US010003298B2

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

(10) **Patent No.: US 10,003,298 B2**
(45) **Date of Patent: Jun. 19, 2018**

(54) **SOLAR COLLECTOR CABLE SUPPORT TRAY AND SUPPORT SYSTEM**

(71) Applicant: **SunPower Corporation**, San Jose, CA (US)

(72) Inventors: **Tyler Grushkowitz**, Hayward, CA (US); **Brian Wares**, Berkeley, CA (US); **Vicent Ripoll Agullo**, Oakland, CA (US); **Shannon Mark Bachart**, Orangevale, CA (US); **Matthew Scott Lambert**, Oakland, CA (US)

(73) Assignee: **SUNPOWER CORPORATION**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days. days.

(21) Appl. No.: **15/057,942**

(22) Filed: **Mar. 1, 2016**

(65) **Prior Publication Data**

US 2016/0261232 A1 Sep. 8, 2016

Related U.S. Application Data

(60) Provisional application No. 62/127,256, filed on Mar. 2, 2015.

(51) **Int. Cl.**
H02S 20/32 (2014.01)
H02S 40/34 (2014.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H02S 40/34*** (2014.12); ***F16L 3/23*** (2013.01); ***F16L 3/26*** (2013.01); ***F16M 11/18*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC .. H02S 40/34; H02S 20/10; F16L 3/26; F16L 3/23; F16M 11/18; F16M 13/02;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,787,016 A * 1/1974 Laval, Jr. F16L 3/23 211/193
5,125,608 A 6/1992 McMaster
(Continued)

FOREIGN PATENT DOCUMENTS

BE 2400198 A1 * 12/2011 ..... F16L 3/26
CH 2262069 A2 * 12/2010 ..... F16L 3/23
(Continued)

OTHER PUBLICATIONS

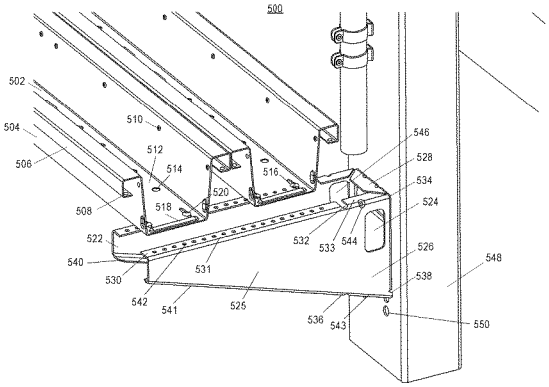
International Search Report and Written Opinion issued in PCT/US2016/020268 dated Jun. 15, 2016.
(Continued)

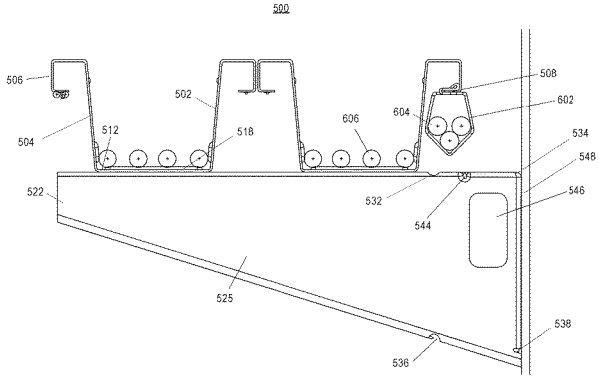
Primary Examiner — Kimberly T Wood
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A cable tray and support system facilitates cable management in a solar energy collector system at reduced cost relative to previous cable tray and support systems. The cable tray and support system comprises cables trays, mounting brackets, and vertically-oriented piles. The mounting brackets are coupled to the cables trays and vertically-oriented piles. The mounting brackets include one or more stress relief features (e.g., notches) to allow the mounting bracket to provide cantilevered deflection in response to thermal expansion or contraction-of the cable tray. The cable tray and support system also provides a ground path from a cable tray, to the mounting bracket, to the pile, and then to the ground to dissipate transient voltages in the solar energy collection system.

19 Claims, 10 Drawing Sheets





(51) **Int. Cl.**

H02S 20/10	(2014.01)
F16L 3/23	(2006.01)
F16L 3/26	(2006.01)
F16M 11/18	(2006.01)
F16M 13/02	(2006.01)
F24J 2/52	(2006.01)
H02G 3/04	(2006.01)
H02G 3/00	(2006.01)
F24J 2/54	(2006.01)
F16B 1/00	(2006.01)
H02G 3/06	(2006.01)

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

CPC ***F16M 13/02*** (2013.01); ***F24J 2/52*** (2013.01); ***F24J 2/5241*** (2013.01); ***F24J 2/541*** (2013.01); ***F24S 25/00*** (2018.05); ***F24S 25/50*** (2018.05); ***H02G 3/04*** (2013.01); ***H02G 3/0437*** (2013.01); ***H02G 3/263*** (2013.01); ***H02S 20/10*** (2014.12); ***H02S 20/32*** (2014.12); *F16B 2001/0064* (2013.01); *F24J 2/523* (2013.01); *F24J 2002/5468* (2013.01); *H02G 3/0608* (2013.01); *Y02E 10/47* (2013.01)

(58) **Field of Classification Search**

CPC .. F24J 2/52; F24J 2/5241; H02G 3/04; H02G 3/0437; H02G 3/0608; F16B 2001/0064

USPC 248/68.1, 65, 70, 49; 211/60.1, 70.4, 211/186, 189, 193, 194, 86.01

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,318,264	A *	6/1994	Meiste	A47B 57/56 108/108
6,082,690	A *	7/2000	Durin	H02G 3/263 211/90.01
7,140,500	B2 *	11/2006	McCoy	H02G 3/30 211/60.1
7,497,533	B2 *	3/2009	Remmers	A47B 57/42 108/108
7,770,344	B2 *	8/2010	Betz	H02G 3/0443 52/126.6
7,797,889	B2	9/2010	McClintock	
8,540,090	B2 *	9/2013	Caveney	H02G 3/0443 211/119
8,684,319	B2 *	4/2014	Brouwer	H02G 3/0443 248/235
9,166,390	B2 *	10/2015	Dean	F16L 3/26
2002/0130099	A1 *	9/2002	Rene	B65D 90/0053 211/189
2004/0104322	A1 *	6/2004	Hennequin	H02G 3/263 248/241
2006/0091088	A1 *	5/2006	McCoy	H02G 3/30 211/60.1
2010/0282943	A1	11/2010	Boyk	
2011/0155120	A1	6/2011	Barsun	
2012/0152868	A1 *	6/2012	Li	G06F 1/183 211/26.2
2012/0216851	A1	8/2012	Jang	
2013/0139375	A1 *	6/2013	Rego	F16L 3/23 29/525.11
2014/0053825	A1	2/2014	Zhou	
2014/0182577	A1	7/2014	Linderman	
2014/0366464	A1	12/2014	Rodrigues	
2015/0323102	A1 *	11/2015	Juillet	B66C 1/16 248/59
2016/0195303	A1 *	7/2016	Lambert	F24J 2/5232 126/605

FOREIGN PATENT DOCUMENTS

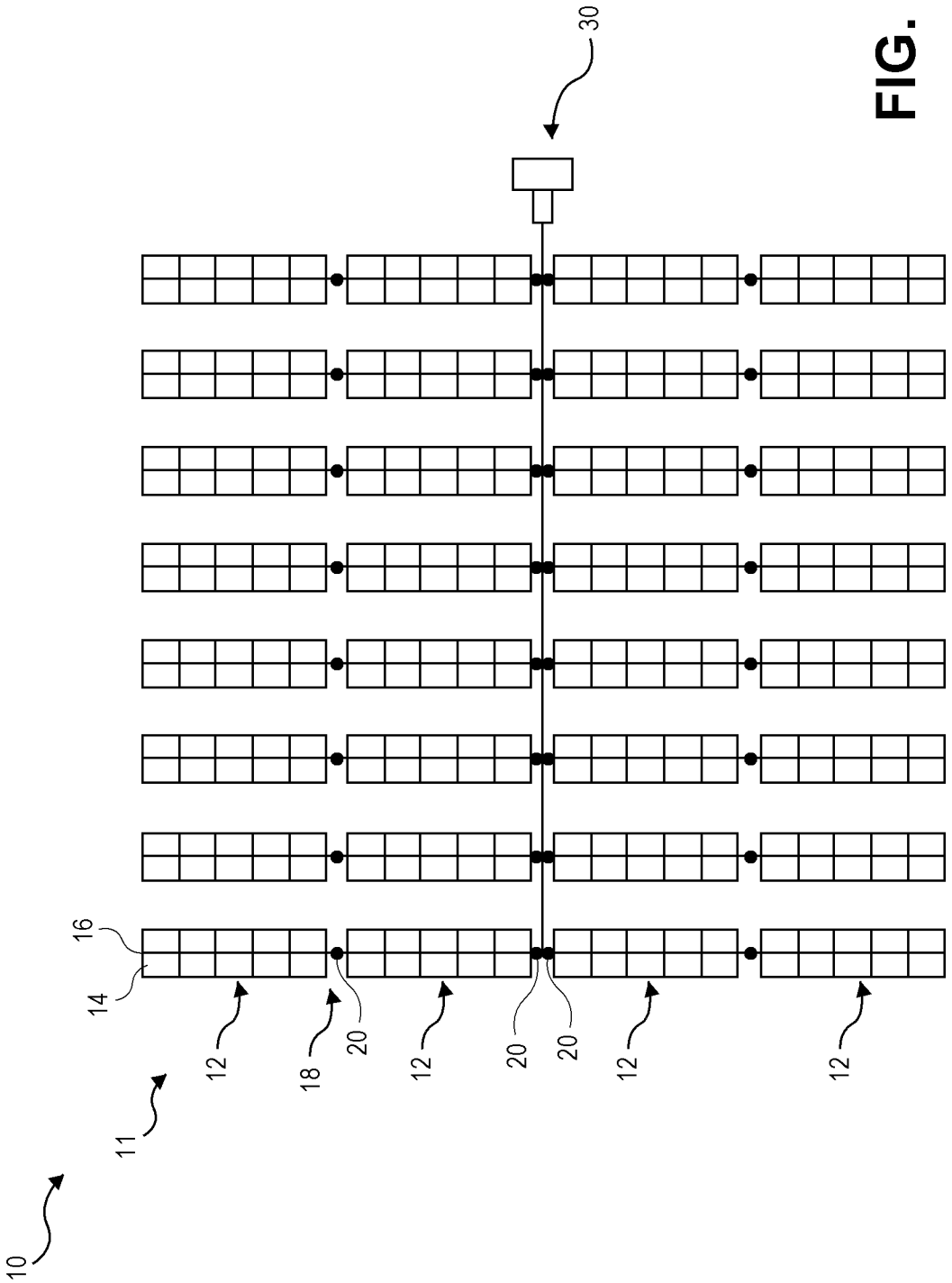
CH	202016104509 U1 *	8/2016	F16M 13/02
DE	3936003 A1 *	5/1990	H02G 3/0412
IT	1475559 A2 *	11/2004	H02G 3/263
JP	2014-011407	1/2014	
WO	WO 2005-119133	12/2005	

OTHER PUBLICATIONS

Search Report and Written Opinion issued in PCT/US2015/066392, dated Mar. 29, 2016.

* cited by examiner

FIG. 1



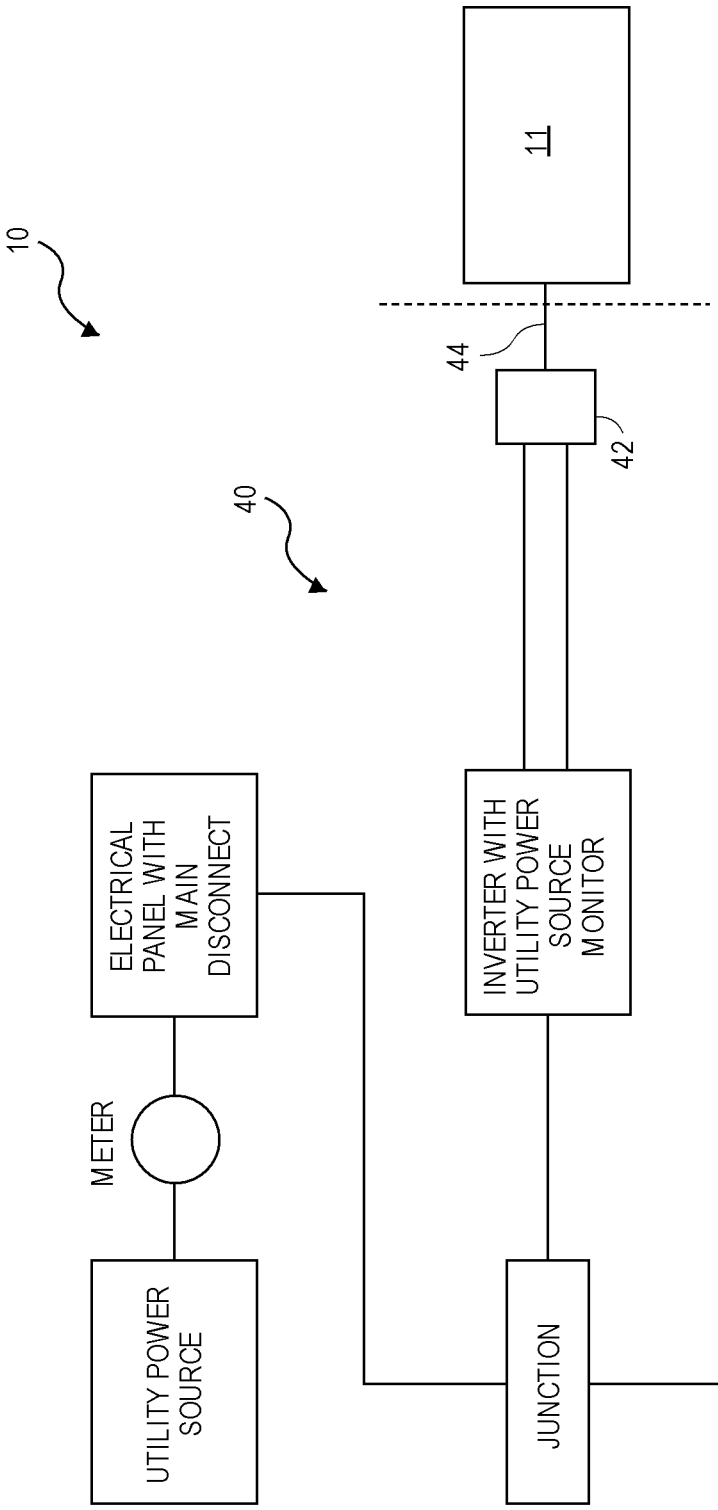

10
11
44
42
40
ELECTRICAL PANEL WITH MAIN DISCONNECT
INVERTER WITH UTILITY POWER SOURCE MONITOR
METER
UTILITY POWER SOURCE
JUNCTION
ELECTRICAL LOAD

FIG. 2

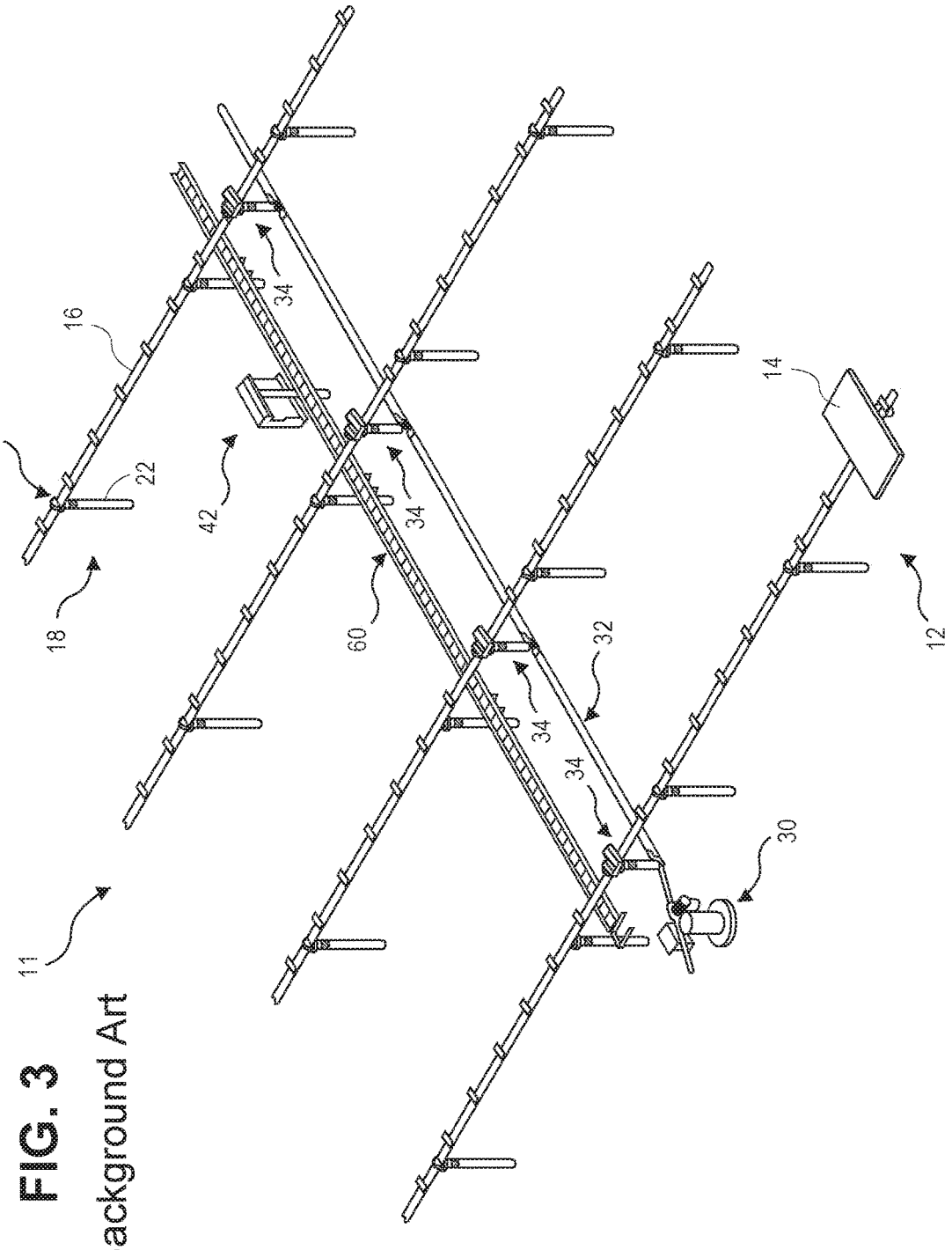


FIG. 3
Background Art

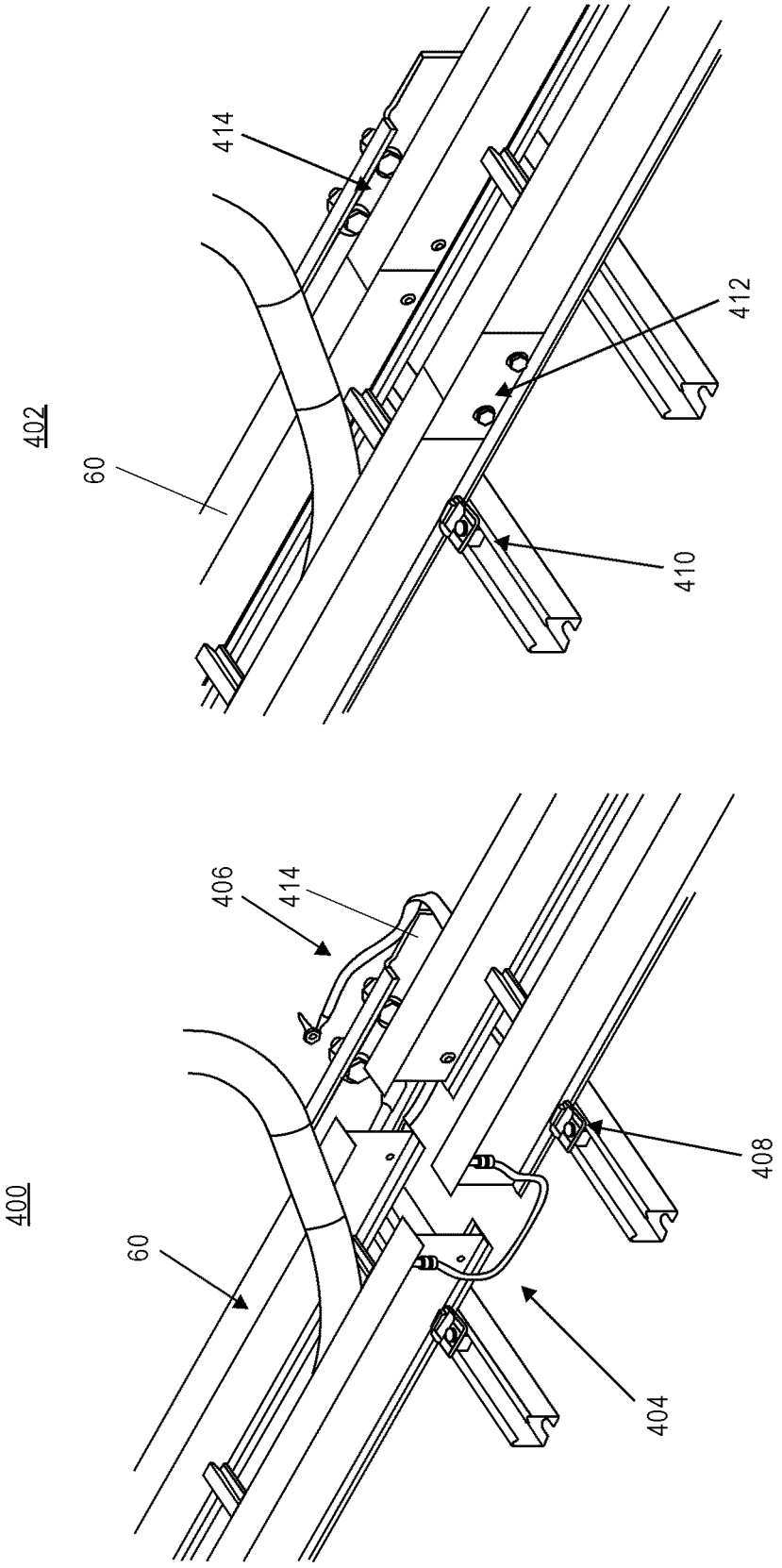


FIG. 4
(PRIOR ART)

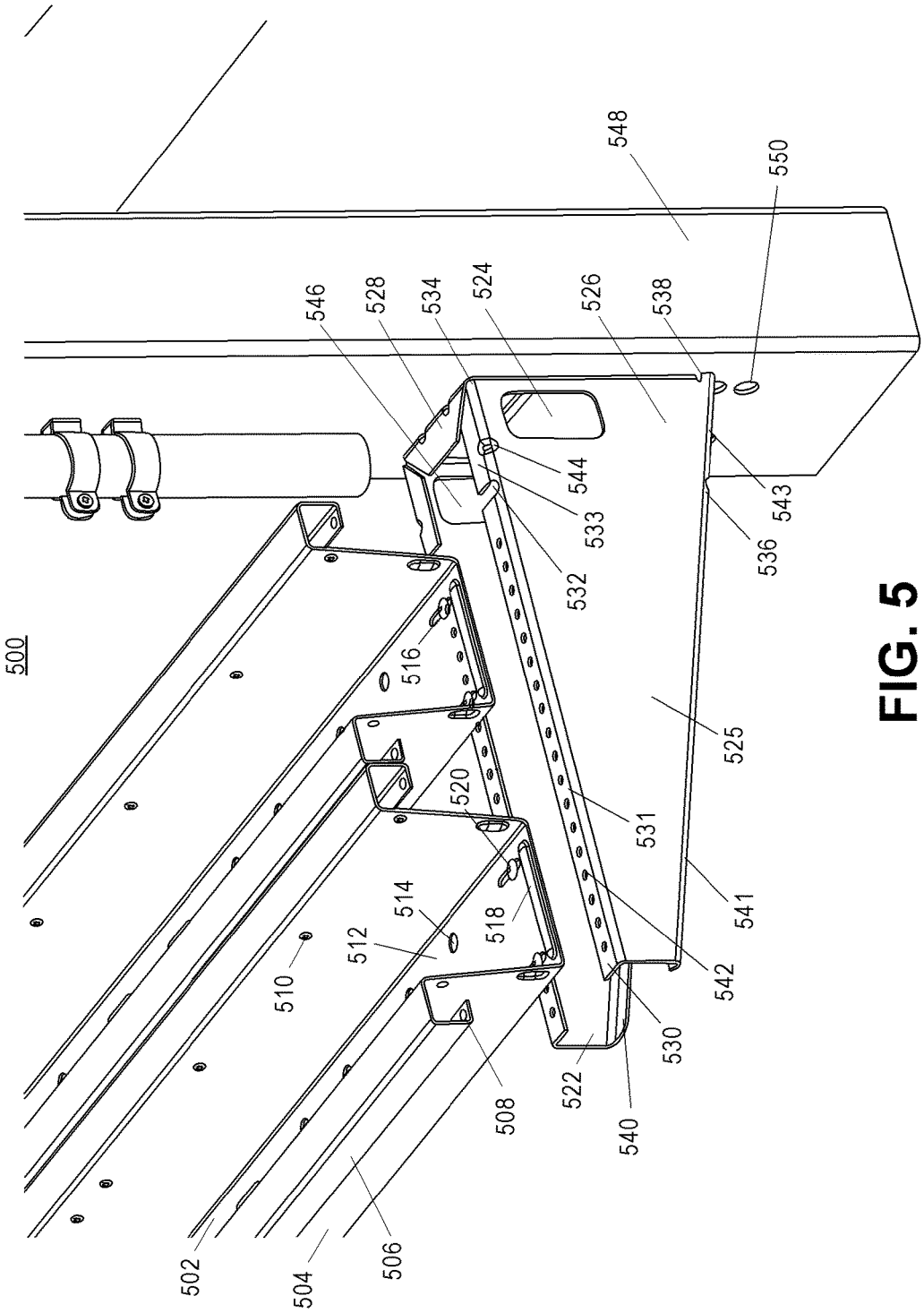

548
550
546
528
534
524
526
538
544
533
532
543
536
500
516
525
520
531
541
514
518
512
510
542
530
522
540
508
502
504
506

FIG. 5

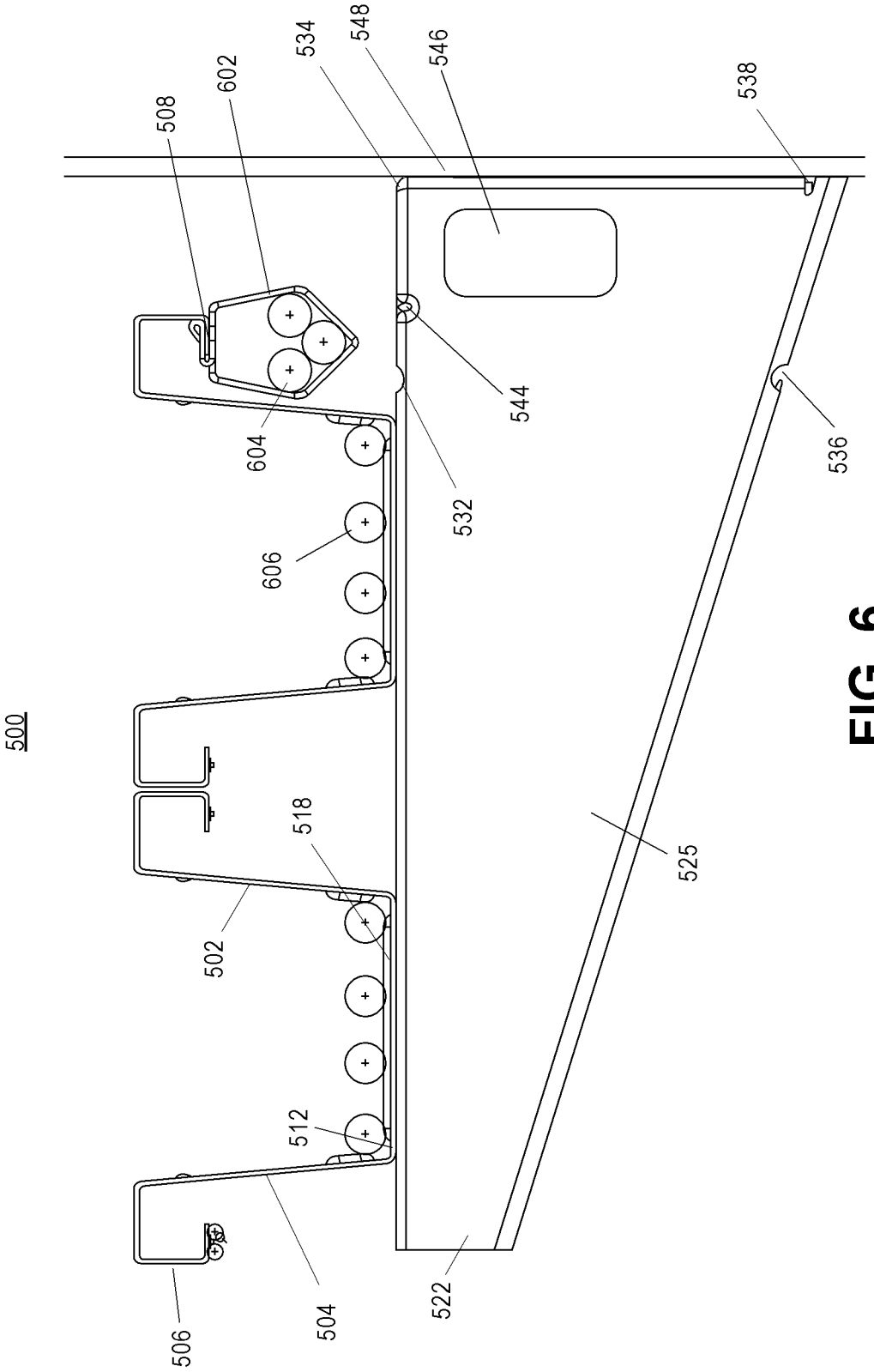

500
502
504
506
508
512
518
522
525
532
534
536
538
544
546
548
602
604
606

FIG. 6

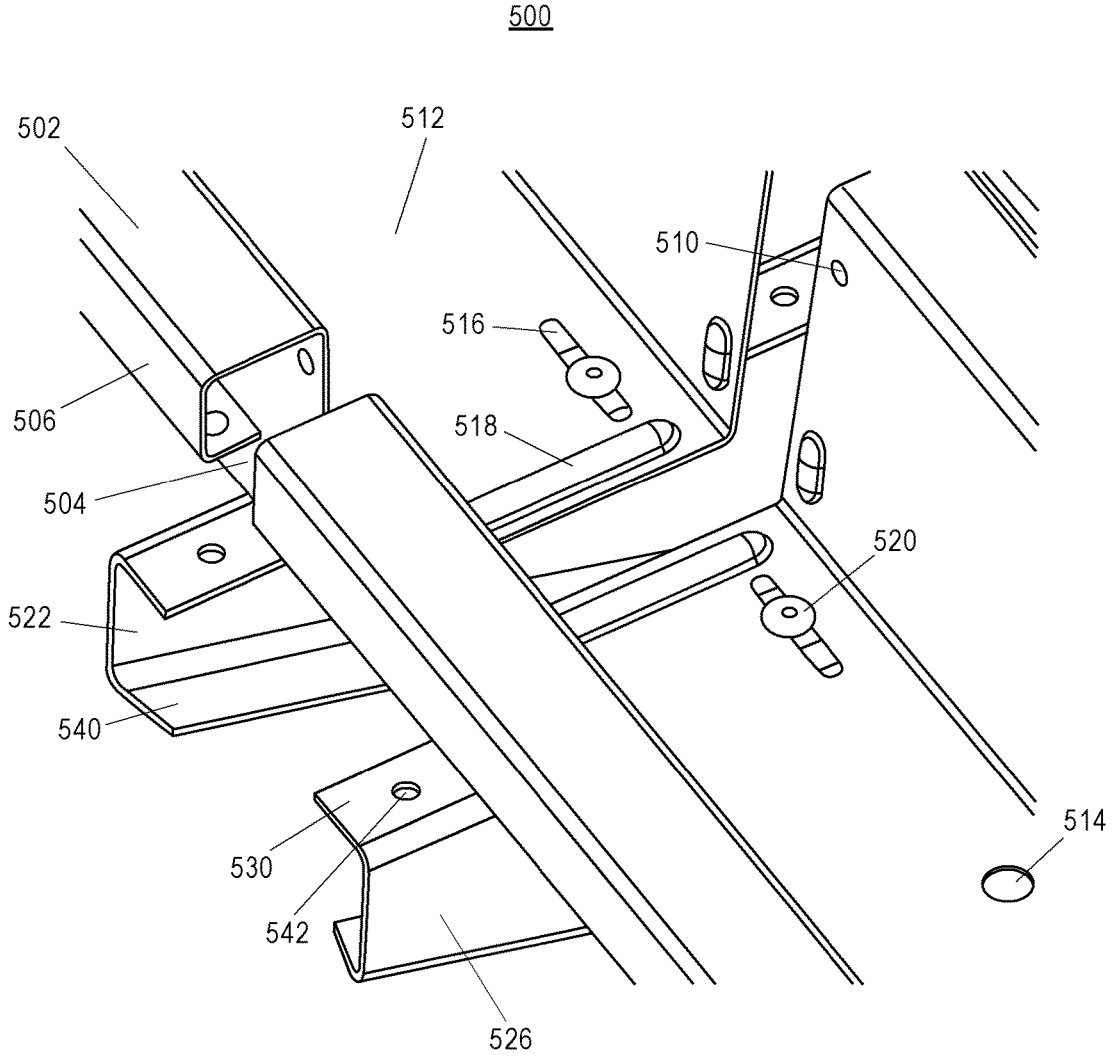


FIG. 7

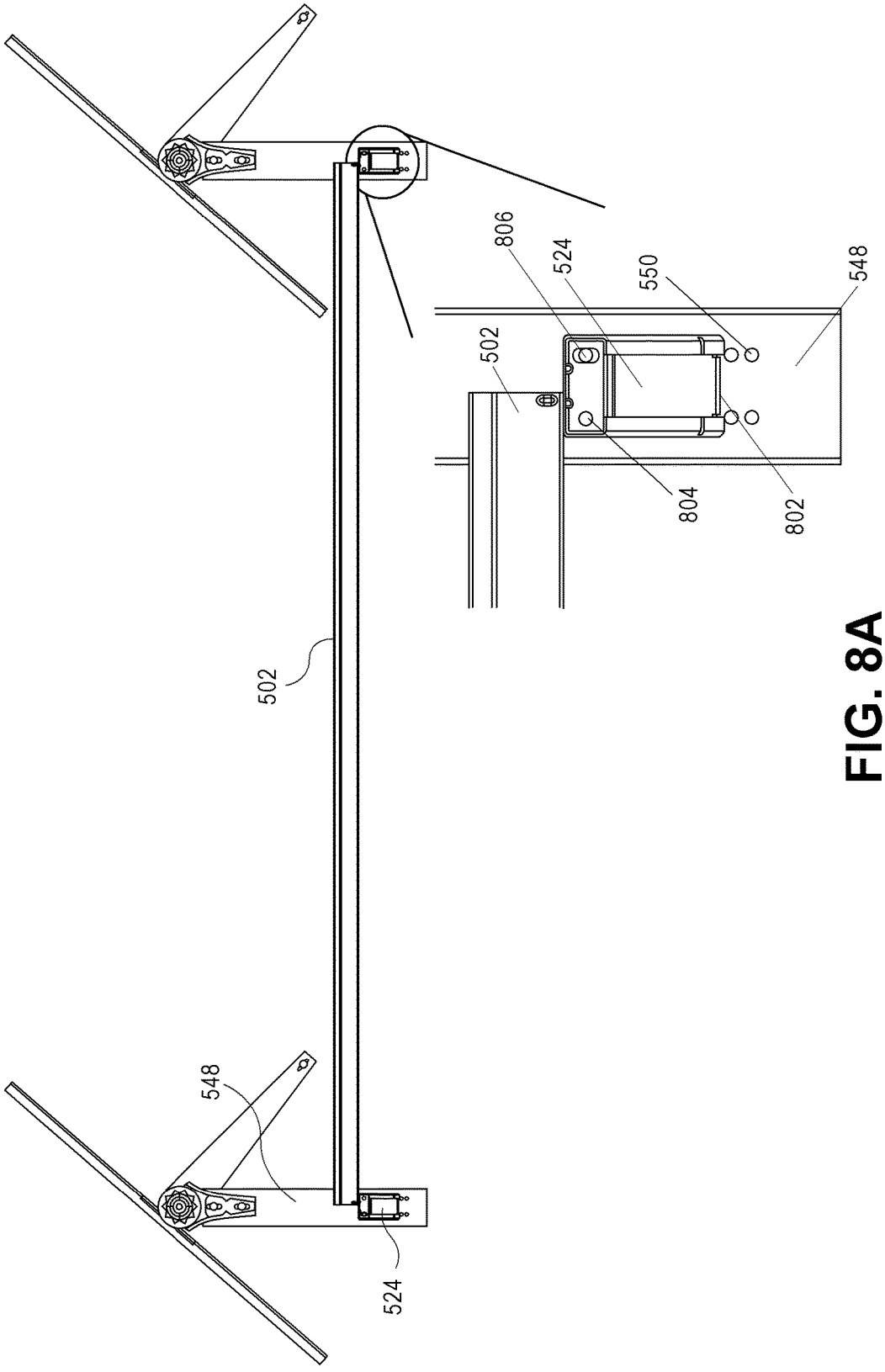


FIG. 8A

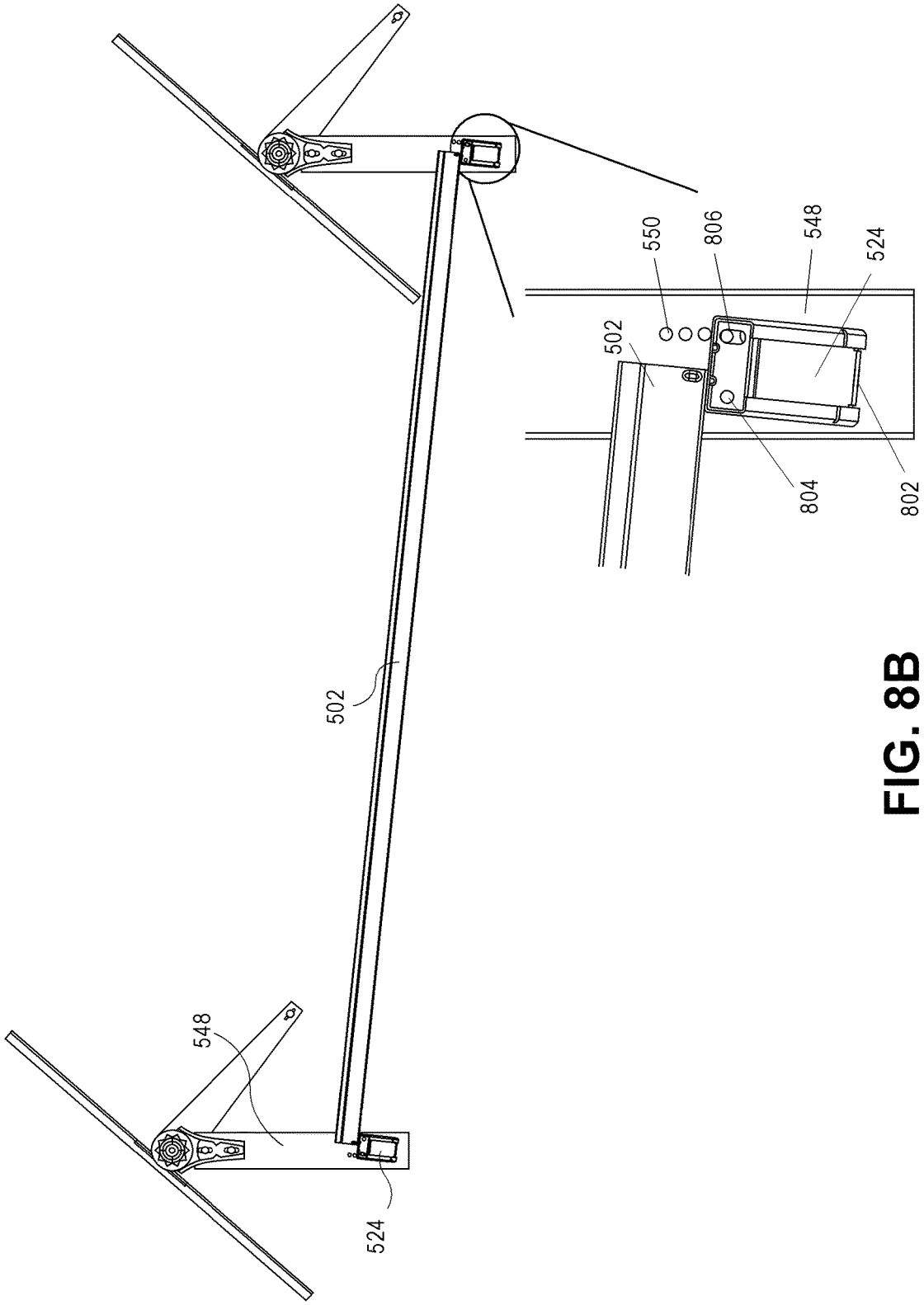
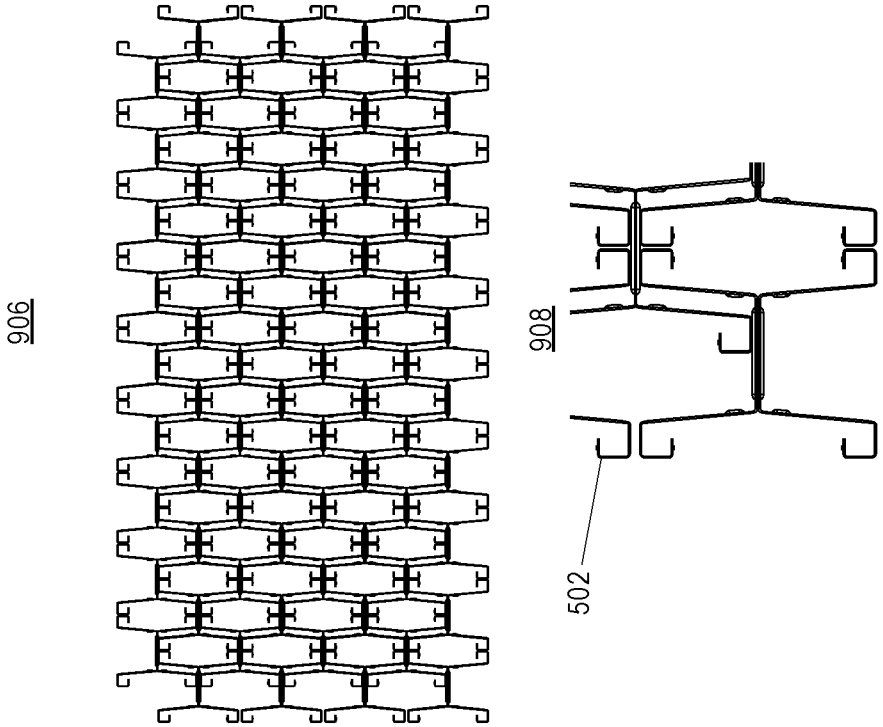


FIG. 8B



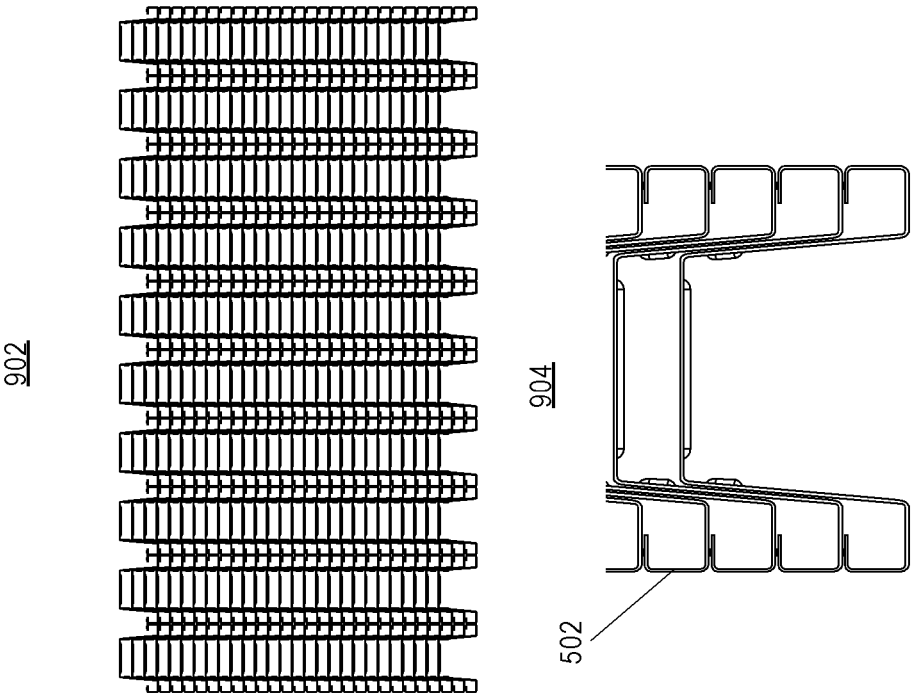


FIG. 9

SOLAR COLLECTOR CABLE SUPPORT TRAY AND SUPPORT SYSTEM

BACKGROUND

Larger solar collector installations usually include an array of solar collector devices. Such systems can be used in conjunction with photovoltaic modules, thermal solar collector devices as well as concentrators for concentrating solar energy onto photovoltaic devices or thermal solar collection devices.

Some of these solar collector installations include hardware for automatically adjusting the position of the collector devices to track the sun as it moves across the sky. This tracking movement can be accomplished in a number of different ways. Some systems use a single axis tracking system in which the collector devices pivot about a single axis. Such single axis type tracking systems often include a drive shaft or "torque tube" which defines a single pivot axis.

Further, in some of these systems, the torque tube can be used to both support the solar collector devices and transmit the torque used for adjusting the position of the solar collecting devices. In order to reduce friction which would resist the pivoting movement of the torque tube, some systems include bearings for supporting the torque tube above the ground and so as to be pivotable about the pivot axis. Such systems also include numerous cables to transfer electrical energy from the solar collectors to the utility grid and to transfer signaling instructions across the sun-tracking solar energy system.

BRIEF DESCRIPTION OF THE DRAWINGS

The figures described below depict various aspects of the systems disclosed herein. It should be understood that each figure depicts an embodiment of a particular aspect of the disclosed systems, and that each of the figures is intended to accord with a possible embodiment thereof. Further, wherever possible, the following description refers to the reference numerals included in the following figures, in which features depicted in multiple figures are designated with consistent reference numerals.

FIG. **1** is a schematic top plan view of a solar collector system;

FIG. **2** is a schematic diagram of the system illustrated in FIG. **1** illustrating optional electrical connections of the collector system with various electrical components;

FIG. **3** is a perspective view of the solar collection system of FIG. **1**, and illustrating a tracking drive system, a plurality of piles mounted to the ground and supporting a plurality of torque tubes with a plurality of bearing assemblies, and a prior art cable support tray;

FIG. **4** includes enlarged perspective views of the prior art cable support tray of FIG. **3**;

FIG. **5** is a perspective view of a cable support tray and mounting bracket in accordance with the presently described embodiments;

FIG. **6** is a cross-sectional view of a cable support tray and mounting bracket in accordance with the presently disclosed embodiments;

FIG. **7** is a perspective view of two cable support trays and mounting bracket in accordance with the presently disclosed embodiments;

FIGS. **8**A-**8**B are side views of a cable support tray and mounting bracket on flat and sloped terrain in accordance with the presently disclosed embodiments;

FIG. **9** is a side view of cable support trays arranged in shipping configurations in accordance with the presently disclosed embodiments.

SUMMARY

An aspect of at least one of the embodiments disclosed herein includes the realization that at least one component of certain types of larger solar energy systems can be simplified so as to reduce component costs. For example, some types of larger solar energy systems, for example, which include a plurality of interconnected sun tracking, solar energy collection modules, includes a cable support tray and support system therefor. One typical cable support tray is made from a ladder-like tray. An aspect of the some of the embodiments disclosed herein includes the realization that a simplified and less costly cable support tray can be made from rolled sheet material, such as galvanized sheet steel. Additionally, thermal expansion of such trays can be accommodated with a less costly, simplified design, for example, providing for cantilevered deflection in response to thermal expansion.

In an embodiment, a cable management system comprises a vertically-oriented pile; a mounting bracket comprising: a central member coupled to the vertically-oriented pile by one or more fasteners and having a top end and a bottom end, the central member comprising a top flange extending outwardly from the central member at the top end in a first direction, a first arm extending from the central member in the first direction, the first arm comprising: a first arm wall having a top edge and a bottom edge extending longitudinally in the first direction from the central member, a top flange extending from the first arm wall at the top edge in a second direction toward the central member, the top flange comprising: a first section having a plurality of ports, and a second section coplanar with the first section and defining a first top flange space disposed between the first section and the second section, wherein the top flange of the first arm and the top flange of the central member define a first corner space therebetween; and a first cable tray comprising: a base including an aperture coupled to a first port of the plurality of ports of the top flange of the first arm by a fastener, a first side wall extending vertically from the base, and a second side wall extending vertically from the base; wherein the mounting bracket receives stress applied from the first cable tray to the first arm by: the first section of the top flange of the first arm deflecting at the first top flange space relative to the second section of the top flange of the first arm, the first arm deflecting at the first corner space relative to the corner.

In another embodiment, a cable management system comprises a vertically-oriented pile; a mounting bracket comprising: a central member coupled to the vertically-oriented pile by one or more fasteners and having a top end and a bottom end, the central member comprising: a top flange extending outwardly from the central member at the top end in a first direction, and a bottom flange extending outwardly from the central member at the bottom end in the first direction, and a first arm extending from the central member in the first direction, the first arm comprising: a first arm wall having a top edge and a bottom edge extending longitudinally in the first direction from the central member, the first arm wall including a first notch proximal to the bottom edge and the central member, a top flange extending from the first arm wall at the top edge in a second direction toward the central member, the top flange comprising: a first section having a plurality of ports, and a second section

coplanar with the first section and defining a first top flange space disposed between the first section and the second section, a bottom flange extending from the first arm wall at the bottom end in the second direction toward the central member, the bottom flange comprising: a first section, and a second section coplanar with the first section and defining a first bottom flange space disposed between the first section and the second section, wherein the top flange of the first arm and the top flange of the central member define a first corner space therebetween; and a first cable tray comprising: a base including an aperture coupled to a first port of the plurality of ports of the top flange of the first arm by a fastener, a first side wall extending vertically from the base, and a second side wall extending vertically from the base; wherein the mounting bracket receives stress applied from the first cable tray to the first arm by: the first section of the top flange of the first arm deflecting at the first top flange space relative to the second section of the top flange of the first arm, the first section of the bottom flange of the first arm deflecting at the first bottom flange space relative to the second section of the bottom flange of the first arm, and the first arm deflecting at the first corner space and the first notch relative to the central member.

In still another embodiment, a cable management system comprises a vertically-oriented pile; a mounting bracket comprising: a central member coupled to the vertically-oriented pile by one or more fasteners and having a top end and a bottom end, the central member comprising: a top flange extending outwardly from the central member at the top end in a first direction, and a first arm extending from the central member in the first direction, the first arm comprising: a first arm wall having a top edge and a bottom edge extending longitudinally in the first direction from the central member, a top flange extending from the first arm wall at the top edge in a second direction toward the central member, the top flange comprising: a first section having a plurality of ports, and a second section coplanar with the first section and defining a space disposed between the first section and the second section, wherein the top flange of the first arm and the top flange of the central member define a first corner space therebetween, and a second arm extending from the central member in the first direction, the second arm comprising: a second arm wall having a top edge and a bottom edge extending longitudinally in the first direction from the central member, a top flange extending from the second arm wall at the top edge in a third direction toward the central member, the top flange comprising: a first section having a second plurality of ports, and a second section coplanar with the first section and defining a second top flange space disposed between the first section and the second section, wherein the top flange of the second arm and the top flange of the central member define a second corner space therebetween; a first cable tray comprising: a base including an aperture coupled to a first port of the plurality of ports of the top flange of the first arm by a fastener, a first side wall extending vertically from the base, and a second side wall extending vertically from the base; and a second cable tray comprising: a base including an aperture coupled to a second port of the plurality of ports of the top flange of the first arm by a fastener, a first side wall extending vertically from the base, and a second side wall extending vertically from the base; wherein the mounting bracket receives stress applied from the first cable tray to the first arm by: the first section of the top flange of the first arm deflecting relative to the second section of the top flange of the first arm, the first arm deflecting at the first corner space relative to the central member; wherein the mounting bracket receives stress applied from the second cable tray to the second arm by: the first section of the top flange of the second arm deflecting at the second top flange space relative to the second section of the top flange of the second arm, the second arm deflecting at the second corner space relative to the central member; and wherein a continuous electrical grounding path is established from the first cable tray to the vertically-oriented pile via the fastener coupling the first cable tray to the mounting bracket, mounting bracket, and the one or more fasteners coupling the mounting bracket to the vertically-oriented pile, and from the second cable tray to the vertically-oriented pile via the fastener coupling the second cable tray to the mounting bracket, mounting bracket, and the one or more fasteners coupling the mounting bracket to the vertically-oriented pile.

DETAILED DESCRIPTION

The following detailed description is merely illustrative in nature and is not intended to limit the embodiments of the subject matter of the application or uses of such embodiments. As used herein, the word "exemplary" means "serving as an example, instance, or illustration." Any implementation described herein as exemplary is not necessarily to be construed as preferred or advantageous over other implementations. Furthermore, there is no intention to be bound by any expressed or implied theory presented in the preceding technical field, background, brief summary or the following detailed description.

This specification includes references to "one embodiment" or "an embodiment." The appearances of the phrases "in one embodiment" or "in an embodiment" do not necessarily refer to the same embodiment. Particular features, structures, or characteristics may be combined in any suitable manner consistent with this disclosure.

Terminology. The following paragraphs provide definitions and/or context for terms found in this disclosure (including the appended claims):

"Comprising." This term is open-ended. As used in the appended claims, this term does not foreclose additional structure or steps.

"Configured To." Various units or components may be described or claimed as "configured to" perform a task or tasks. In such contexts, "configured to" is used to connote structure by indicating that the units/components include structure that performs those task or tasks during operation. As such, the unit/component can be said to be configured to perform the task even when the specified unit/component is not currently operational (e.g., is not on/active). Reciting that a unit/circuit/component is "configured to" perform one or more tasks is expressly intended not to invoke 35 U.S.C. §112, sixth paragraph, for that unit/component.

"First," "Second," etc. As used herein, these terms are used as labels for nouns that they precede, and do not imply any type of ordering (e.g., spatial, temporal, logical, etc.). For example, reference to a "first" microinverter does not necessarily imply that this microinverter is the first microinverter in a sequence; instead the term "first" is used to differentiate this microinverter from another microinverter (e.g., a "second" microinverter).

"Based On." As used herein, this term is used to describe one or more factors that affect a determination. This term does not foreclose additional factors that may affect a determination. That is, a determination may be solely based on those factors or based, at least in part, on those factors. Consider the phrase "determine A based on B." While B may be a factor that affects the determination of A, such a phrase

does not foreclose the determination of A from also being based on C. In other instances, A may be determined based solely on B.

"Coupled"—The following description refers to elements or nodes or features being "coupled" together. As used herein, unless expressly stated otherwise, "coupled" means that one element/node/feature is directly or indirectly joined to (or directly or indirectly communicates with) another element/node/feature, and not necessarily mechanically.

"Inhibit"—As used herein, inhibit is used to describe a reducing or minimizing effect. When a component or feature is described as inhibiting an action, motion, or condition it may completely prevent the result or outcome or future state completely. Additionally, "inhibit" can also refer to a reduction or lessening of the outcome, performance, and/or effect which might otherwise occur. Accordingly, when a component, element, or feature is referred to as inhibiting a result or state, it need not completely prevent or eliminate the result or state.

In addition, certain terminology may also be used in the following description for the purpose of reference only, and thus are not intended to be limiting. For example, terms such as "upper", "lower", "above", and "below" refer to directions in the drawings to which reference is made. Terms such as "front", "back", "rear", "side", "outboard", and "inboard" describe the orientation and/or location of portions of the component within a consistent but arbitrary frame of reference which is made clear by reference to the text and the associated drawings describing the component under discussion. Such terminology may include the words specifically mentioned above, derivatives thereof, and words of similar import.

In the following description, numerous specific details are set forth, such as specific operations, in order to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to one skilled in the art that embodiments of the present disclosure may be practiced without these specific details. In other instances, well-known techniques are not described in detail in order to not unnecessarily obscure embodiments of the present disclosure.

The inventions disclosed herein are described in the context of photovoltaic arrays and modules. However, these inventions can be used in other contexts as well, such as concentrated PV systems, thermal solar systems, etc.

In the description set forth below, a solar energy collection system **10** is described in the context of being formed by a plurality of solar collection modules, supported so as to be pivotally adjustable for sun-tracking purposes. Each of the modules can include a support member supporting a plurality of solar collection devices as well as wiring for connecting the various solar collection devices to each other and to other modules. The system **10** can also include devices for reducing labor, hardware, or other costs associated with installing such a system. For example, the collection system or the modules included in such a system can be supported above the ground with bearing assemblies that include one or more various features designed to reduce the cost of the manufacture of such bearings and simplify the installation of related components at an installation site.

FIG. **1** illustrates the solar collection system **10** including a solar collector array **11** which includes a plurality of solar collection modules **12**. Each of the solar collection modules **12** can include a plurality of solar collecting devices **14** supported by a drive shaft or torque tube **16**. Each of the torque tubes **16** are supported above the ground by a support assembly **18**. Each of the support assemblies **18** can include a pile and a bearing assembly **20**.

With continued reference to FIG. **1**, the system **10** can also include a tracking drive **30** connected to the torque tube **16** and configured to pivot the torque tube **16** so as to cause the collector devices **14** to track the movement of the sun. In the illustrated embodiment, the torque tubes **16** are arranged generally horizontally and the modules **12** are connected to each other in an end to end arrangement. However, inventions disclosed herein can be used in the context of other types of arrangements. For example, the system **10** can include a plurality of modules **12** that are arranged such that the torque tube **16** is inclined relative to horizontal, wherein the torque tubes **16** are not connected in an end to end fashion, such as the arrangement illustrated and disclosed in U.S. Pat. No. 8,101,849.

The drive system **30** can be constructed and operated in the manner disclosed with regard to the tilt assembly 50 of U.S. Pat. No. 7,958,886. The entire contents of U.S. Pat. No. 7,958,886 is hereby expressly incorporated by reference.

Additionally, the solar collection devices **14** can be in the form of photovoltaic panels, thermal solar collection devices, concentrated photovoltaic devices, or concentrated thermal solar collection devices. In the illustrated embodiment, the solar collection devices **14** are in the form of photovoltaic panels.

With reference to FIG. **2**, solar collection system **10** can further include an electrical system **40** connected to the array **11**. For example, the electrical system **40** can include the array **11** as a power source connected to a remote connection device **42** with power lines **44**. The electrical system **40** can also include a utility power source, a meter, an electrical panel with a main disconnect, a junction, electrical loads, and/or an inverter with the utility power source monitor.

FIG. **3** illustrates the array **11** with all but one of the solar collection devices **14** removed. As shown in FIG. **3**, each of the support assemblies **18** includes the bearing **20** supported at the upper end of a pile **22**. The torque tube **16** can be of any length and can be formed in one or more pieces. The spacing of the piles **22** relative to one another, can be determined based on the desired limits on deflection of the torque tubes **16** between the support structures **18**, wind loads, and other factors.

The tilt drive **30** can include a drive strut **32** coupled with the torque tube **16** in a way that pivots the torque tube **16** as the drive strut **32** is moved axially along its length. The drive strut **32** can be connected with the torque tube **16** with torque arm assemblies **34**. In the illustrated embodiment, the torque arm assemblies **34** disposed at an end of each of the torque tube **16**. Additionally, the array **11** can include a cable tray **60** supported by one or more of the piles **22**, or by other means. The cable tray **60** illustrated in FIG. **3**, is in the form of a prior art ladder type constructed steel tray **60**, a more detailed view of which is included in FIG. **4** herein.

FIG. **4** is a perspective vie of a prior art cable tray **60** and its support system. As shown in FIG. **4**, the cable tray **60** is a ladder tray, which advantageously allows drainage and may reduce the accumulation of debris in the cable tray **60**. While the primary function of the cable tray **60** is to support the various wires and cables of the solar energy collection system **10**, the cable tray **60** and its support system must also be capable of handling additional vertical loads (e.g., accumulated snow, human workers, animals, etc.) and thermal expansion of the cable tray **60**. Additionally, for safety and regulatory compliance the cable tray **60** and its support system must also be capable of dissipating transient voltages with an ground connection. Under many regulations, the equipment ground connections between the various components of the cable tray **60** and its support system must be

fixed connections (i.e., jumpers, immobile clamps, rivets, bolts, etc. and not sliding ground connections).

FIG. **4** illustrates two types of joints used in a prior art cable tray **60**: an expansion joint **400** and a splice joint **402**. The expansion joint **400** and splice joint **402** are used alternatively one after the other in the solar energy collection system **10** (i.e., an expansion joint **400** is used at odd numbered rows of solar collection devices **14** and an expansion joint **420** is used at even numbered rows of solar collection devices **14** or vice versa).

The expansion joint **400** includes a grounding jumper **404** providing an electrical grounding connection between the first cable tray **60** and the second cable tray **60** and a grounding jumper **406** providing an electrical grounding foundation connection to the pile (not shown). The cable trays **60** are coupled to the mounting bracket **414** by guide clamps **408**, which allow the cable trays **60** to slide across the mounting bracket **414** as the cable trays **60** undergo thermal expansion or contraction. The splice joint **402** includes clamps **410** coupling the cable trays **60** to the mounting bracket **414** and a splice joint plate **412** coupling the first cable tray **60** to the second cable tray **60**. Unlike the guide clamps **408**, the clamps **410** do not allow the cable trays **60** to slide. Because the splice joint **402** is operatively immobile, each metal-on-metal connection is fixed and thus no grounding connection is required for safety and regulatory compliance.

It will be appreciated that the cable tray **60** and its support system may be changed and improved to reduce the costs to build solar energy collection systems **10** while supporting the cables of the solar energy collection system **10**, accommodating thermal expansion and contraction, and maintaining safe and code-compliant grounding connections. One way to reduce costs is to reduce the number of components used to build the cable tray and support system (e.g., removing clamps **404** and **410**, jumpers **404** and **406**, and/or splice joint plates **412**). Another way to reduce costs is to replace more complex and expensive components (e.g., cable trays **60**, clamps **404** and **410**, mounting bracket **414**) with simpler and less expensive components (e.g., cable trays **502** discussed herein, nuts and bolts, rivets, mounting bracket **524** discussed herein, etc.). A third way to reduce costs is to replace more expensive materials (e.g., copper in jumpers **404** and **406**) with less expensive materials (e.g., galvanized steel).

FIG. **5** depicts a cable tray and support system **500** in accordance with the presently disclosed embodiments. Instead of a cable tray **60** and mounting bracket **414** (FIG. **4**), the cable tray and support system **500** includes a cable tray **502** and a mounting bracket **522**. The cable tray **502** and the mounting bracket **522** may be made of galvanized steel, although other materials may be used such as metals like aluminum or titanium, electrically conductive composite materials, or electrically conductive polymers. As shown in FIG. **5**, two cable trays **502** may be connected to the mounting bracket **522** side-by-side. The mounting bracket **522** is coupled to the vertically-oriented pile **548** by one or more fasteners **804** (referring to FIGS. **8**A-**8**B), and supports the weight of the cable trays **502** plus additional vertical loads (e.g., accumulated snow, human workers, animals, debris). In some embodiments, the cable tray and support system **500** is able to support over 700 pounds of vertical load in addition to the weight of the cable trays **502** and mounting bracket **414**. In addition to vertical support, the mounting bracket **414** provides for cantilevered deflection in response to thermal expansion or contraction in the cable trays **502**. Further, the cable tray and support system **500** provides a continuous (i.e., not sliding) electrical grounding path from the cable trays **502** to the vertically-oriented pile **548** the mounting bracket **522** without using jumpers.

The pile **548** may be a post secured into a foundation deep in the ground at the site of the solar energy collector system **10**, and may be laid out in a manner similar to the piles **22** depicted in FIG. **3**. The pile **548** may be a metal (e.g., galvanized steel, aluminum, titanium, etc.) post placed in hole in the ground that is then filled with concrete or metal and concrete post driven into the ground by a pile driver. The pile **548** may also be secured to a wide concrete foundation instead of driven into the ground. The pile **548** may also be made out of an electrically conductive composite material or an electrically conductive polymer. The pile **548** includes a plurality of ports **550** adapted to receive a fastener **804** (referring to FIGS. **8**A-**8**B) to couple the mounting bracket **522** to the pile **548** (the fastener **804** is occluded in FIG. **5** by one of the arms **526**).

In contrast to the cable tray **60**, the cable tray **502** may be made of a single piece of rolled metal with the various features disclosed herein stamped in or otherwise cut out, unlike the ladder-like prior art cable tray **60**, which may comprise several individual components assembled together and may involve a more complicated manufacturing process. The cable trays **502** installed on solar energy collector system **10** may vary in length. In some embodiments, the cable trays **502** may be between 9 and 22 feet long, although it will be understood that other lengths may be used. The cable tray **502** includes a base **512** and side walls **504** on either side of the base **512** extending vertically from the base **512**. Extending from the side walls **504** on an end distal from the base **512**, the cable tray **502** may include a rim **506**. The side walls **504** may also include dimples **510** for shipping offsets (discussed herein in relation to FIG. **9**) and to keep a gap between adjacent, installed cable trays **502**. The cable tray **502** may also include one or more drain holes **514** in the base **512** to allow water to drain from the cable tray **502**. The cable tray **502** may also include an embossment **518** on the base **512** and/or side walls **504**. Because the edges of the cable tray **502** may be sharp enough to damage cables (not shown in FIG. **5**) lying in the cable tray **502**, the embossment **518** may prevent the cables from contacting the edges of the cable tray **502** and being cut or otherwise damaged. The risk for damage to the cables may be particularly high during installation of the cables when installers may be moving the cables through the cable tray **502**. The cable tray **502** also includes one or more apertures **516** in the base **512**. The apertures **516** are adapted to receive a fastener **520** to couple the base **512** of the cable tray **502** to the mounting bracket **522**. The apertures **516** may be elongated to allow for the fastener **520** to be received in a range of locations to accommodate sloped terrain and slight variability in the distance between piles **548**. The fasteners **520** may be any of a rivet, nut and bolt, screw, etc. It will be appreciated that the fastener **520** may represent a cost savings over the clamps **408** and **410** discussed herein. It will be understood that a two-armed mounting bracket **522** such as the one depicted in FIG. **5** may be thus coupled to four cable trays **502**, two side-by-side coupled to each of the two arms **526**.

The mounting bracket **522** includes a central member **524** and one or more arms **526** extending from the central member **524** away from the pile **548**. The central member **524** may include a top flange **528** extending outwardly from the central member **524** away from the pile **548**. The central member **524** may also include a bottom flange **802** (referring to FIGS. **8**A-**8**B) extending outwardly from the central member **524** away from the pile **548** (the bottom flange **802**

is occluded in FIG. **5** by one of the arms **526**). The top flange **528** and the bottom flange **802** may include a plurality of dimples at the edge proximal to the central member **524**. Such dimples may stiffen the top flange **528** and bottom flange **802**, respectively.

The one or more arms **526** of the mounting bracket **522** include an arm wall **525**. The arm wall **525** extends longitudinally away from the central member **524** in a first direction and includes a tope edge and a bottom edge. The arm wall **525** may include a notch **538** proximal to the central member **524**. As discussed herein, the notch **538** may assist in accommodating the thermal expansion and contraction of the cable tray **502**. The arm wall **525** may also include a tool cutout **546**. The tool cutout **546** may enable easier access to the fasteners coupling the mounting bracket **522** to the pile **548** (e.g., by the tool cutout **546** being large enough to accommodate a wrench, etc.). Extending from the top end of arm wall **525** may be a top flange **530**. The top flange **530** extends outwardly from the arm wall **525** in a second direction toward the central member **524**. Additionally or alternatively, extending from the bottom end of the arm wall **525** may be a bottom flange **540**. The bottom flange extends outwardly from the arm wall **525** in a second direction toward the central member **524**. While FIG. **5** depicts the top flange **530** as being co planar with the top flange **528** and the bottom flange **540** as being on an upwardly-oriented diagonal plane intersecting with the plane of the top flange **530** and top flange **528**, it will be understood the bottom flange **540** may be on a plane parallel with the plane of the top flange **530** and top flange **528** or on a downwardly-oriented diagonal plane. The corners between the top flange **530**, bottom flange **540**, and the arm wall **525** may be single angular folds, multiple folds, or continuous rounded folds. The top flange **530** and the top flange **528** may define between them a corner space **534**. As discussed herein, the corner space **534** may assist in managing the thermal expansion and contraction of the cable trays **502**.

The top flange **530** may include a first section **531** and a second section **533**. The first section **531** may include a plurality of ports **542** disposed at intervals along the length of the first section **531**. The plurality of ports **542** are adapted to receive the fastener **520**, thus coupling the base **512** of the cable tray **502** to the top flange **530** and thus the mounting bracket **524**. As depicted in FIG. **5**, it may be advantageous to include a ports **542** at regular intervals across the first section **531** because such a configuration allows for variability in the horizontal location of the piles **548** due to terrain or installation variance. For example, if a solar energy collector system **10** has a first pile **548**, a second pile **548**, and a third pile **548** oriented sequentially in a line running north to south, and the second pile **548** is a few inches east of the first pile **548** and third pile **548**, the cable tray and support system **500** could accommodate this variance by the mounting bracket **524** coupled to the second pile **548** receiving the fasteners **520** at ports **542** further way from the central member **524**. The second section **533** may include a dimple **544**, which may stiffen the second section **533**.

The first section **531** and the second section **533** may be separated by a top flange space **532**. The top flange space **532** may be a linear notch cut into the top flange **530** and a hemispherical notch in the corner between the arm wall **525** and the top flange **530**. It will be understood, of course, that other shapes of notch would also suffice (e.g., a circular, triangular, square, hexagonal, octagonal, etc. notch cut into the top flange **530** and the corner between the arm wall **525** and the top flange **530**). While the top flange space **532** depicted in FIG. **5** is orthogonal to the arm wall **525**, it will be appreciated that the top flange space **532** could be angled away or angled toward the central member **524**. Additionally, the top flange space **532** could be located closer to or further away from the central member **524** than depicted in FIG. **5**.

The bottom flange **540** may include a first section **541** and a second section **543**. The first section **541** and the second section **543** may be separated by a bottom flange space **536**. The bottom flange space **536** may be a linear notch cut into the bottom flange **540** and a hemispherical notch in the corner between the arm wall **525** and the bottom flange **540**. It will be understood, of course, that other shapes of notch would also suffice (e.g., a circular, triangular, square, hexagonal, octagonal, etc. notch cut into the bottom flange **540** and the corner between the arm wall **525** and the bottom flange **540**). Additionally, the top flange space **536** could be located closer to or further away from the central member **524** than depicted in FIG. **5**.

The top flange space **532**, corner space **534**, bottom flange space **536**, and notch **538** may assist in accommodating the thermal expansion and contraction of the cable trays **502** alone or in combination. Depending on the length of the cable tray **502** and the temperature, each cable tray may expand by up to about 6 mm in length or contract by up to about 6 mm in length. Because the cable trays **502** are coupled to a mounting bracket **522** on each end by the fixed fasteners **520**, an expanding cable tray **502** will push the mounting bracket **522** on each end and a contracting cable tray **502** will pull on the mounting bracket **522** on each end. In order to relieve the stress applied by this pushing and pulling, the mounting bracket provides for cantilevered deflection one or more of the top flange space **532**, corner space **534**, bottom flange space **536**, and notch **538**. The mounting bracket **522** may be capable of accommodating expansion and contraction of the cable tray **502** by up to 10 mm without structural failure (i.e., inelastic bending, cracking, or breaking of the mounting bracket **522**) and without fatiguing the material of the mounting bracket **522**. In some embodiments, the mounting bracket **522** may include all, some, or just one of the top flange space **532**, corner space **534**, bottom flange space **536**, and notch **538**. For example, in some embodiments the mounting bracket **512** may only include the top flange space **532** and corner space **534**.

As a push or pull force is applied to the mounting bracket **522**, the first section **531** will deflect relative to the second section **533** at the top flange space **532** (if present). The top flange space **532** may spread the stress of the deflection across the portion of the top flange space **532** proximal to the arm wall **525** (e.g., along the hemispherical notch in the corner between the arm wall **525** and the top flange **530**). As a push or pull force is applied to the mounting bracket **522**, the first section **541** will deflect relative to the second section **543** at the bottom flange space **546** (if present). The bottom flange space **536** may spread the stress of the deflection across the portion of the bottom flange space **536** proximal to the arm wall **525** (e.g., along the hemispherical notch in the corner between the arm wall **525** and the bottom flange **540**). Additionally, as a push or pull force is applied to the mounting bracket **522**, the arm **522** will deflect relative to the central member at the corner space **534** (if present) and/or at the notch **538**.

As discussed herein, the cable tray and support system **500** provides a continuous electrical grounding path from the cable trays **502** to the vertically-oriented pile **548** the mounting bracket **522** without using jumpers. In some embodiments, the cable tray **502**, fastener **520**, mounting

bracket **522**, fastener **804**, and pile **548** all comprise metal (e.g., steel, aluminum, titanium, etc.) or other conductive material (e.g., conductive composite, conductive polymer). In such embodiments, a continuous ground path is established from the cable tray **502**, to the fastener **520**, to the mounting bracket **522**, to the fastener **804**, to the pile **548**, and into the earth at the site of the solar energy collector system **10**. Such a ground path will safely dissipate transient voltages that may otherwise build up due to arcing, static electricity, or accidental contact with higher potential circuits. This ground path may also be sufficient to satisfy regulatory requirements for grounding the solar energy collector system **10**.

FIG. **6** is s cross-sectional view of the cable tray and support system **500** including additional components. Coupled to the rim **508** on the cable tray **502** proximal to the pile **548** is a wire clip **602**. The wire clip **602** may be used to support cables **604**. The cables **604** may be low-power signaling cables (e.g., cables connecting sensors, actuators, motors, etc. to control systems configured to communicate with such sensors, actuators, motors, etc.). While three cables **604** are shown in FIG. **6**, it will be understood that any number of cables **604** may be used. Disposed inside the cable trays **502** are cables **606**. The cables **606** may be AC or DC power cables conducting the electricity generated by the solar energy collector system **10** to an interconnection to a building or larger energy grid (e.g., a utility grid). While four cables **606** are down in each cable tray **502** in FIG. **6**, it will be understood that any number of cables **606** may be used (subject to solar energy collector system **10** requirements, safety requirements, regulatory compliance, etc.).

FIG. **7** is a perspective view of the cable tray and support system showing two cable trays **502** running end to end. As discussed herein, a two-armed mounting bracket **522** may support two cable trays **502** side-by-side on each of the two arms **526** for a total of four cable trays **502**. When two cable trays **502** run end to end and cables **606** (not shown in FIG. **7**) are installed, the cables **606** run through the cable trays **502** and are set off from the edge of the cable trays **502** by the embossments **518** in the side walls **504** and/or base **518**.

FIG. **8**A is a side view of a cable tray and support system **500** installed on level terrain. Also shown in FIG. **8**A is the bottom flange **802** and fastener **804**. The central member **524** may also include a bottom flange **802** extending outwardly from the central member **524** away from the pile **548**. The bottom flange **802** may include a plurality of dimples at the edge proximal to the central member **524**. Such dimples may stiffen bottom flange **802**. The pile **548** includes a plurality of ports **550** adapted to receive a fastener **804** to couple the mounting bracket **522** to the pile **548**. The fastener **804** may also be received by a plurality of ports **806** in the central member **524**. The fastener **804** may be any of a rivet, bolt (e.g., a ⅝ inch bolt), screw, etc. As shown in FIG. **8**A, one of the plurality of ports **806** may be elongated relative to the other and the pile **548** may have a plurality of ports **550** spaced regularly up the body of the pile **548** to accommodate sloped terrain and variance in the height of different piles **548**. As shown in FIG. **8**A, on level terrain, it may be advantageous to use the two topmost ports **550** to receive the fasteners **804** through the middle of the both of the ports **806** to couple the mounting bracket **524** to the pile **548**.

FIG. **8**B is a side view of a cable tray and support system **500** installed on sloped terrain. Because one pile **548** is higher than the other, it may be advantageous to use higher or lower ports **550** and to receive the fasteners **804** though the top or bottom portion of the elongated port **806** to couple the mounting bracket **524** to the pile **548**.

FIG. **9** depicts two groupings of cable trays **502** stacked for shipping. The cable trays **502** may be shipped in a nested configuration **902** (a plurality of stacks of plurality of cable trays **502** stacked directly on top of each other) or an interlocked configuration **906** (a stack of cable trays **502** placed together in alternating vertical orientations). The nested configuration **902** is shown in closer detail in **904**. The interlocked configuration **906** is shown in closer detail at **908**. Shipping cable trays **502** in a nested configuration **902** may have several advantages including a high density of cable trays **502**, a direct load path for the cable trays **502**, reduced movement during shipping, and uses the dimples **510** to offset each cable tray **502** from the cable trays **502** stacked above and below. Shipping cable trays **502** in a interlocked configuration **906** has the advantage of giving the cable tray stack more stability, but at the cost of lower shipping density, less accessible loading path for cable trays **502**, the potential for lateral movement of cable trays **502** in the stack.

Although specific embodiments have been described above, these embodiments are not intended to limit the scope of the present disclosure, even where only a single embodiment is described with respect to a particular feature. Examples of features provided in the disclosure are intended to be illustrative rather than restrictive unless stated otherwise. The above description is intended to cover such alternatives, modifications, and equivalents as would be apparent to a person skilled in the art having the benefit of this disclosure.

The scope of the present disclosure includes any feature or combination of features disclosed herein (either explicitly or implicitly), or any generalization thereof, whether or not it mitigates any or all of the problems addressed herein. Accordingly, new claims may be formulated during prosecution of this application (or an application claiming priority thereto) to any such combination of features. In particular, with reference to the appended claims, features from dependent claims may be combined with those of the independent claims and features from respective independent claims may be combined in any appropriate manner and not merely in the specific combinations enumerated in the appended claims.

What is claimed is:

1. A cable management system comprising:

a vertically-oriented pile;

a mounting bracket comprising:

a central member secured to the vertically-oriented pile by one or more couplers and having a top end and a bottom end, the central member comprising a planar projection extending outwardly from the central member at the top end in a first direction,

a first arm extending from the central member in the first direction, the first arm comprising:

a first arm wall having a top edge and a bottom edge extending longitudinally in the first direction from the central member,

a top flange extending from the first arm wall at the top edge in a second direction toward the central member, the top flange of the first arm comprising:

a first section of the first arm top flange having a plurality of ports, and

a second section of the first arm top flange coplanar with the first section of the first arm top flange and defining a first top flange space, the first top flange space disposed between the first section of the first arm top flange and the second section of the first arm top flange and extending across an entire width of the top flange,

wherein the top flange of the first arm and the planar projection of the central member define a first corner space the first corner space positioned between and on a same plane as the top flange of the first arm and the planar projection of the central member; and

a first cable tray comprising:

a base of the first cable tray including a first aperture coupled to a first port of the plurality of ports of the top flange of the first arm by a first fastener,

a first side wall of the first cable tray extending vertically from the base of the first cable tray, and

a second side wall of the first cable tray extending vertically from the base of the first cable tray;

wherein the mounting bracket receives stress applied from the first cable tray to the first arm by:

the first section of the top flange of the first arm deflecting at the first top flange space relative to the second section of the top flange of the first arm, and

the first arm deflecting at the first corner space relative to the central member.

2. The cable management system of claim **1** wherein the mounting bracket, first cable tray, and fastener coupling the first cable tray to the mounting bracket form a continuous electrical connection.

3. The cable management system of claim **1** wherein a continuous electrical grounding path is established from the first cable tray to the vertically-oriented pile via the fastener coupling the first cable tray to the mounting bracket, mounting bracket, and the one or more couplers securing the central member to the vertically-oriented pile.

4. The cable management system of claim **1** wherein the mounting bracket further comprises:

a second arm extending from the central member in the first direction, the second arm comprising:

a second arm wall having a top edge and a bottom edge extending longitudinally in the first direction from the central member,

a top flange extending from the second arm wall at the top edge in a third direction toward the central member, the top flange of the second arm comprising:

a first section of the second cable tray having a second plurality of ports, and

a second section of the second cable tray coplanar with the first section of the second arm top flange and defining a second top flange space disposed between the first section of the second arm top flange and the second section of the second arm top flange,

wherein the top flange of the second arm and the planar projection of the central member define a second corner space therebetween;

the cable management system further comprising:

a second cable tray comprising:

a base of the second cable tray including a second aperture coupled to a second port of the plurality of ports of the top flange of the first arm by a second fastener,

a first side wall of the second cable tray extending vertically from the base of the second cable tray, and

a second side wall of the second cable tray extending vertically from the base of the second cable tray;

wherein the mounting bracket receives stress applied from the second cable tray to the second at iii by:

the first section of the top flange of the second arm deflecting at the second top flange space relative to the second section of the top flange of the second arm,

the second arm deflecting at the second corner space relative to the central member.

5. The cable management system of claim **1** wherein the first cable tray comprises steel and the mounting bracket comprises steel.

6. The cable management system of claim **1** wherein the first cable tray is between 9 and 22 feet long.

7. The cable management system of claim **1** wherein the base of the first cable tray includes one or more raised embossments on an end of the first cable tray proximal to the mounting bracket.

8. The cable management system of claim **1** wherein the first cable tray further includes a rim extending from the first side wall on an end distal from the base of the first cable tray, the cable management system further comprising a wire clip coupled to the rim of the first cable tray, the wire clip adapted to support cables disposed on an outside of the first cable tray.

9. The cable management system of claim **1** wherein the base of the first cable tray includes a plurality of drain holes.

10. The cable management system of claim **1** wherein the first aperture of the base of the first cable tray includes a plurality of elongate apertures.

11. The cable management system of claim **1** wherein a body of the first arm includes a tool access cutout.

12. The cable management system of claim **1** wherein the cable management system is coupled to a solar energy collection system.

13. A cable management system comprising:

a vertically-oriented pile;

a mounting bracket comprising:

a central member secured to the vertically-oriented pile by one or more couplers and having a top end and a bottom end, the central member comprising:

a planar projection extending outwardly from the central member at the top end in a first direction, and

a bottom flange extending outwardly from the central member at the bottom end in the first direction, and a first arm extending from the central member in the first direction, the first arm comprising:

a first arm wall having a top edge and a bottom edge extending longitudinally in the first direction from the central member, the first arm wall including a first notch proximal to the bottom edge and the central member,

a top flange extending from the first arm wall at the top edge in a second direction toward the central member, the top flange of the first arm comprising:

a first section of the first wall top flange having a plurality of ports, and

a second section of the first wall top flange coplanar with the first section of the first wall top flange and defining a first top flange space, the first top flange space disposed between the first section of the first wall top flange and the second section of the first wall top flange,

a bottom flange extending from the first arm wall at the bottom end in the second direction toward the central member, the first arm bottom flange comprising:

a first section of the first arm bottom flange, and

a second section of the first arm bottom flange coplanar with the first section of the first arm bottom flange and defining a first bottom flange space disposed between the first section of the first arm bottom flange and the second section of the first arm bottom flange,

wherein the top flange of the first arm and the planar projection of the central member define a first corner space therebetween; and a first cable tray comprising:

a base of the first cable tray including a first aperture coupled to a first port of the plurality of ports of the top flange of the first arm by a fastener,

a first side wall of the first cable tray extending vertically from the base of the first cable tray, and

a second side wall of the first cable tray extending vertically from the base of the first cable tray;

wherein the mounting bracket receives stress applied from the first cable tray to the first arm by:

the first section of the top flange of the first arm deflecting at the first top flange space relative to the second section of the top flange of the first arm,

the first section of the first arm bottom flange deflecting at the first bottom flange space relative to the second section of the first arm bottom flange, and

the first arm deflecting at the first corner space and the first notch relative to the central member.

14. The cable management system of claim **13** wherein the mounting bracket further comprises:

a second arm extending from the central member in the first direction, the second arm comprising:

a second arm wall having a top edge and a bottom edge extending longitudinally in the first direction from the central member, the second arm wall including a second notch proximal to the bottom edge and the central member,

a top flange extending from the second arm wall at the top edge in a third direction toward the central member, the top flange of the second arm comprising:

a first section of the second arm having a second plurality of ports, and

a second section of the second arm coplanar with the first section of the second arm and defining a second top flange space disposed between the first section of the second arm top flange and the second section of the second arm top flange,

a bottom flange extending from the second arm wall at the bottom end in the second direction toward the central member, the second arm bottom flange comprising:

a first section of the second arm bottom flange, and a second section of the second arm bottom flange coplanar with the first section of the second arm bottom flange and defining a second bottom flange space disposed between the first section of the second arm bottom flange and the second section of the second arm bottom flange,

wherein the top flange of the second arm and the planar projection of the central member define a second corner space therebetween;

the cable management system further comprising: a second cable tray comprising:

a base of the second cable tray including a second aperture coupled to a second port of the plurality of ports of the top flange of the first arm by a second fastener,

a first side wall of the second cable tray extending vertically from the base of the second cable tray, and

a second side wall of the second cable tray extending vertically from the base of the second cable tray;

wherein the mounting bracket receives stress applied from the second cable tray to the second arm by:

the first section of the top flange of the second arm deflecting at the second top flange space relative to the second section of the top flange of the second arm,

the first section of the second arm bottom flange deflecting at the second bottom flange space relative to the second section of the second arm bottom flange, and

the second arm deflecting at the second corner space and the second notch relative to the central member.

15. The cable management system of claim **13** further comprising:

a third cable tray comprising:

a base of the third cable tray including a third aperture coupled to a second port of the plurality of ports of the top flange of the first arm by a third fastener,

a first side wall of the third cable tray extending vertically from the base of the third cable tray, and

a second side wall of the third cable tray extending vertically from the base of the third cable tray;

wherein the mounting bracket receives stress applied from the third cable tray to the first arm by:

the first section of the top flange of the first arm deflecting at the first top flange space relative to the second section of the top flange of the first arm,

the first section of the bottom flange of the first arm deflecting at the first bottom flange space relative to the second section of the bottom flange of the first arm, and

the first arm deflecting at the first corner space and first notch relative to the central member.

16. The cable management system of claim **13** wherein the mounting bracket, first cable tray, and first fastener coupling the first cable tray to the mounting bracket form a continuous electrical connection.

17. The cable management system of claim **13** wherein a continuous electrical grounding path is established from the first cable tray to the vertically-oriented pile via the first fastener coupling the first cable tray to the mounting bracket, mounting bracket, and the one or more couplers securing the central member to the vertically-oriented pile.

18. A cable management system comprising:

a vertically-oriented pile;

a mounting bracket comprising:

a central member secured to the vertically-oriented pile by one or more couplers and having a top end and a bottom end, the central member comprising:

a planar projection extending outwardly from the central member at the top end in a first direction, and a first arm extending from the central member in the first direction, the first arm comprising:

a first arm wall having a top edge and a bottom edge extending longitudinally in the first direction from the central member,

a top flange extending from the first arm wall at the top edge in a second direction toward the central member, the top flange of the first arm comprising:

a first section of the first arm top flange having a plurality of ports, and

a second section of the first arm top flange coplanar with the first section of the first arm top flange and defining a space disposed between the first section of the first arm top flange and the second section of the first arm top flange,

wherein the top flange of the first arm and the planar projection of the central member define a first corner space therebetween, and

a second arm extending from the central member in the first direction, the second arm comprising:

a second arm wall having a top edge and a bottom edge extending longitudinally in the first direction from the central member,

a top flange extending from the second arm wall at the top edge in a third direction toward the central member, the top flange of the second arm comprising:

a first section having a second plurality of ports, and

a second section coplanar with the first section and defining a second top flange space disposed between the first section and the second section,

wherein the top flange of the second arm and the planar projection of the central member define a second corner space therebetween;

a first cable tray comprising:

a base of the first cable tray including a first aperture coupled to a first port of the plurality of ports of the top flange of the first arm by a first fastener,

a first side wall of the first cable tray extending vertically from the base of the first cable tray, and

a second side wall of the first cable tray extending vertically from the base of the first cable tray; and

a second cable tray comprising:

a base of the second cable tray including a second aperture coupled to a second port of the plurality of ports of the top flange of the first arm by a second fastener,

a first side wall of the second cable tray extending vertically from the base of the second cable tray, and

a second side wall of the second cable tray extending vertically from the base of the second cable tray;

wherein the mounting bracket receives stress applied from the first cable tray to the first arm by:

the first section of the top flange of the first arm deflecting relative to the second section of the top flange of the first arm,

the first arm deflecting at the first corner space relative to the central member;

wherein the mounting bracket receives stress applied from the second cable tray to the second arm by:

the first section of the top flange of the second arm deflecting at the second top flange space relative to the second section of the top flange of the second arm,

the second arm deflecting at the second corner space relative to the central member; and wherein a continuous electrical grounding path is established

from the first cable tray to the vertically-oriented pile via the first fastener coupling the first cable tray to the mounting bracket, mounting bracket, and the one or more couplers securing the central member to the vertically-oriented pile, and

from the second cable tray to the vertically-oriented pile via the second fastener coupling the second cable tray to the mounting bracket, mounting bracket, and the one or more couplers securing the central member to the vertically-oriented pile.

19. The cable management system of claim **18** wherein:

the base of the first cable tray includes a raised embossment on an end of the first cable tray proximal to the mounting bracket, and the base of the second cable tray includes a raised embossment on an end of the second cable tray proximal to the mounting bracket.

* * * * *