Low Profile Solar Tracker System and Method Intellectual Property Offering

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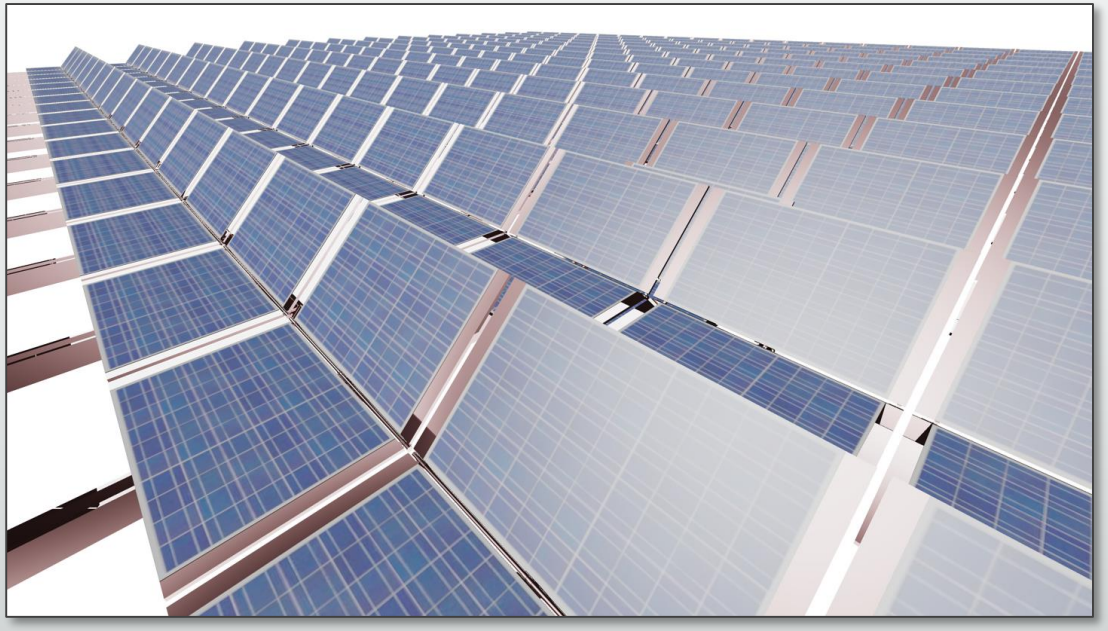
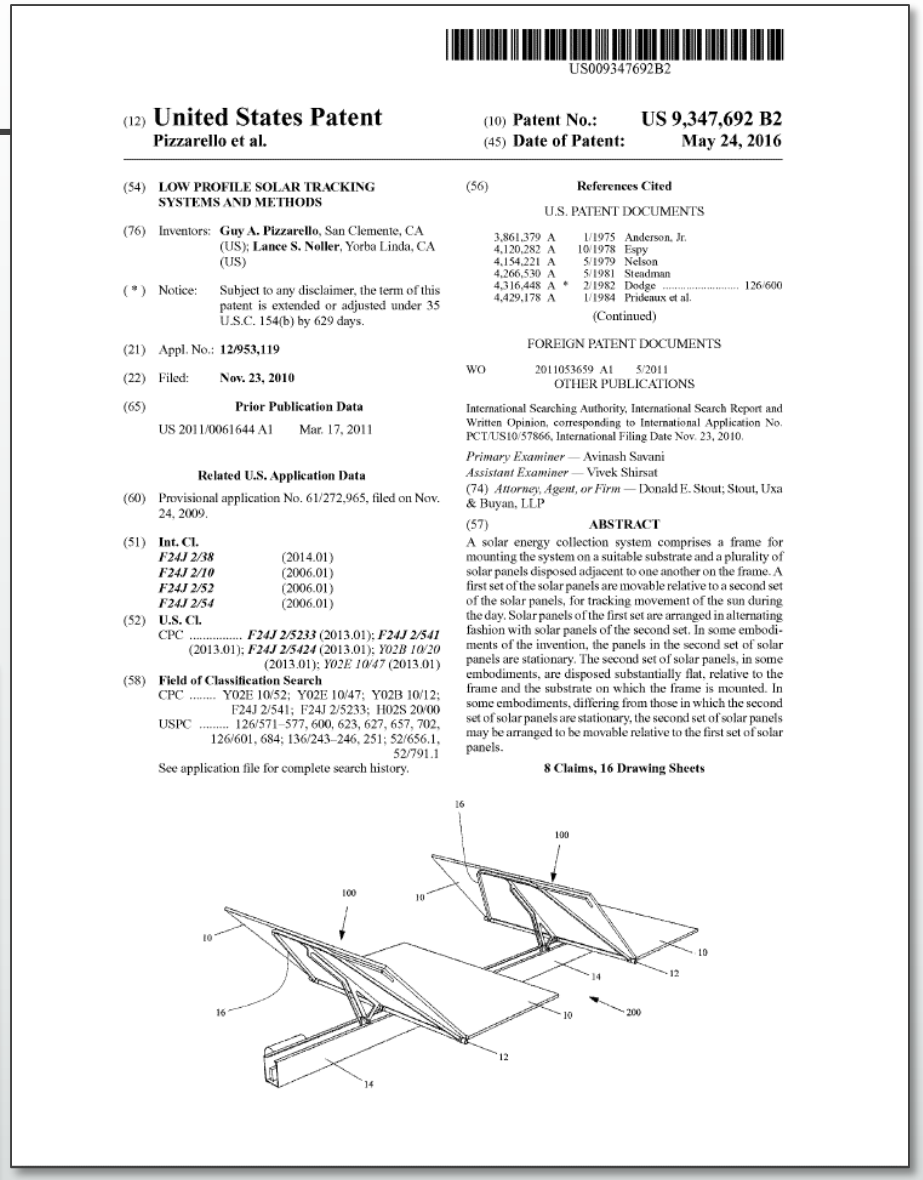
Intellectual Property Offering

Rooftop Solar Tracker IP available for sale\licensing

- Domestic and international protection
- US Patent 9,347,692
- US Patent 9,729,102 (continuation)
- EU patent pending
- India patent pending





US009347692B2

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

(10) **Patent No.: US 9,347,692 B2**
(45) **Date of Patent: May 24, 2016**

(54) **LOW PROFILE SOLAR TRACKING SYSTEMS AND METHODS**

(76) Inventors: **Guy A. Pizzarello**, San Clemente, CA (US); **Lance S. Noller**, Yorba Linda, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 629 days.

(21) Appl. No.: **12/953,119**

(22) Filed: **Nov. 23, 2010**

(65) **Prior Publication Data**

US 2011/0061644 A1 Mar. 17, 2011

Related U.S. Application Data

(60) Provisional application No. 61/272,965, filed on Nov. 24, 2009.

(51) **Int. Cl.**

F24J 2/38	(2014.01)
F24J 2/10	(2006.01)
F24J 2/52	(2006.01)
F24J 2/54	(2006.01)

(52) **U.S. Cl.**

CPC ***F24J 2/5233*** (2013.01); ***F24J 2/541*** (2013.01); ***F24J 2/5424*** (2013.01); *Y02B 10/20* (2013.01); *Y02E 10/47* (2013.01)

(58) **Field of Classification Search**

CPC Y02E 10/52; Y02E 10/47; Y02B 10/12; F24J 2/541; F24J 2/5233; H02S 20/00

USPC 126/571–577, 600, 623, 627, 657, 702, 126/601, 684; 136/243–246, 251; 52/656.1, 52/791.1

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,861,379	A	1/1975	Anderson, Jr.	
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4,154,221	A	5/1979	Nelson	
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4,316,448	A *	2/1982	Dodge	126/600
4,429,178	A	1/1984	Prideaux et al.	

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OTHER PUBLICATIONS

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Primary Examiner — Avinash Savani
Assistant Examiner — Vivek Shirsat
(74) *Attorney, Agent, or Firm* — Donald E. Stout; Stout, Uxa & Buyan, LLP

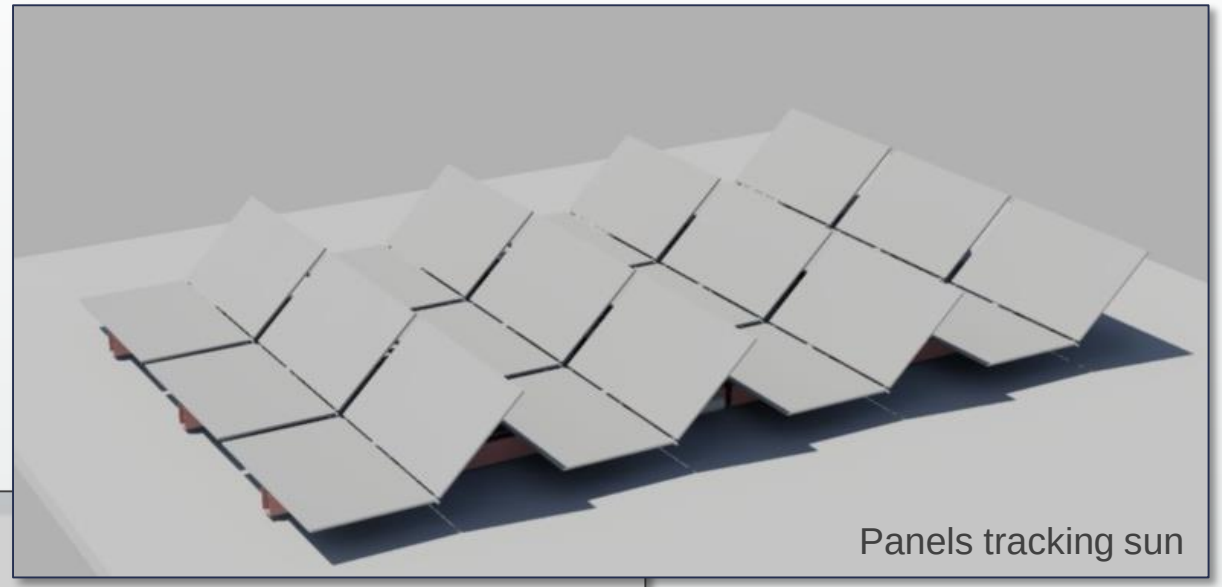
(57) **ABSTRACT**

A solar energy collection system comprises a frame for mounting the system on a suitable substrate and a plurality of solar panels disposed adjacent to one another on the frame. A first set of the solar panels are movable relative to a second set of the solar panels, for tracking movement of the sun during the day. Solar panels of the first set are arranged in alternating fashion with solar panels of the second set. In some embodiments of the invention, the panels in the second set of solar panels are stationary. The second set of solar panels, in some embodiments, are disposed substantially flat, relative to the frame and the substrate on which the frame is mounted. In some embodiments, differing from those in which the second set of solar panels are stationary, the second set of solar panels may be arranged to be movable relative to the first set of solar panels.

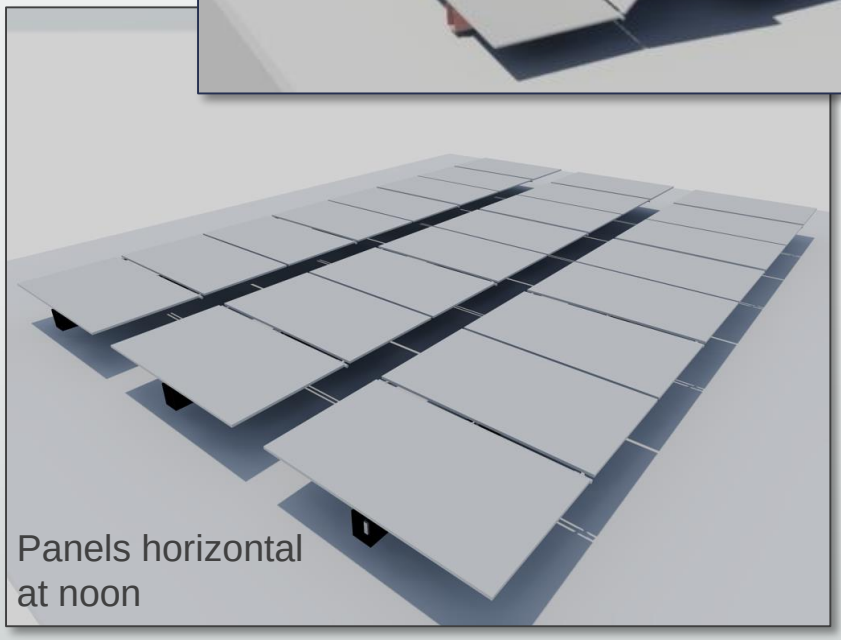
8 Claims, 16 Drawing Sheets

Invention Description

- Rooftop mounted solar tracking system
- Best suited for industrial/ commercial building rooftops and carports
  - These applications are seldom able to meet their electrical energy needs due to limiting constraints of available rooftop area.
- Provides energy gains beyond "flush" mount
- Permits high rooftop coverage ratio



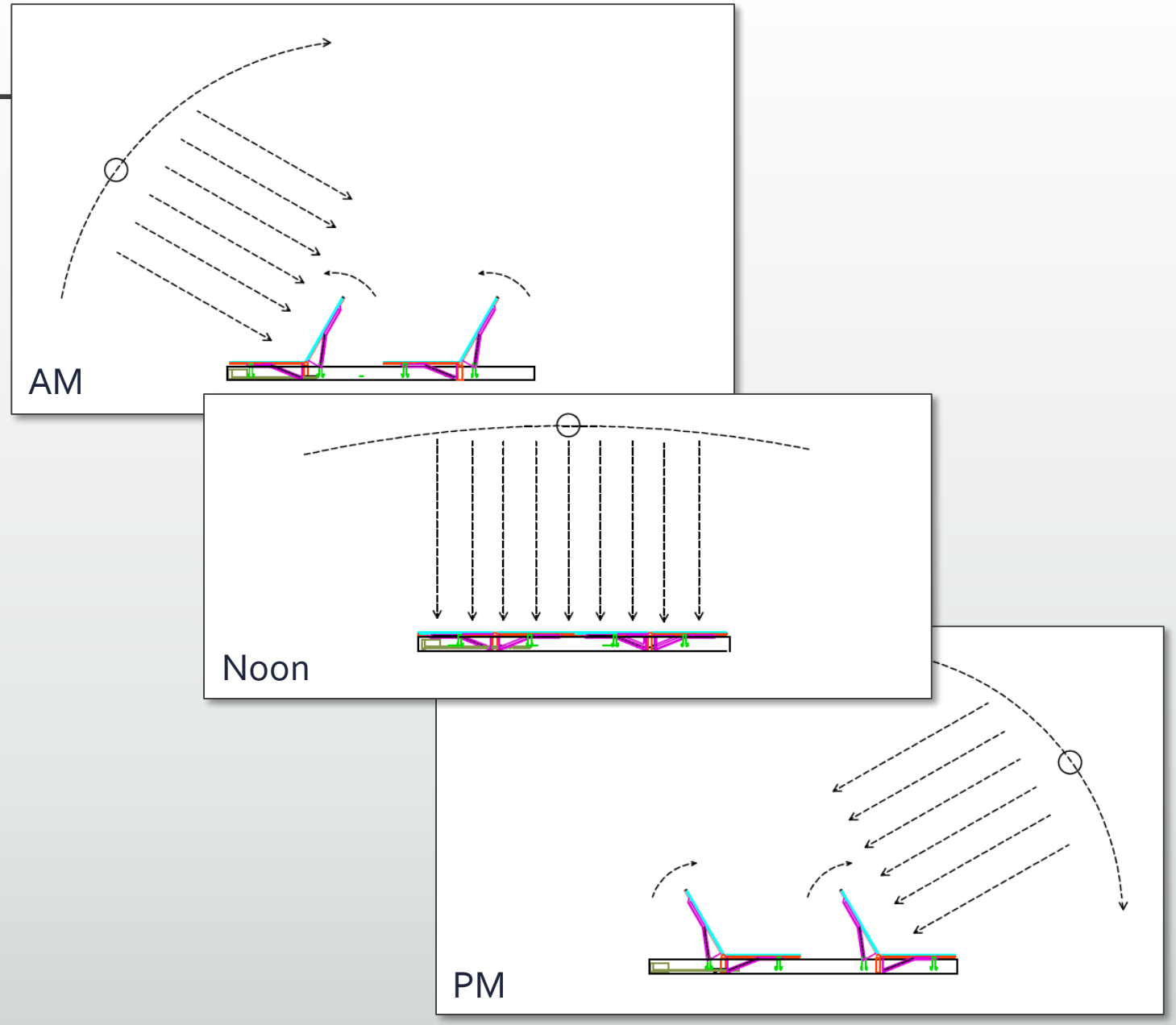
Panels tracking sun



Panels horizontal at noon

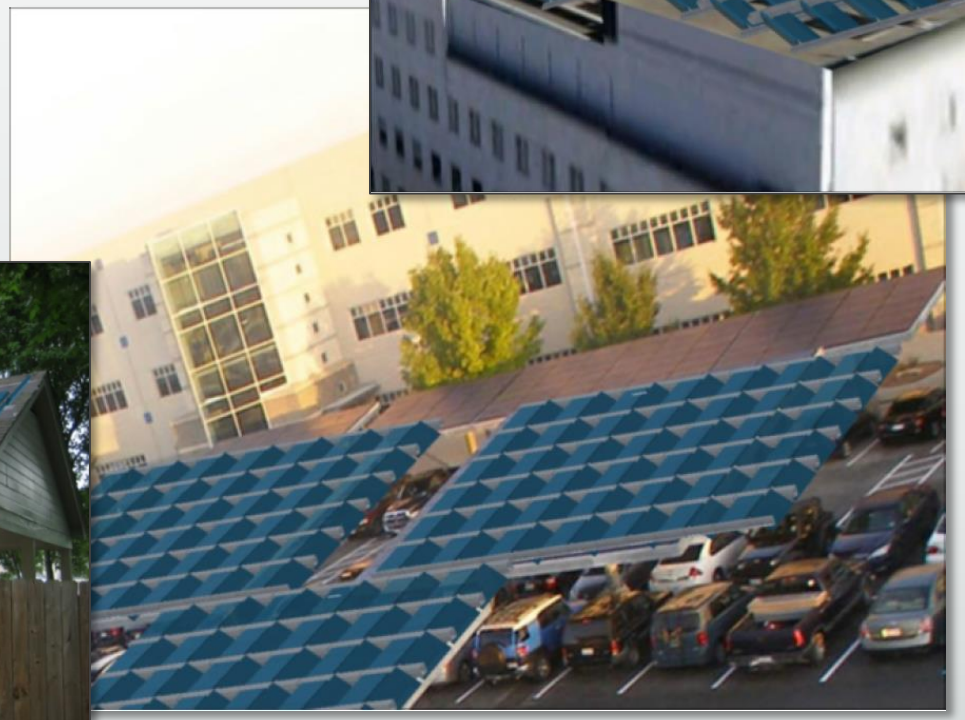
Theory of operation

- Unique linear cam rotates panels about their lower edge.
- Only one panel, out of a pair, is actively tracking the sun.
- Morning:
  - 2nd and 4th panels rotate together from eastwardly-facing direction to horizontal at solar noon
  - 1st and 3rd panels remain horizontal
- Afternoon:
  - 2nd and 4th panels remain horizontal
  - 1st and 3rd panels rotate together from horizontal to a westerly-facing direction



Applications

- Commercial rooftops
  - Single & Dual axis tracking
  - ½ tracking
- Carports
- Inclined rooftops

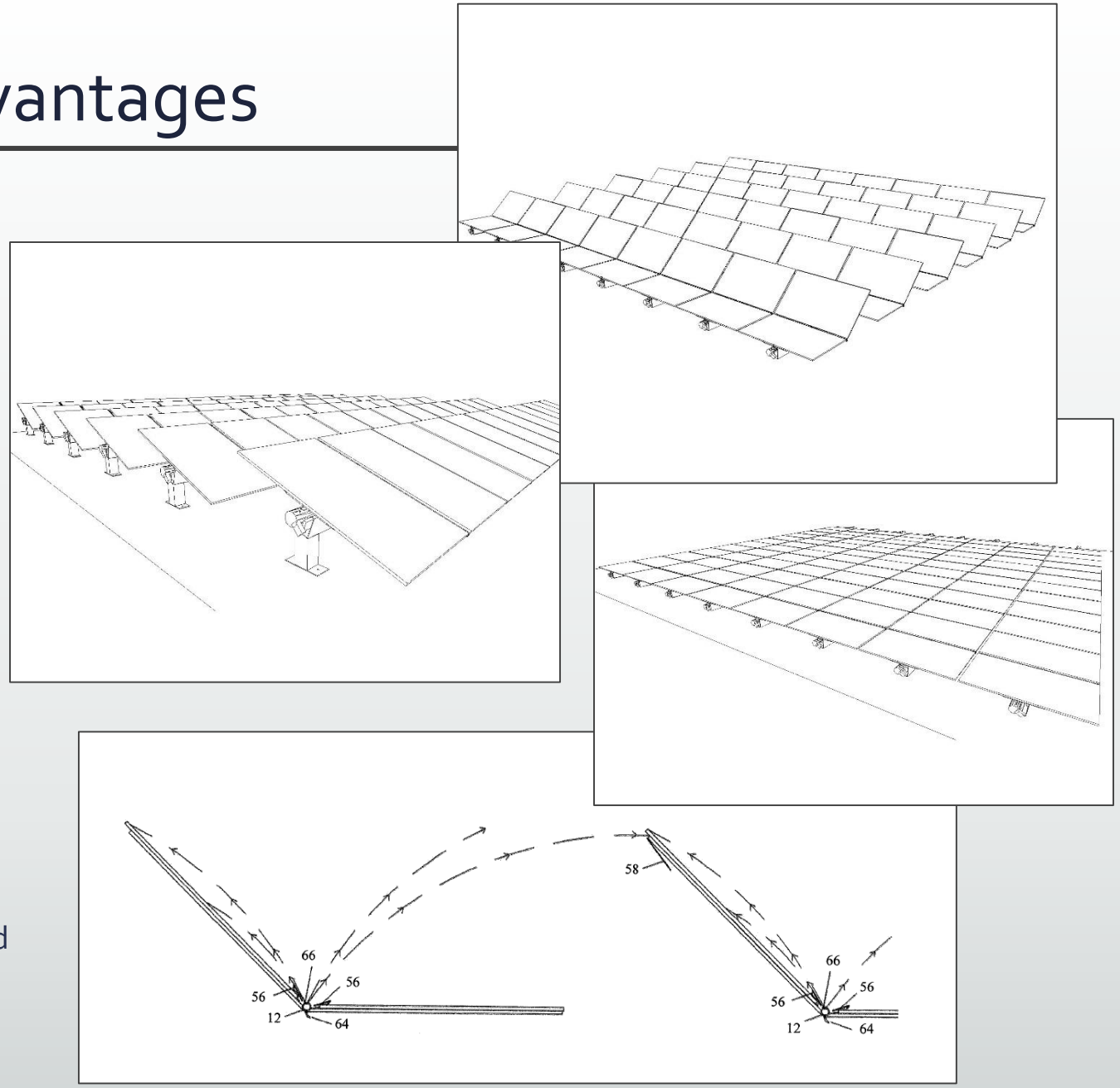


Prior practice and competition

- Arranged in an array mounted flush to the roofline
- Arranged in rows, wherein each row is tilted at a favorable angle to the sun
- Arranged in rows, wherein each row is, in turn, attached to a single-axis tracker system
- Arranged in rows or other groupings, wherein each grouping of panels is attached to a dual-axis tracker system
- Tracker challenges
  - High profile
  - Poor rooftop coverage ratio

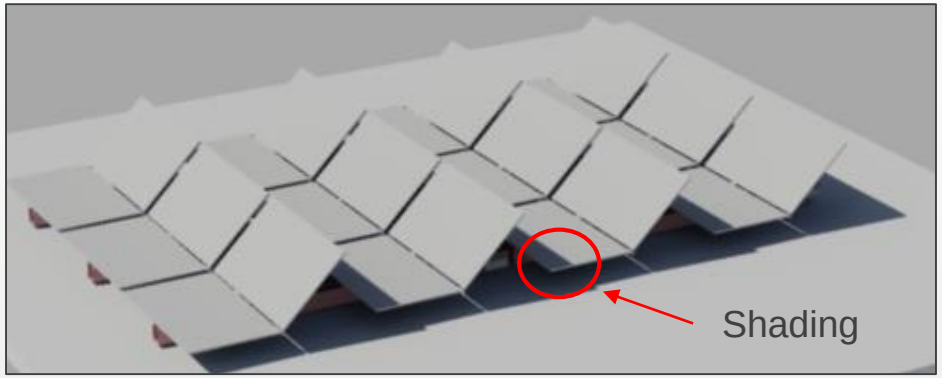
Features and competitive advantages

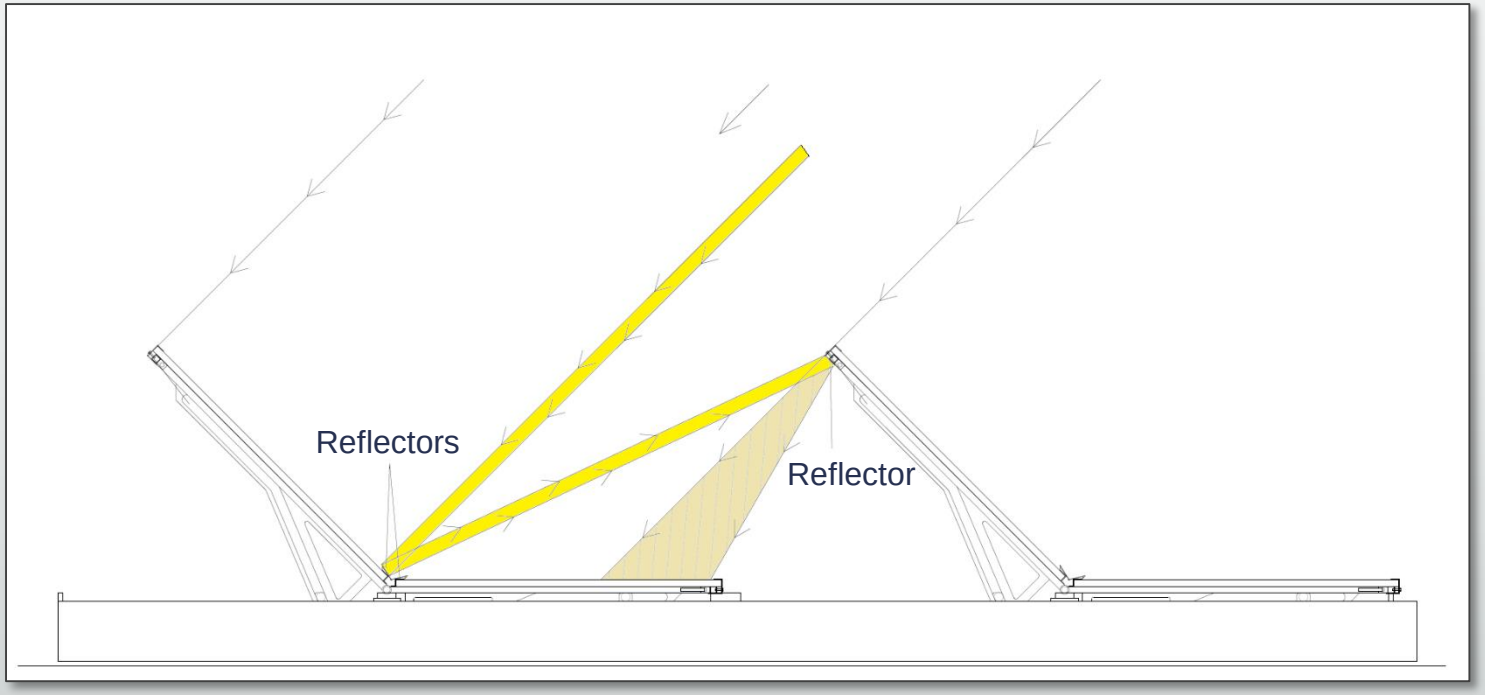
- Provides energy gains beyond "flush" mount installation
- Maximizes rooftop area coverage ratio
- Single & Dual axis tracking
- Low profile design
  - Unique linear cam rotates panels about lower edge
- Robustness against high winds due to low profile
  - Software additionally positions panels flat upon high wind
- Esthetically pleasing
  - Similar to typical low profile "flush" mount installation
  - Can be concealed below rooftop parapet
- Simplifies maintenance
  - "Quick" release handle - permits the solar panel to be rotated up and out the way
  - Integrated fluidics cleaning system



Shade mitigation using reflectors

- Depending on centerline distance separating tracking units, shading can occur on the horizontal panels as panels are tilted to track sun.
- Reflectors on top and bottom panel surfaces mitigate energy losses due to shading.

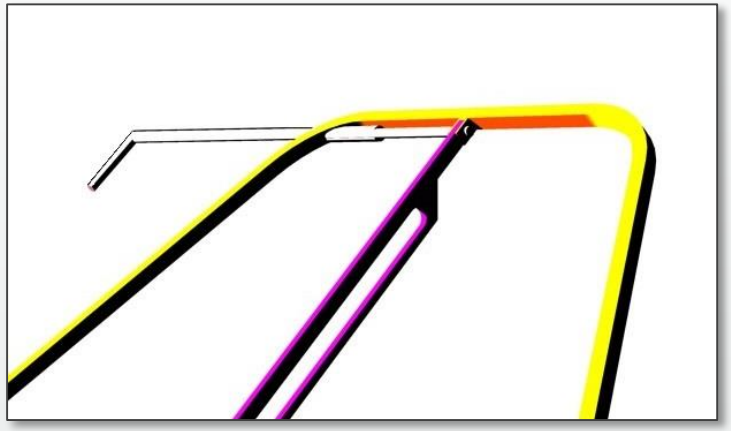


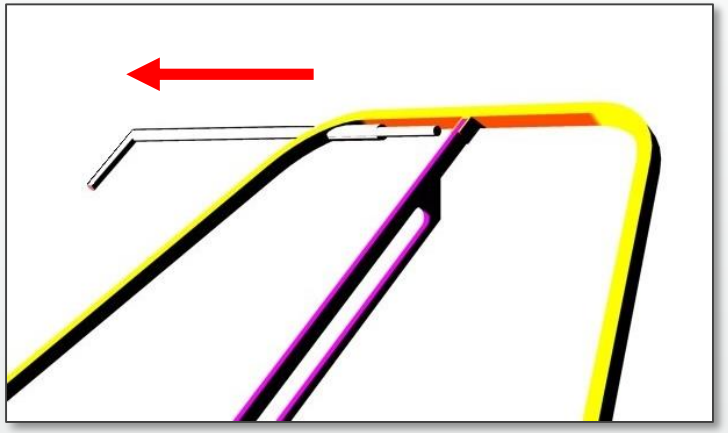


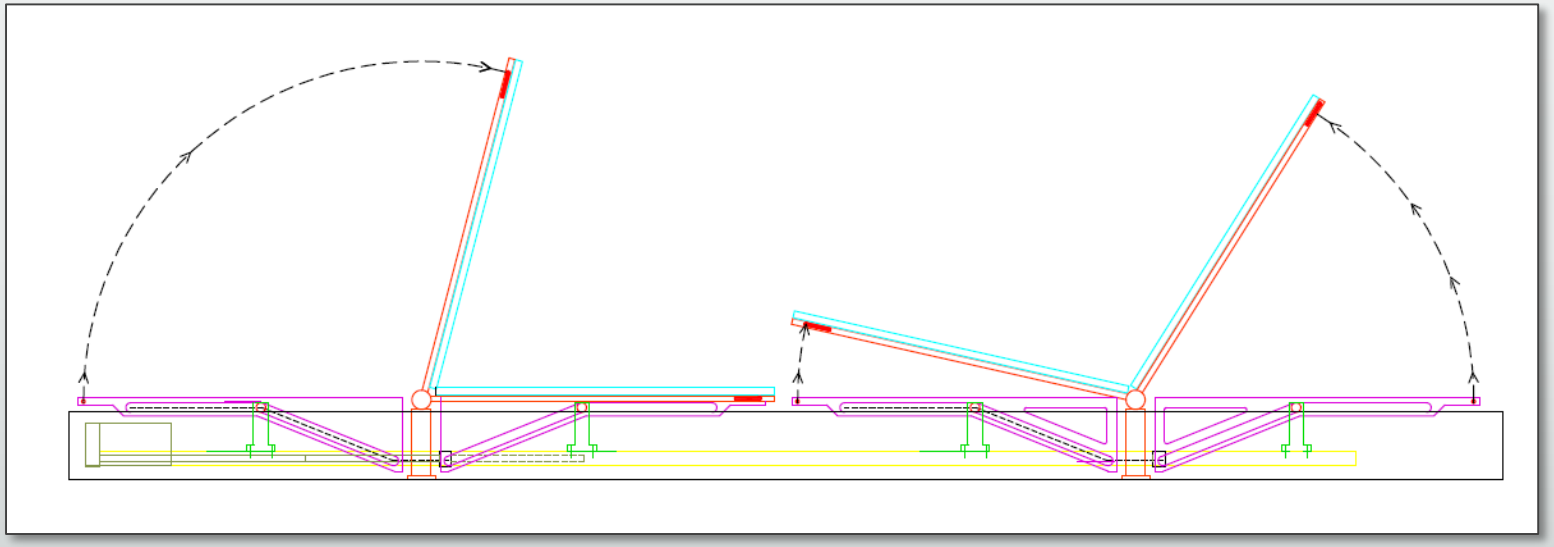
- Direct beam radiation strikes the hinge reflector and is reflected into the panel reflector attached to the underside of the adjacent tilted solar panel.
- The radiation is then subsequently reflected from the panel reflector down onto the shaded area of the horizontal solar panel, which is shaded by the shadow cast upon it by the tilted panel.

System Maintenance – Solar panel access

- "Quick-disconnect" handle
  - No tools required – human hand palm actuated
- Retracting handle disengages panel frame from drive system cam
- Panel can then be manually rotated about its hinge axis into an upright position
- Simplifies maintenance
  - Permits panel to be removed for repair
  - Access to the underlying tracking unit
  - Access to another panel

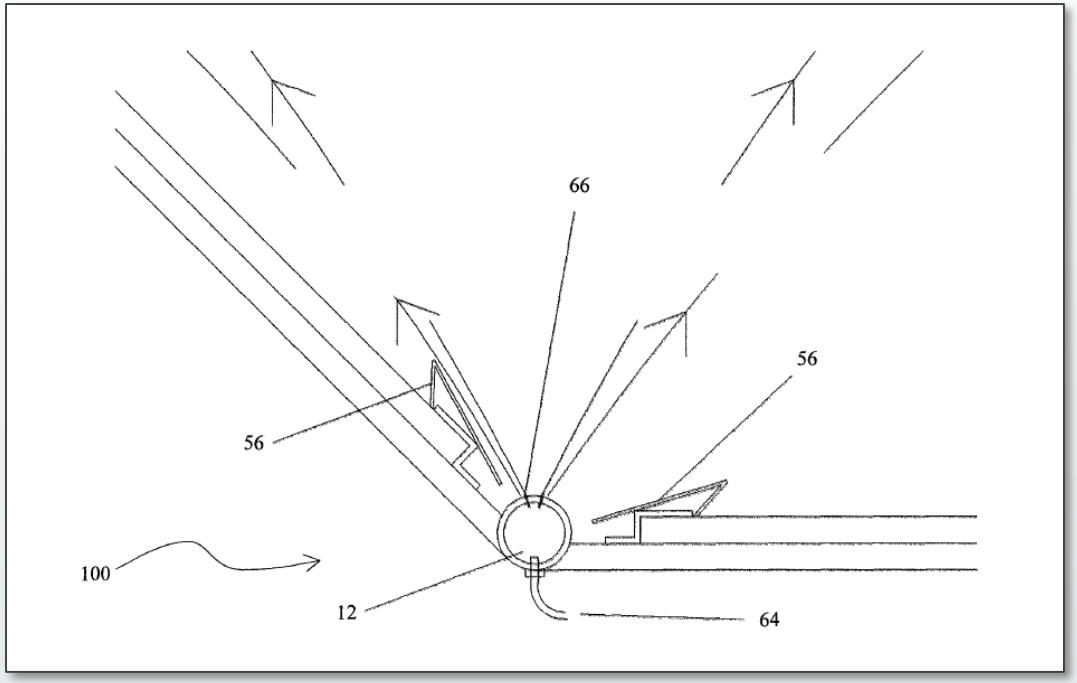


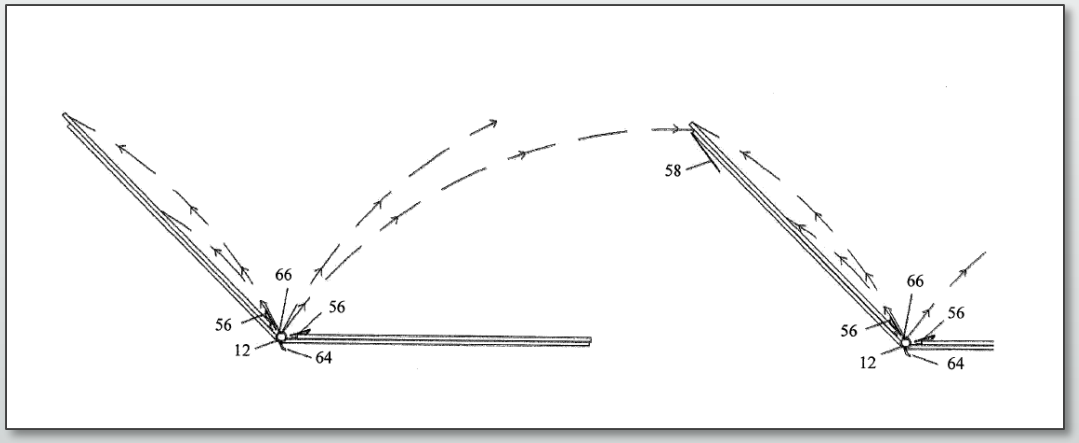




System Maintenance – Solar panel cleaning

- Integrated fluidics cleaning system
- Pressurized cleaning fluid exits hinge shaft (12) through numerous water jet orifices (66), and is distributed evenly along the entire length of hinge shaft.
- Pressurized cleaning fluid exits in a trajectory that strikes the inclined panel and hinge reflector (56).
- Pressurized cleaning fluid also strikes backside of the next inclined panel, such that the panel reflector (58)is cleaned.
- Cleaning may be scheduled to occur automatically, or may be performed manually, upon demand.

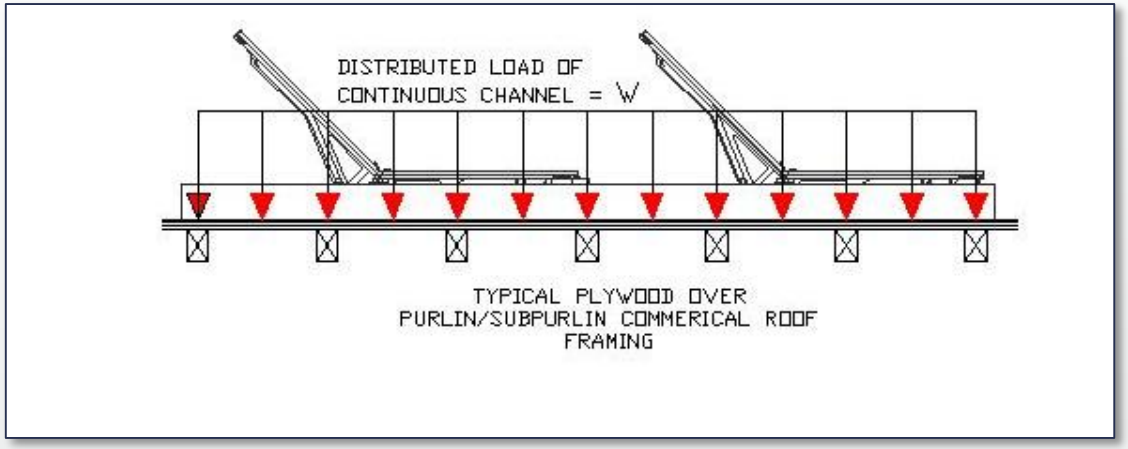




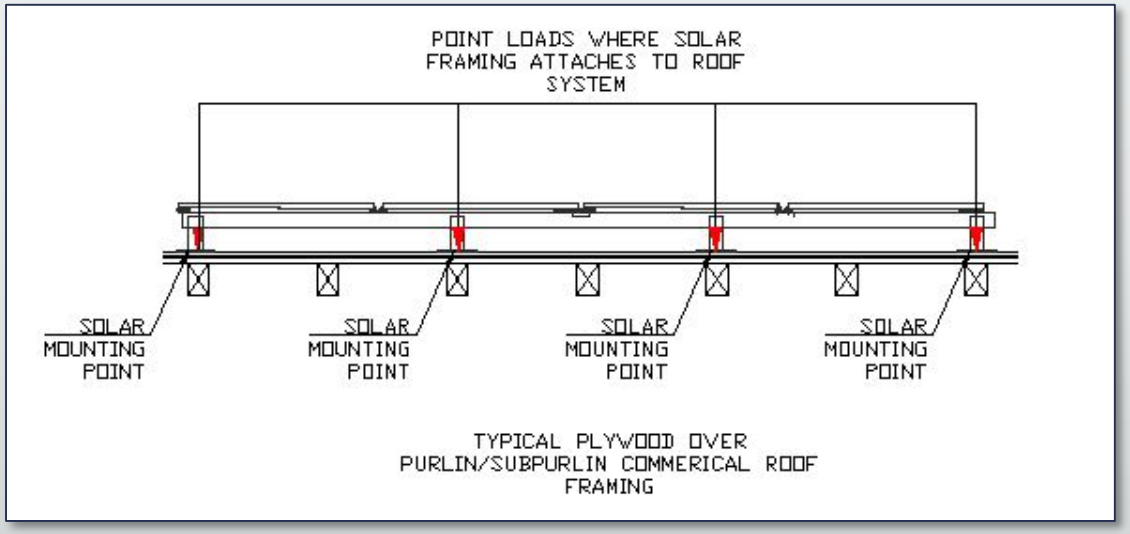
Load distribution advantages

- Tracker channel provides more distributed loading versus typical flush mount installation
- Improves adherence to building load limit codes (ASCE 7)

Tracker channel mounting

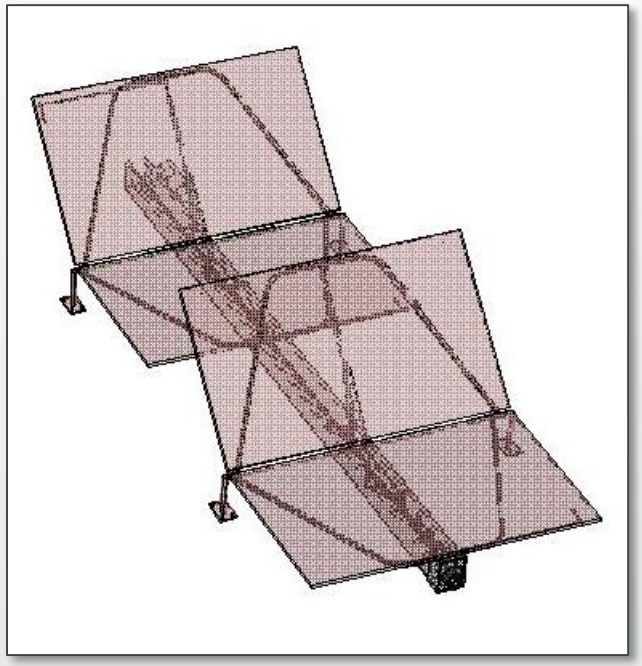


Typical flush mount

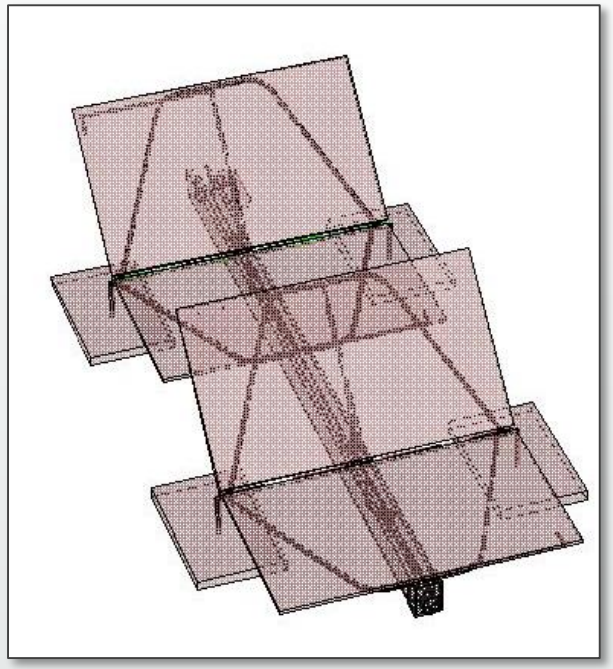


Roof mounting options

- Supports penetrating attachment requirements
- Supports ballast mounting for non-penetrating installation requirements
- Also supports a hybrid approach with a minimal number of roof penetrations and some level of ballasting



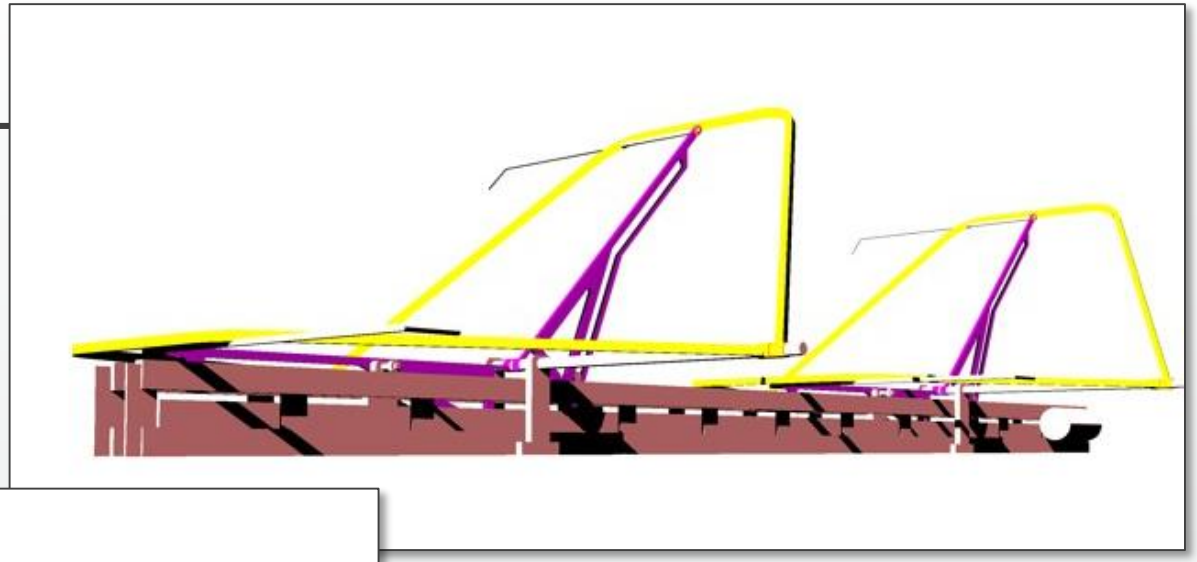
Penetrating attachment

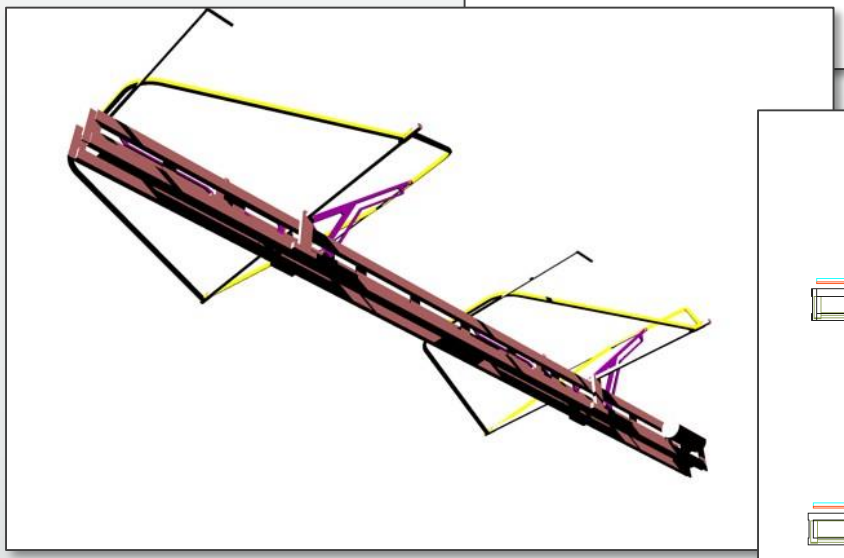


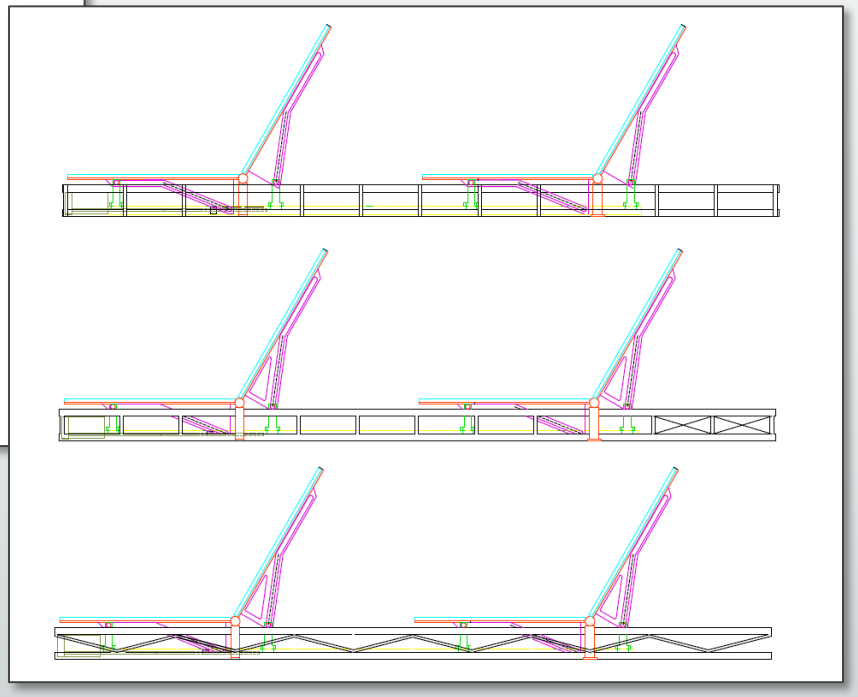
Ballast mounting (non-penetrating)

Weight reduction development

- Opportunities for weight reduction are available
- Current one-piece channel can be replaced with a lighter weight multiple member structure and supporting lattice
- Material options include:
  - Aluminum
  - Carbon fiber
  - Molded composites
- U.S. continuation patent is pursuing claims in this area







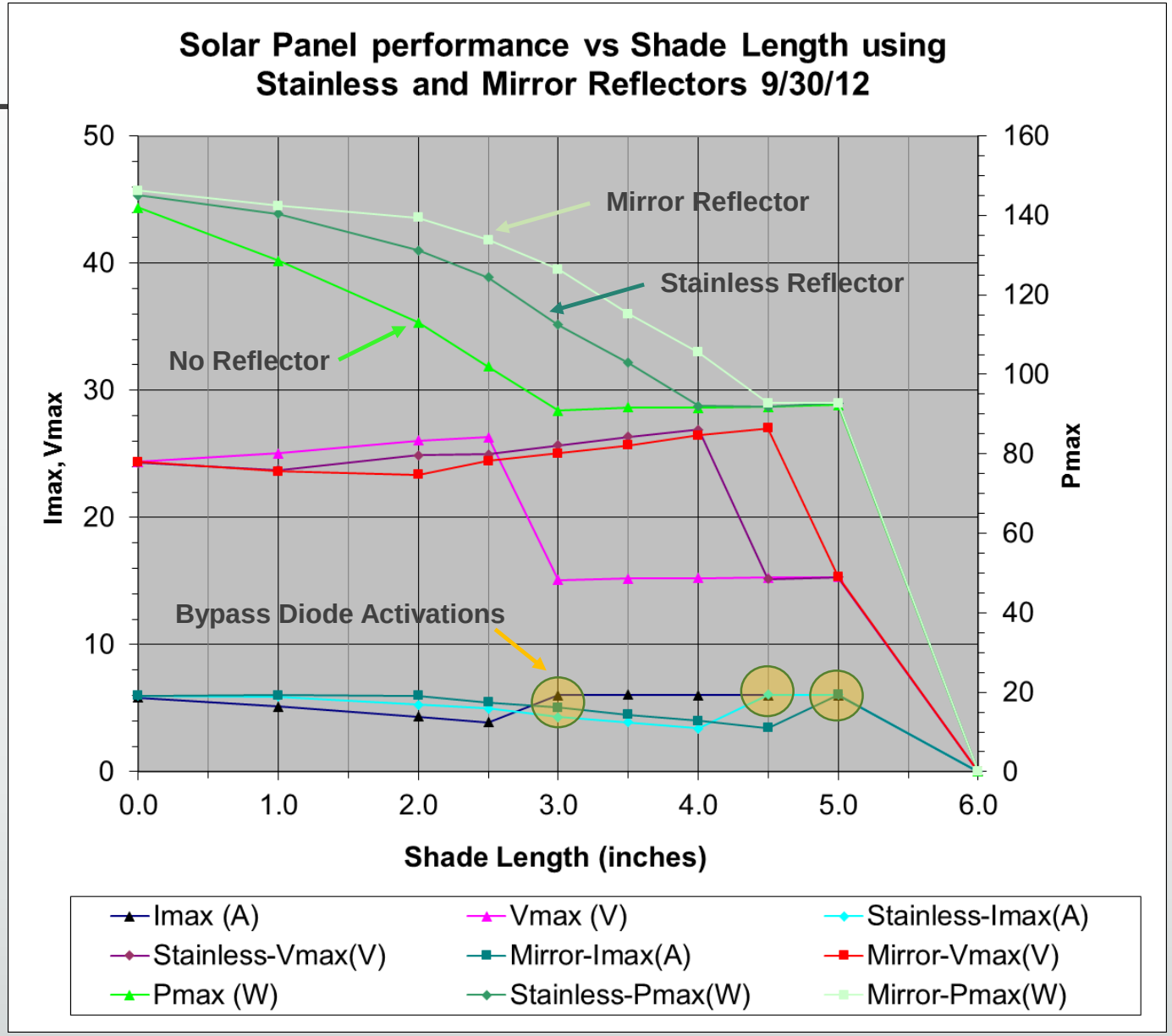
Shade mitigation testing

- Reflectors delay Bypass Diode activation

Reflector Type	Shade length at Bypass Diode activation
None	3 inches
Stainless	4.5 inches
Mirror	5 inches

- Reflectors reduce power loss

Reflector Type	Power at 3” shading (Watts)	Power loss (%)	Gain above no reflector (%)
None	90.87	36.0	N/A
Stainless	112.5	20.7	23.8
Mirror	126.4	10.9	39.0

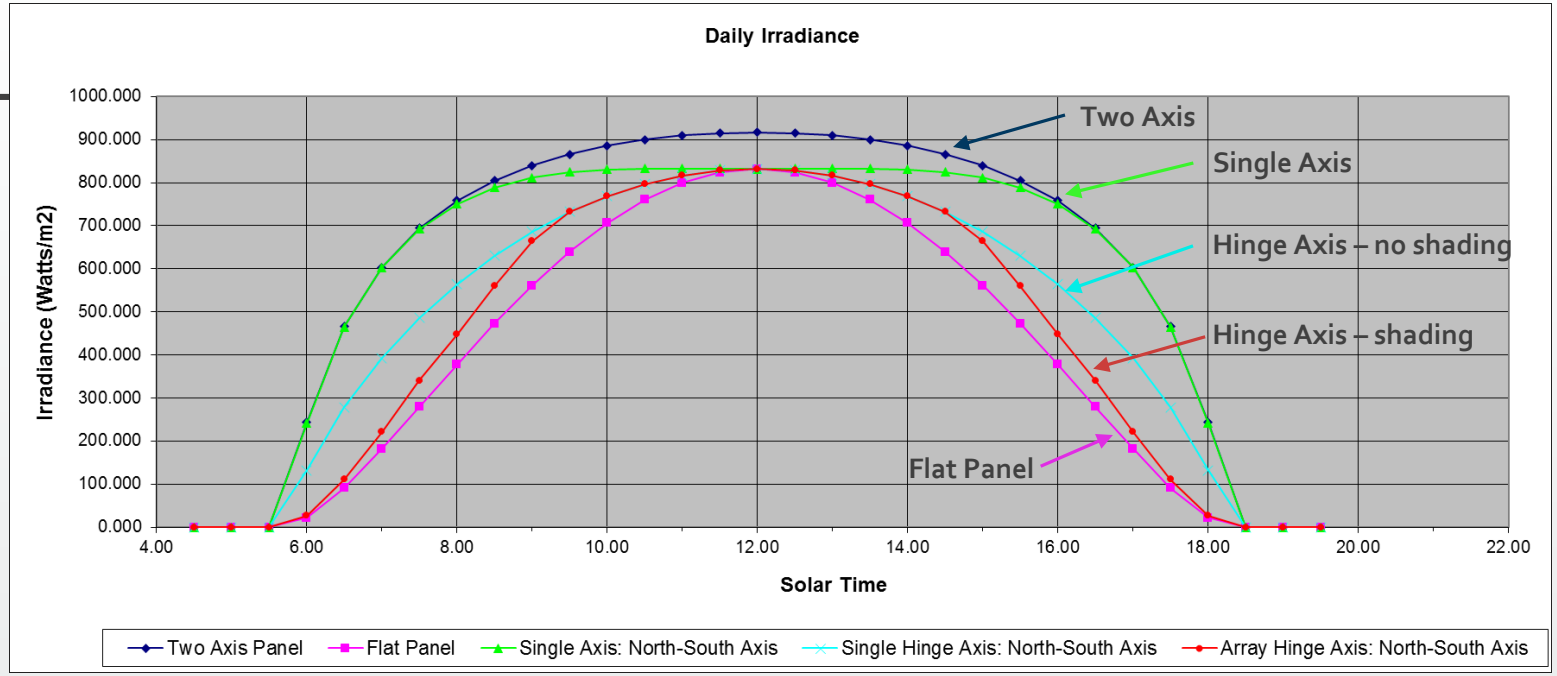


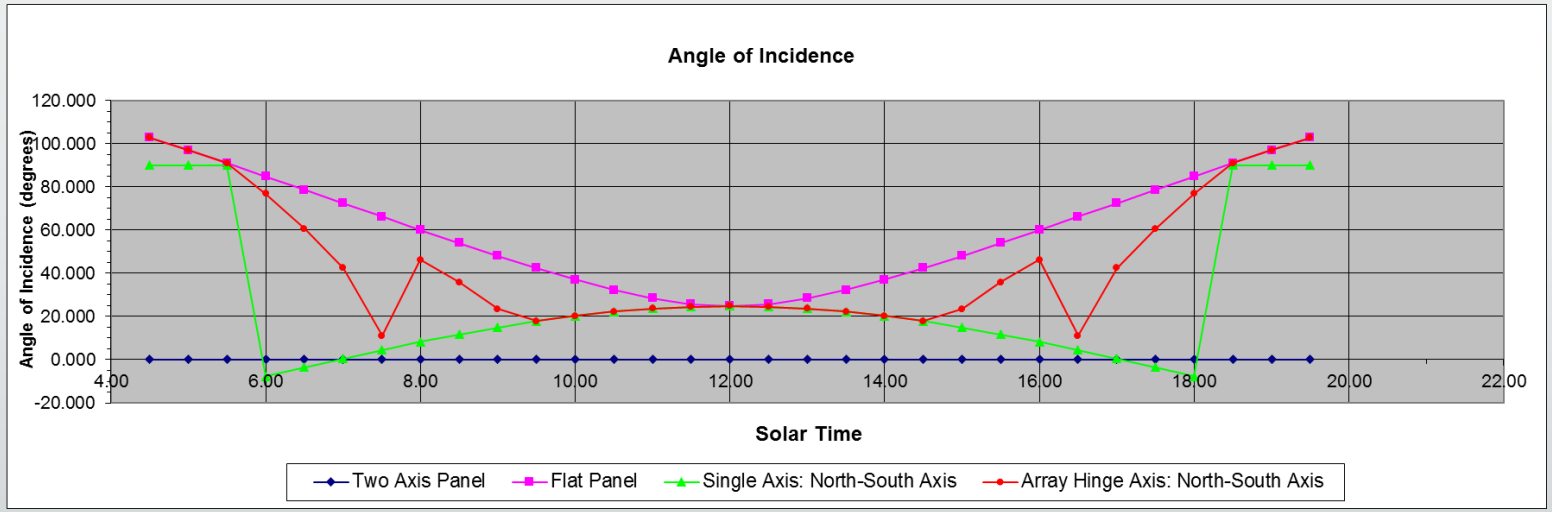
Performance Modeling

- Extensive modeling application developed
  - Excel spreadsheet with custom VBA code
  - Exoatmospheric Radiation
  - Air Mass attenuated Direct Radiation
  - Earth Declination Angle
  - Sun Zenith\Azimuth angles
  - Day of year, Latitude\Longitude
  - Solar Panel geometry, Hinge Axis geometry
  - Shade mitigation with reflectors and back tracking algorithm

Hinge Axis-shading Performance Range

Flat Panel < Hinge Axis <= ½*Single Axis Tracker

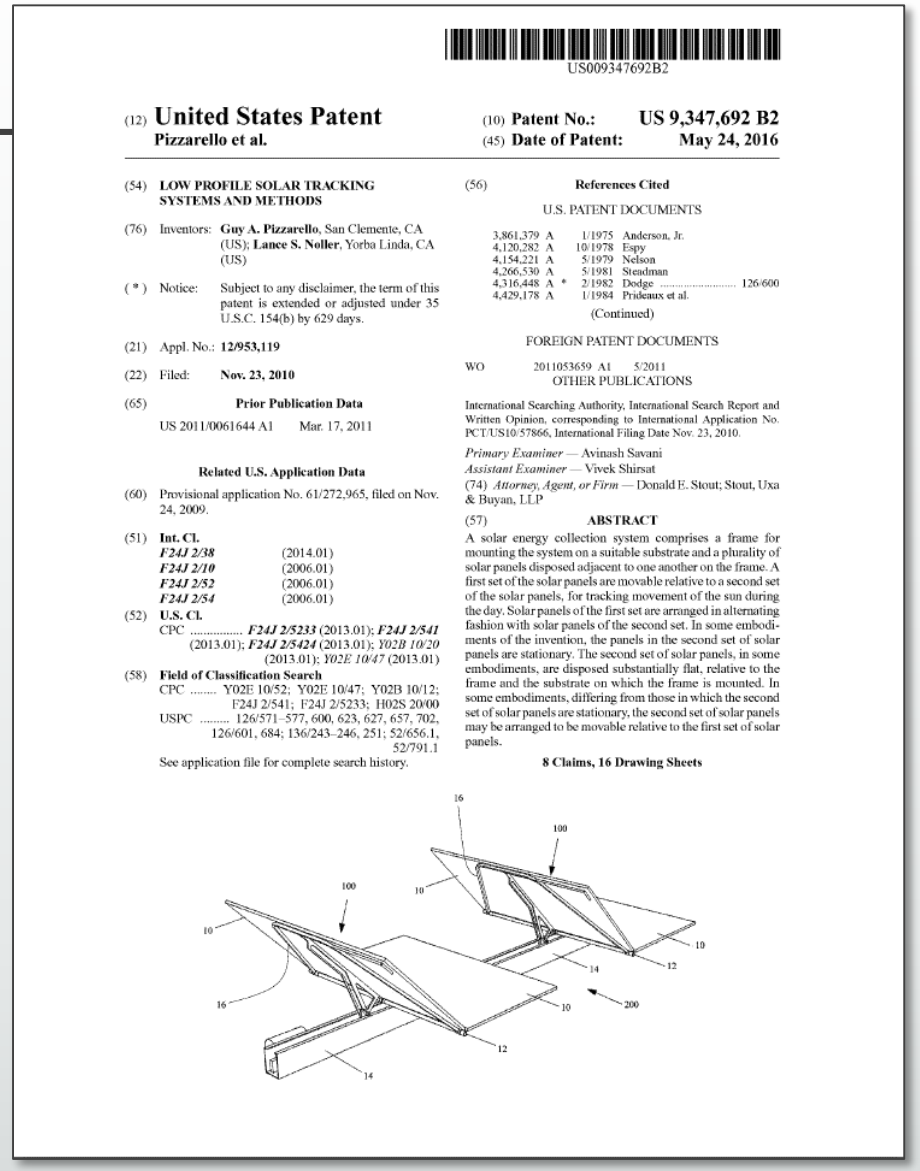




Hinge Axis Simulation: Day of year = 240 (8/27), Adjacent panel gap = 12”, BP321B panel 65.6”x39.4”, 6 rows

Intellectual Property Status

- US Patent 9,347,692
  - Filed Nov. 23, 2010. Granted May 24, 2016.
  - 20 year term from filing + term extension of 629 days
  - Remains in force thru Aug 13, 2032
- US Patent 9,729,102 (continuation)
  - Filed May 10, 2016. Granted August 8, 2017.
  - Remains in force thru November 23, 2030
- EPO patent pending, #10833876.5
  - Filed June 2012 based on International (PCT) application filed in November 2010.
  - Search Report completed 2015. Response to search report filed 2016.
  - First substantive office action expected later in 2017
  - Expected granting in 2018
- India patent pending, #4745/CHENP/2012A
  - Filed June 2012 based on International (PCT) application filed in November 2010.
  - Application review underway. First office action expected in 2017.
  - Expected granting in 2018-2019



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Primary Examiner — Avinash Savani
Assistant Examiner — Vivek Shirsat
(74) *Attorney, Agent, or Firm* — Donald E. Stout; Stout, Uxa & Buyan, LLP

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8 Claims, 16 Drawing Sheets

Forward citations to US patent 9,347,692

Citing Patent	Filing date	Publication date	Applicant	Title
US9166525	Nov 14, 2011	Oct 20, 2015	Soltec Energias Renov Ables, S.L.	Solar tracker
US9236514	Oct 21, 2013	Jan 12, 2016	ViaSol Energy Solutions	Solar panel riser assembly and weight balanced solar panel array using same
US9281777	Nov 15, 2012	Mar 8, 2016	Charles B. Borgstrom	Solar panel support apparatus
US9496822	Sep 18, 2013	Nov 15, 2016	Lockheed Martin Corporation	Hurricane proof solar tracker
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US20150013750 *	May 12, 2014	Jan 15, 2015	Mobile Grid, Llc	Mobile Solar Power Rack
EP3088817A1 *	Apr 30, 2015	Nov 2, 2016	Novosol GmbH & Co. KG	Modular solar collector
WO2013021078A1	May 4, 2012	Feb 14, 2013	Soltec Energias Renovables, Sl	Solar tracker
WO2015122891A1 *	Feb 12, 2014	Aug 20, 2015	Goren Andy	Retractable intelligent reflector system
WO2016174272A1 *	May 2, 2016	Nov 3, 2016	Novosol Gmbh & Co. Kg	Modular solar collector

- Cited by examiner

https://www.google.com/patents/US20110061644?dq=patent:9347692#forward-citations

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