible—The inventive apparatus can be manufactured in a way which is completely backward compatible with all standard photovoltaic frames and mounting techniques. Almost all photovoltaic modules come with a C-shaped frame that includes mounting holes on an inward

facing bottom flange. In addition to all of its other features, the inventive apparatus can include the exact same holes in the same relative place.

Low Cost—Unlike other attempts to integrate more features into the PV module frame, the inventive apparatus includes frame members which are extruded from the exact same die, thereby minimizing manufacturing tooling costs. Low part count and simple installation also save PV contractor time & money.

Removing single modules—A preferred embodiment includes coupling members which are removable from the top thereby allowing removal of single PV modules no matter what location in the PV array (and without requiring the seals to be broken between module and the roof, if applicable).

Thus, the invention may be characterized as a photovoltaic module comprising a photovoltaic laminate having a perimeter; a frame member for enclosing the perimeter of the photovoltaic laminate, the frame member having a top portion, bottom portion, inside surface, and outside surface, the inside surface including a recess for capture of said laminate, and the outside surface including at least one interlocking means for connection to a frame member of an adjacent photovoltaic module so that the photovoltaic laminate is coplanar with the photovoltaic laminate of the adjacent photovoltaic module. In addition, the photovoltaic module frame member comprises individually disengageable interlocking mechanisms for the photovoltaic modules in a formed array.

Alternatively, the invention may be characterized as a method for mounting photovoltaic laminates to a roof comprising the steps of: enclosing the perimeter of each photovoltaic laminate in a frame member having a top portion, bottom portion, inside surface, and outside surface, the inside surface including a recess for capture of the photovoltaic laminate; and interlocking one frame member outside surface to the complementary outside surface of an adjacent frame member to form a planar array of photovoltaic laminates on the roof.

The above disclosure is sufficient to enable one of ordinary skill in the art to practice the invention, and provides the best mode of practicing the invention presently contemplated by the inventor. While there is provided herein a full and complete disclosure of the preferred embodiments of this invention, it is not desired to limit the invention to the exact construction, dimensional relationships, and operation shown and described. Various modifications, alternative constructions, changes and equivalents will readily occur to those skilled in the art and may be employed, as suitable, without departing from the true spirit and scope of the invention. Such changes might involve alternative materials, components, structural arrangements, sizes, shapes, forms, functions, operational features or the like.

Therefore, the above description and illustrations should not be construed as limiting the scope of the invention, which is defined by the appended claims.

What is claimed as invention is:

1. A photovoltaic module array comprising:

a first frame member enclosing a single photovoltaic laminate, said first frame member having a plurality of side wall portions each having a top portion, bottom portion, inside surface, and outside surface, said inside surface including a recess for capture of said photovoltaic laminate, at least one of said side wall portions including at least one interlocking means comprising a female receiving portion integrated into said outside surface;

a second frame member enclosing a single photovoltaic laminate, said second frame member having a plurality of side wall portions each having a top portion, bottom portion, inside surface, and outside surface, said inside surface including a recess for capture of said photovoltaic laminate, at least one of said side wall portions including at least one interlocking means comprising a female receiving portion integrated into said outside surface; and

a discrete male coupling portion interlocking said first frame member female receiving portion and said second frame member female receiving portion, wherein said first frame member female receiving portion comprises an inside surface which positively engages an outside surface of said male coupling portion to resist a downward force on said second frame member.

2. The photovoltaic module array of claim **1** wherein said male coupling portion solely spans between immediately adjacent side wall portions in said photovoltaic module array.

3. The photovoltaic module array of claim **1** wherein said first and second frame member side wall portions outside surfaces face a direction substantially opposite respective inside surfaces and comprise a length substantially parallel with a skyward facing plane of said photovoltaic laminate, said female receiving portions running substantially the entire length of said side wall portions, and said male coupling portion has a length substantially less than the length of said frame member side wall portions, thereby enabling said male coupling portion to be located at substantially any position along the length of said frame member side wall portions.

4. The photovoltaic module array of claim **3** wherein said first frame member side wall portion outside surface is immediately adjacent to said second frame member side wall portion outside surface, said first frame member side wall portion outside surface being substantially parallel with and substantially nonlinear relative to said second frame member side wall portion outside surface.

5. The photovoltaic module array of claim **1** wherein said male coupling portion further comprises means for providing electrical ground continuity between said first and second frame members.

6. The photovoltaic module array of claim **1** wherein said first frame member includes a cap member for affixation between said first frame member and an adjacent frame member.

7. The photovoltaic module array of claim **1** wherein said male coupling portion comprises a double male connector.

8. The photovoltaic module array of claim **1** wherein said first frame member female receiving portion inside surface comprises at least two opposing surfaces, a first opposing surface resisting downward forces presented to said second frame member and a second opposing surface resisting upward forces presented to said second frame member.

9. A photovoltaic module array comprising:

(a) a plurality of photovoltaic modules; and

(b) a plurality of coupling members; wherein each photovoltaic module comprises an integral frame member enclosing a single photovoltaic laminate, said frame member having a plurality of side wall portions each having a top portion, bottom portion, inside surface, and outside surface, said inside surface including a recess for capture of said photovoltaic laminate, at least one of said side wall portions including at least one interlocking means comprising a female receiving portion integrated into said outside surface, each coupling member interlocking a first photovoltaic module and second photovoltaic module and comprising at least two male portions, a first male portion being inserted into the frame member female receiving portion of a first photovoltaic module, and a second male portion being inserted into

the frame member female receiving portion of a second photovoltaic module, wherein said first photovoltaic module frame member female receiving portion comprises an inside surface which positively engages an outside surface of said male coupling portion to resist a downward force on said second photovoltaic module frame member.

10. The photovoltaic module array of claim **9** wherein said coupling members solely span between side wall portions of immediately adjacent photovoltaic modules in said photovoltaic module array, each side wall portion comprising inside and outside surfaces facing substantially opposite directions, each outside surface comprising a length running along a perimeter of said photovoltaic laminate, said female receiving portion running substantially the whole length of said side wall portion, adjacent side wall portions of said immediately adjacent photovoltaic modules comprising outside surfaces which are substantially parallel with and substantially nonlinear relative to each other.

11. The photovoltaic module array of claim **9** wherein said photovoltaic modules are individually deployable.

12. The photovoltaic module array of claim **9** wherein said first frame member includes at least one height-adjustable foot portion for supporting said first frame member.

13. The photovoltaic module array of claim **9** wherein said first frame member female receiving portion inside surface comprises at least two opposing surfaces, a first opposing surface resisting downward forces presented to said second frame member and a second opposing surface resisting upward forces presented to said second frame member.

14. The photovoltaic module array of claim **9** wherein said coupling member further comprises means for providing electrical ground continuity between said first and second photovoltaic modules.

15. A method for mounting photovoltaic modules to a roof structure, said method comprising the steps of:

providing a first frame member enclosing a single photovoltaic laminate, the first frame member having a plurality of side wall portions each having a top portion, bottom portion, inside surface, and outside surface, the inside surface including a recess for capture of the photovoltaic laminate, and at least one of the side wall portions including at least one interlocking means comprising a female receiving portion integrated into the outside surface;

providing a second frame member enclosing a single photovoltaic laminate, the second frame member having a plurality of side wall portions each having a top portion, bottom portion, inside surface, and outside surface, the inside surface including a recess for capture of the photovoltaic laminate, and at least one of the side wall portions including at least one interlocking means comprising a female receiving portion integrated into the outside surface; and

inserting a discrete male coupling portion into the first frame member female receiving portion and the second frame member female receiving portion to interlock the first frame member and the second frame member in an array above the structure, wherein the first frame member female receiving portion comprises an inside surface which positively engages an outside surface of the male coupling portion to resist a downward force on the second frame member.

16. The method for mounting photovoltaic modules to a structure of claim **15** further including the step of leveling the array on the structure with a height-adjustable foot portion.

17. The method for mounting photovoltaic modules to a structure of claim **16** further including the step of securing the foot portion to the structure with a fastener.

18. The method for mounting photovoltaic modules to a structure of claim **16** further including the step of laterally adjusting the foot portion within the frame to align with a structural member.

19. A photovoltaic module array comprising:

a first frame member enclosing a single photovoltaic laminate, said first frame member having a plurality of side wall portions each having a top portion, bottom portion, inside surface, and outside surface, said inside surface including a recess for capture of said photovoltaic laminate, at least one of said side wall portions including at least one interlocking means comprising a female receiving portion integrated into said outside surface, wherein said female receiving portion only opens substantially perpendicularly relative to said side wall portion;

a second frame member enclosing a single photovoltaic laminate, said second frame member having a plurality of side wall portions each having a top portion, bottom portion, inside surface, and outside surface, said inside surface including a recess for capture of said photovoltaic laminate, at least one of said side wall portions including at least one interlocking means comprising a female receiving portion integrated into said outside surface, wherein said female receiving portion only opens substantially perpendicularly relative to said side wall portion; and

a discrete male coupling portion interlocking said first frame member female receiving portion and said second frame member female receiving portion, wherein said male coupling portion solely spans between immediately adjacent side wall portions in said photovoltaic module array.

20. The photovoltaic module array of claim **19** wherein said first and second frame member side wall portions outside surfaces face a direction substantially opposite respective inside surfaces and comprise a length substantially parallel with a skyward facing plane of said photovoltaic laminate, said female receiving portions running substantially the entire length of said side wall portions, and said male coupling portion has a length substantially less than the length of said frame member side wall portions, thereby enabling said male coupling portion to be located at substantially any position along the length of said frame member side wall portions.

21. The photovoltaic module array of claim **19** wherein said first frame member side wall portion outside surface is immediately adjacent to said second frame member side wall portion outside surface, said first frame member side wall portion outside surface being substantially parallel with and substantially nonlinear relative to said second frame member side wall portion outside surface.

22. The photovoltaic module array of claim **19** wherein said male coupling portion further comprises means for providing electrical ground continuity between said first and second frame members.

23. The photovoltaic module array of claim **19** wherein said male coupling portion comprises a double male connector.

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