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Clamp apparatuses and components thereof for mounting solar panel modules

Abstract

A clamp assembly includes a clamp with a lateral edge support portion that extends in a first direction to support against a lateral edge of the module. A flange extends in a second direction transverse to the first direction to clamp against an upper surface of the solar panel module in coordination with the lateral edge support portion. A nut is configured to align with the clamp. The nut receives a fastener. The nut has an outer surface to engage the second surface of the lateral edge support portion to prevent rotation of the nut. A connection member extends from the nut in a position that is fixed. A head of the connection member is shaped such that, in a first orientation, the head is accommodated passage through a slot in the intermediary member, and in a second orientation, the head is prevented from passage through the slot.

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Background/Summary

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS (1) This application claims priority to U.S. patent application Ser. No. 17/344,403, filed on Jun. 10, 2021, which claims priority to U.S. Provisional Patent Application 63/068,271, filed Aug. 20, 2020, both of which are titled “Clamp Apparatuses and Components Thereof for Mounting Solar Panel Modules,” and incorporates the entireties thereof by reference.

BACKGROUND
(1) Despite the numerous existing types and embodiments of clamps for mounting solar panel

modules available or known, each seems to have a deficiency in at least one aspect or another, or if not perceived as a deficiency, it seems that there is room for improvement. That is to say, while in some cases, a clamp might be configured to include various independent features of multiple different known clamps (ignoring competitor patents for the sake of the example), thereby forming a product that might be superior in many aspects, there remain features desired by installers and users alike that enhance the ease of installation and improve the functionality, durability, strength, etc. For example, some clamps may not provide a satisfactory electrical bond between the module and the rail, other clamps may be overly complex by including a cumbersome number of parts or be challenging to install. Others still may be simple yet so simple that they are ultimately ineffective in adequately securing the module to a rail or other structure according to the design. Therefore, additional improvements to existing solar panel module clamps are desired.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The Detailed Description is set forth with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The use of the same reference numbers in different figures indicates similar or identical items. Furthermore, the drawings may be considered as providing an approximate depiction of the relative sizes of the individual components within individual figures. However, the drawings are not to scale, and the relative sizes of the individual components, both within individual figures and between the different figures, may vary from what is depicted. In particular, some of the figures may depict components as a certain size or shape, while other figures may depict the same components on a larger scale or differently shaped for the sake of clarity.

(2) FIG. **1** illustrates a top perspective view of an exemplary solar panel mounting system including a rail segment for attaching to a bracket attachable to a roof.

(3) FIG. **2** illustrates an exploded view of a universal clamp in an embodiment of the instant disclosure as an end clamp.

(4) FIG. **3** illustrates an assembled side view of the end clamp of FIG. **2**.

(5) FIG. **4** illustrates an assembled top view of the end clamp of FIG. **2**.

(6) FIG. **5** illustrates an exploded view of a universal clamp in an embodiment of the instant disclosure as a mid clamp.

(7) FIG. **6** illustrates an assembled side view of the mid clamp of FIG. **5**.

(8) FIG. **7** illustrates an assembled top view of the mid clamp of FIG. **5**.

(9) FIG. **8**. illustrates an assembled and installed view of the end clamp of FIG. **1** on a rail, according to an embodiment of the instant disclosure.

(10) FIG. **9**. illustrates an assembled and installed view of the mid clamp of FIG. **5** on a rail, according to an embodiment of the instant disclosure.

DETAILED DESCRIPTION

Overview

(11) This disclosure is directed to a universal clamp to secure solar panel modules. More specifically, embodiments of an end cap clamp and a mid clamp that may be claimed as variations of the universal clamp to secure modules of various sizes of solar panel modules. Features are further described as shown in the figures and expressed in the claims listing.

(12) In an embodiment, a bonding clamp assembly includes a clamp, a nut, and a connection member. The clamp includes a lateral edge support portion that extends in a first direction to support against a lateral edge of a solar panel module (“module”) and a flange that extends in a second direction transverse to the first direction to clamp against an upper surface of the module in coordination with the lateral edge support portion. The nut is configured to align with the clamp

and engage with the second surface of the lateral edge support portion of the clamp to prevent rotation of the nut. The connection member extends from the nut in a position that is fixed, and a head of the connection member is shaped such that, in a first orientation, the head is accommodated passage through a slot in a rail segment, and in a second orientation, the head is prevented from passage through the slot in the rail segment. The clamp assembly electrically bonds with any one of a plurality of modules having a different thickness.

(13) As used herein, the term “electrical bond,” “electrically bonding,” “bonding,” or “grounding,” includes any act of joining electrical conductors together. For example, the term “electrical bond,” “electrically bonding,” “bonding,” or “grounding,” includes the practice of intentionally electrically connecting metallic items together. The electrical bonding may be conducted in accordance with the National Electric Code (NEC).

Illustrative Embodiments

(14) FIG. **1** illustrates a top perspective view **100** of an embodiment solar panel mounting system **102** including a rail segment **104** (or rail), which may include an elongated member having a channel therein that extends through all or a portion of the length of the rail segment. For the purposes of this application, a rail segment **104** may be referred to as one of many contemplated possibilities of an “intermediary member” in that, in this instance, the expected use of the components of the mounting system **102** is to support solar panel modules upon a structure to prevent the modules from being directly against the mounting surface. Hence, the term “intermediary member” may be used whether a “rail segment” is used or if instead a substitute structure becomes the structure between (i.e., intermediate to) the mounted object (e.g., the solar panel module or other desired apparatus, device, etc.) and the roof or surface. In other words, while in the solar panel industry, the mounting system **102** is used for mounting solar panel modules on a rail segment structure, it is contemplated by the Applicant that there may be additional uses for one or more of the components of the disclosed mounting system or the system in its entirety. Though minor adaptations may potentially be needed to serve other industries more effectively. Regardless of use, any use of the components as may be claimed based on the disclosure herein is considered proprietary to the applicant and within the scope of the disclosure.

(15) Returning to the mounting system **102**, the rail segment **104** may be attached to a bracket that is in turn attached to a roof. The rail segment **104** may be an extrusion. For example, the rail segment **104** may be a metal extrusion, such as an aluminum extrusion, although other suitable materials for manufacture may be considered according to desired performance and function. Notably, the term “rail” as used herein may refer either to a full length rail member according to various standards in the industry for rails, or to shorter segments less than a standard sized rail, such as those depicted in a figure in some instances. However, for the sake of this application, reference to a rail segment is to be understood to include a full standard length rail or a shorter than full length portion of a rail, inasmuch as the term segment is relative to different manufacturing standards anyway.

(16) The solar panel mounting system **102** may mount solar panel modules (“modules”) (not shown in FIG. **1**, but discussed in more detail below) to a roof or other surfaces, structures, machines, etc. For example, the solar panel mounting systems may be used to mount modules to walls, to the ground, to poles, to bridges, to vehicles, etc. The sizes of the modules may vary. That is, the various distinct manufacturers of modules have not standardized the sizes of the modules available in the industry, and thus the size of each module may vary based on the manufacturer producing the module. For example, one manufacturer may produce a module having a thickness (e.g., height) of about 32 millimeters (mm), while another manufacturer may produce another different module having a thickness of about 40 mm. As such, the solar panel mounting system **102** may include a clamp assembly (not shown) (discussed in more detail below) that attaches to the rail segment **104** and electrically bonds with any one of the modules having a different thickness. For example, the clamp assembly may attach to the rail segment **104** and electrically bond to a module having a

thickness of about 32 mm. In another example, the clamp assembly may attach to the rail segment **104** and electrically bond to another different module having a thickness of about 40 mm. Different modules may have different respective thicknesses depending on a solar cell efficiency of the modules. For example, modules may have different respective thicknesses depending on strength and/or cost. Regardless, a solar panel mounting system as described herein facilitates a user (e.g., an installer, a technician, etc.) to quickly and easily install modules having varying thicknesses on surfaces such as the ground or a roof, structures, machines, etc. as desired. The clamp assembly may provide for fitting modules having a size of at least about 32 mm to about 40 mm. Although, the range of thicknesses as aforementioned is not to be understood as a limit on the capability of the instant disclosure to accommodate sizes outside of that range.

(17) FIG. **2** illustrates an exploded view **200** of a universal clamp in an embodiment of the instant disclosure as an end clamp **202**. The end clamp **202** may be used for mounting a module on a rail segment such as rail segment **104**. The end clamp **202** may include a clamp **204**. The clamp **204** may further include a lateral edge support portion **206** that extends in a first direction **208** to support against a lateral edge of the module. The lateral edge support portion **206** has at least a first surface **210** to face the module and a second surface **212** opposite the first surface **210**. The clamp **204** further includes a flange **214** extending in a second direction **216** transverse to the first direction **208** to clamp against an upper surface of the module in coordination with the lateral edge support portion **206**. Although shown as two structurally distinct elements in FIG. **2**, it is contemplated (and further shown in the mid clamp embodiment, of the universal clamp, in FIG. **5**) that the flange **214** may be structurally continuous (i.e., formed materially in an integral manner) with the lateral edge support portion **206**.

(18) The end clamp **202** includes a nut **218** configured to align with the clamp **204**. The nut **218** has a first end **220** to receive a bolt **222** and a second end **224** opposite the first end **220**. The nut **218** has an outer surface **226** shaped to engage with the second surface **212** of the lateral edge support portion **206** of the clamp **204** to prevent rotation of the nut **218**. For example, the outer surface **226** of the nut **218** may be shaped to engage at least one side thereof with the second surface **212** of the lateral edge support portion **206** of the clamp **204** to prevent rotation of the nut **218**. Moreover, the outer surface **226** of the nut **218** is shaped to engage with the second surface **212** of the lateral edge support portion **206** of the clamp **204** to prevent rotation of the clamp **204**. For example, once the nut **218** is engaged with the lateral edge support portion **206** of the clamp **204**, the nut **218** then also prevents rotation of the clamp **204**. In an embodiment, the nut **218** may have a multi-sided outer surface. For example, the nut **218** may have at least a first side distinguished from a second side by a discontinuity in the directionality of the surface. In a two-sided example, though not depicted in the figures, it is contemplated that a nut could have a circular outer perimeter intersected by a planar portion, which shape thus would be considered to have two-sides. In such a two-sided example, the planar side may engage the second surface **212**. Additionally, and/or alternatively, other shapes for the outer surface of the nut **218**, having more than two sides, are contemplated including three sides, four sides, five sides, six sides, etc. Moreover, the nut **218** may be an elongated nut formed as a sleeve, as depicted, whereby the elongation provides additional surface area to enhance engagement with the second surface **212**. However, it is contemplated that the nut may also be a standard length or even shortened, as long as a side surface thereof effectively engages the second surface **212** to prevent rotation. Thus, as depicted in FIG. **2**, in an embodiment the nut **218** may be an elongated hexagonal sleeve. While FIG. **2** illustrates the nut **218** may be an elongated hexagonal sleeve, the nut **218** may be an elongated square sleeve.

(19) The nut **218** and bolt **222** define a height adjustment component where the bolt **222** is connected to the first end **220** of the nut **218** such that, via rotational movement of the bolt **222** within the nut **218**, a height of the clamp **204** is adjustable to accommodate a height of a module to be clamped.

(20) The end clamp **202** includes a connection member **228** extending from the second end **224** of

the nut **218** in a position that is fixed with respect to the nut **218**. A head **230** of the connection member **228** is shaped such that, in a first orientation, the head **230** is accommodated passage through a slot in a rail segment, and in a second orientation, the head is prevented from passage through the slot in the rail segment. The position of the head **230** of the connection member **228** being fixed in an orientation with respect to the outer surface **226** of the nut **218**. In an embodiment, as shown, the head **230** of the connection member **228** has a rhomboidal cross-section, whereby a portion to be trapped in a slot in a rail segment to prevent passage therethrough is minimized. In this way, the material of the connection member is minimized as well. Alternatively, it is understood that many other shapes, for either or both of the head of the connection member and the slot in the rail segment, might be used to provide a similar function of trapping and passage, as explained above. Moreover, although the nut **218** is shown as structurally continuous (i.e., formed materially in an integrally manner) in FIG. **2**, it is contemplated that the nut **218** may be multiple distinct elements. For example, the connection member **228** may be a structurally distinct element from of the nut **218**.

(21) In an embodiment, as shown in FIG. **2**, the lateral edge support portion **206** may be structurally defined by a first protrusion (i.e., a planar component that "protrudes" or extends in the first direction **208** and bears the first surface **210** to face the module and the second surface **212** opposite the first surface **210**, as described above). The first protrusion of the lateral edge support portion **206** may be further connected in parallel to a second protrusion **232** to form an upside-down U-shape. As depicted, the second protrusion **232** may be structurally continuous by integral formation with the lateral edge support portion **206**. Additionally, the second protrusion **232** may include consecutive teeth **234** along an outer side **236** thereof. As explained below, the teeth **234** are engageable with another element of the clamp **204**. Therefore, upon installation, the first protrusion of the lateral edge support portion **206** is positioned against the lateral edge of the module, and the second protrusion **232** is positioned parallel to and away from the lateral edge of the module.

(22) In an embodiment, the flange **214** may be continuously connected to an extension **238** having at least two corresponding teeth **240** to engage the consecutive teeth **234** of the second protrusion **232**. For example, the at least two corresponding teeth **240** may engage with one or more of the consecutive teeth **234** when the flange **214** clamps against an upper surface of a module in coordination with the lateral edge support portion **206**. Although the flange **214** is shown having at least two corresponding teeth **240** along an inside thereof in FIG. **2**, it is contemplated that the flange **214** may include consecutive teeth along the inside thereof and the second protrusion **232** may include at least two corresponding teeth along an outer side **236** thereof that are engageable with the consecutive teeth of the second protrusion **232**.

(23) FIG. **2** illustrates the outer surface **226** of the nut **218** may have at least two parallel sides such that a first side **242**(**1**) of the parallel sides abuts the second surface **212** of the first protrusion of the lateral edge support portion **206**, and a second side **242**(**2**) of the parallel sides abuts an inside surface **244** of the second protrusion **232**. As discussed above, the nut **218** may have a multi-sided outer surface. Additionally, and/or alternatively, the nut **218** may have a two-sided outer surface. In a two-sided example, though not depicted, in the figures, it is contemplated that a nut could have a circular outer perimeter intersected by a single planar portion. In such a two-sided example, the single planar portion may engage the second surface **212** or engage the inside surface **244**.

(24) FIG. **2** illustrates the lateral edge support portion **206** and the flange **214** include a through hole **246**(**1**) and **246**(**2**). Upon installation, the bolt **222** passes through the through holes **246**(**1**) and **246**(**2**) to connect to the nut **218**.

(25) FIG. **2** illustrates the end clamp **202** includes a first end cap **248**(**1**) to cover a right side of the clamp **204** and a second end cap **248**(**2**) to cover a left side of the clamp **204**. The first and second end caps **248**(**1**) and **248**(**2**) may include one or more fastening members **250**. The one or more fastening members **250** may be one or more press-fit members, snap-fit members, interference-fit

members, etc. for securing the first and second end caps **248**(**1**) and **248**(**2**) to the right and left sides of the clamp **204**. The first and second end caps **248**(**1**) and **248**(**2**) may include one or more alignment members **252**(**1**) and **252**(**2**). The one or more alignment members **252**(**1**) and **252**(**2**) keep the end caps **248**(**1**) and **248**(**2**) aligned with the flange **214** and/or the extension **238** of the clamp **204**, respectively. The one or more fastening members **250** and/or the one or more alignment members **252**(**1**) and **252**(**2**) may keep the end caps **248**(**1**) and **248**(**2**) and clamp **204** securely connected together. The first and second end caps **248**(**1**) and **248**(**2**) may include one or more spring members **254**. The one or more spring members **254** being adapted to provide a spring force between the at least two corresponding teeth **240** of the extension **238** and the consecutive teeth **234** of the second protrusion **232**. For example, in a default position of the end clamp **202**, the at least two corresponding teeth **240** of the extension **238** and the consecutive teeth **234** of the second protrusion **232** are held in engagement because the one or more spring members **254** is sandwiched between the second protrusion **232** and the extension **238**. When a user applies a force to a portion (e.g., an end) of the flange **214**, with the end clamp **202** assembled, the flange **214** rotates about the bolt **222** proximate to the through holes **246**(**1**) and **246**(**2**). This causes the spring member **254** to flex (e.g., elastically deform) and allows the at least two corresponding teeth **240** of the extension **238** to separate from the consecutive teeth **234** of the second protrusion **232**. When a user stops applying the force to the portion of the flange **214**, the spring member **254** engages and holds the at least two corresponding teeth **240** of the extension **238** and the consecutive teeth **234** of the second protrusion **232** together.

(26) FIG. **3** illustrates a side view **300** of the end clamp **202** of FIG. **2**. FIG. **3** illustrates the head **230** of the connection member **228** is defined by a T-shape in a side profile thereof (note, as shown, the orientation of the “T” is upside down, formed by the vertically oriented shaft connected to the nut **218**, with the horizontally-oriented bar portion connected to the shaft at the lower end of the shaft). Moreover, as is visible in the hidden broken line in FIG. **4** (discussed further herein below), the horizontally-oriented bar portion of the head **230** is longer in a first dimension than in the transverse dimension so as to form a cross-sectional profile of an elongated rhomboid shape. The position of the horizontal bar portion of the T-shape of the head **230** of the connection member **228** is fixed to form, when installed properly, a predetermined angle (described in more detail below) with respect to the pair of the opposing parallel sides **242**(**1**) and **242**(**2**) of the nut **218** at the outer surface **226** of the nut **218**.

(27) The flange **214** may include a pin **302** (e.g., bonding pin) disposed in a bottom surface of the flange **214** for puncturing or compromising an anodized layer, a galvanized layer, a painted layer, etc. of a module to electrically bond with module. A top surface of the head **230** of the connection member **228** may include one or more protrusions **304** (e.g., serrations, teeth, etc.) for puncturing or compromising an anodized layer, a galvanized layer, a painted layer, etc. of the rail segment **104** to electrically bond with the rail segment **104**. The connection member **228** being electrically bonded with the rail segment **104** and with the nut **218**, the nut **218** being electrically bonded with the bolt **222**, the bolt **222** being electrically bonded to the clamp **204**, and the clamp **204** being electrically bonded to a module when the clamp **204** is assembled and/or installed. The one or more protrusions **304** on the connection member **228** enable penetration of non-conductive anodization finish on aluminum rail and thus the connection member **228** imbed into rail aluminum and provide an electrical bond between the rail and connection member **228**, and by assembly connection member **228** to nut **218** and also by assembly nut **218** to bolt **222**, and through one or more protrusions (e.g., serrations, teeth, etc.) arranged on the underside of the head of bolt **222**, penetrate the anodization on flange **214**, thus bonding all the aforementioned items to clamp **204**. The clamp **204**, bonds to a module through pin **302**.

(28) FIG. **4** illustrates a top view **400** of the end clamp **202** of FIG. **2**. FIG. **4** illustrates the position of the head **230** (shown in hidden broken lines) of the connection member **228** is fixed to form, when installed properly, a predetermined angle **402** with respect to the pair of the opposing parallel

sides **242**(**1**) and **242**(**2**) of the nut **218** at the outer surface **226** of the nut **218**. The predetermined angle **402** being about 17° to about 37°. The predetermined angle **402** of the head **230** providing for securing the clamp **204** in a desired position when the end clamp **202** is installed to the rail segment **104**. For example, at a time of installation, the end clamp **202** may be fully assembled and a user may pass the head **230**, in a first orientation, through a slot in the rail segment **104**, and then rotate the end clamp **202** until the head **230** having the predetermined angle **402** contacts opposing walls in the rail segment **104**. Subsequent to rotating the end clamp **202** to engage the head **230** having the predetermined angle **402** with the opposing walls in the rail segment **104**, the engaged head **230** ensures the end clamp **202** is properly positioned for maximum strength of engagement of the head **230** and the rail segment **104**.

(29) FIG. **5** illustrates an exploded view **500** of a universal clamp in an embodiment of the instant disclosure as a mid clamp **502**. The mid clamp **502** may be used for mounting adjacent modules on a rail segment such as rail segment **104**. For example, the mid clamp **502** may mount a pair of modules on the rail segment **104**. The mid clamp **502** may include a clamp **504**, a nut **506**, a connection member **508**, and a bolt **510**. Inasmuch as a more detailed description of the clamp **504**, the nut **506**, the connection member **508**, and the bolt **510** has been given heretofore, specific details about these mechanisms is not repeated here. However, a brief description of how the clamp **504** relates to mounting a pair of modules is described hereafter.

(30) FIG. **5** illustrates the clamp **504** includes a first lateral edge support portion **512** that extends in a first direction **514** to support against a lateral edge of a first module of adjacent modules. The first lateral edge support portion **512** has at least a first surface **516** to face the first module and a second surface **518** opposite the first surface **516**. The clamp **504** may further include a first flange **520** extending in a second direction **522** transverse to the first direction **514** to clamp against an upper surface of the first module in coordination with the first lateral edge support portion **512**.

(31) The clamp **504** may further include a second flange **524** extending opposite the second direction **522** such that the clamp **504** is a mid clamp, and the clamp **504** is configured to secure adjacent modules beneath the first flange **520** and the second flange **524**, respectively.

(32) The clamp **504** may further include a second lateral edge support portion **526** that extends in a direction parallel to the first direction **514** to support against a lateral edge of a second module of adjacent modules. The second lateral edge support portion **526** has at least a first surface **528** to face the second module and a second surface **530** opposite the first surface **528**. Thus, the second flange **524** may clamp against an upper surface of the second module in coordination with the second lateral edge support portion **526**. Although the clamp is shown as a structurally continuous (i.e., formed materially in an integral manner) in FIG. **5**, it is contemplated (and further shown in the end clamp embodiment, of the universal clamp, in FIG. **2**) that the first flange **520** and/or the second flange **524** may be structurally distinct elements from the first lateral edge support portion **512** and/or the second lateral edge support portion **526**. For example, the first flange **520** and/or the second flange **524** may be a first structurally continuous portion and the first lateral edge support portion **512** and/or the second lateral edge support portion **526** may be a second structurally continuous portion. In such an embodiment having two structurally distinct elements, the first structurally continuous portion may be secured to the second structurally continuous portion.

(33) As depicted in FIG. **5**, the clamp **504** includes a through hole **532** located in an area of the material adjoining the first flange **520** and the second flange **524**. Upon installation, the bolt **510** passes through the through hole **532** to connect to the nut **506**. The nut **506** and bolt **510** define a height adjustment component where the bolt **510** is connected to the first end of the nut **506** such that, via rotational movement of the bolt **510** within the nut **506**, a height of the clamp **502** is adjustable to accommodate heights of adjacent modules beneath the first flange **520** and the second flange **524**, respectively, to be clamped.

(34) FIG. **6** illustrates a side view **600** of the mid clamp **502** of FIG. **5**. FIG. **6** As similarly shown in FIG. **3**, FIG. **6** illustrates the head **602** of the connection member **508** is defined by an upside

down T-shape in a side profile thereof. The position of the T-shape of the head **602** of the connection member **508** is fixed to form, upon installation, a predetermined angle (described in more detail below) with respect to the pair of the opposing parallel sides **604**(**1**) and **604**(**2**) of the nut **506**. The first parallel side **604**(**1**) abuts the second surface **518** of the first lateral edge support portion **512**, and the second side **604**(**2**) abuts the second surface **530** of the second lateral edge support portion **526**. The opposing parallel sides **604**(**1**) and **604**(**2**) of the nut **506** are engaged with the second surfaces **518** and **530** of the first and second lateral edge support portions **512** and **526**. Therefore, the nut **506** and the connection member **508** are configured to be fixed in place, thereby preventing rotational movement.

(35) The head **602** of the connection member **508** may include the one or more protrusions **304** for puncturing or compromising an anodized layer, a galvanized layer, a painted layer, etc. of the rail segment **104** to electrically bond with the rail segment **104**.

(36) FIG. **6** further illustrates the first flange **520** and the second flange **524** may each include a pin **606**(**1**) and **606**(**2**), respectively, disposed in the bottom surfaces of the first and second flanges **518** and **522**. The pins **606**(**1**) and **606**(**2**), are, like pin **302**, configured for puncturing or compromising an anodized layer, a galvanized layer, a painted layer, etc. of adjacent modules beneath the first flange **520** and the second flange **524**, respectively, to electrically bond with adjacent modules.

(37) FIG. **7** illustrates a top view **700** of the mid clamp **502** of FIG. **5**. As shown, the position of the T-shape of the head **602** (shown in hidden broken lines) of the connection member **508** is fixed to the nut **506** so as to form, when installed, a predetermined angle **702** with respect to the pair of the opposing parallel sides **604**(**1**) and **604**(**2**) of the nut **506** at the outer surface of the nut **506**. The predetermined angle **702** being about 17° to about 37°.

(38) FIG. **8**. illustrates an assembled and installed view **800** of the end clamp **202** of FIG. **2** on a rail segment **802**, according to an embodiment of the instant disclosure. FIG. **8** illustrates the first surface **210** of the lateral edge support portion **206** against a lateral edge **804** of a portion of a module **806** and the flange **214** clamped against an upper surface **808** of the module **806** in coordination with the lateral edge support portion **206**.

(39) FIG. **8** additionally illustrates the consecutive teeth **234** of the second protrusion **232** engaged with the at least two corresponding teeth **240** (not visible in FIG. **8**) of the extension **238** while the flange **214** clamps against the upper surface **808** of the module **806** in coordination with the lateral edge support portion **206**. Further, as shown, the first end cap **248**(**1**) covers the right side of the clamp **204**, and the second end cap **248**(**2**) covers the left side of the clamp **204**.

(40) Moreover, FIG. **8** depicts a slot **810** in the rail segment **802**. As discussed above, the head **230** of the connection member **228** is shaped such that, in a first orientation, the head **230** is accommodated passage through the slot **810** in the rail segment **802**, and in a second orientation, the head **230** is prevented from passage through the slot **810** in the rail segment **802**. Because the head **230** of the connection member **228** has a rhomboidal cross-section, a portion of the head **230** is trapped in the slot **810** in the rail segment **802** to prevent passage of the head **230** through the slot **810**. The one or more protrusions **304** of the head **230** of the connection member **228** may puncture or compromise an anodized layer, a galvanized layer, a painted layer, etc. of a bottom portion of one or more opposing lips **812**(**1**) and **812**(**2**) that define the slot **810** of the rail segment **802** to electrically bond with the rail segment **802**.

(41) Before tightening the bolt **222** with the nut **218**, the end clamp **202** may be slideably displaced along the slot **810** of the rail segment **802** to position the end clamp **202** on the rail segment **802** to accommodate the module **806**. Subsequent to positioning the end clamp **202** to accommodate the module **806**, the bolt **222** may be tightened with the nut **218** to engage the at least two corresponding teeth **240** of the extension **238** with consecutive teeth **234** of the second protrusion **232**. The nut **218** may then be tightened to engage the at least two corresponding teeth **240** of the extension **238** with consecutive teeth **234** of the second protrusion **232** to adjust a height of the clamp **204** to accommodate a height of the module **806**.

(42) FIG. **9**. illustrates an assembled and installed view **900** of the mid clamp **502** of FIG. **5** on a rail segment **902**, according to an embodiment of the instant disclosure. FIG. **9** illustrates the first surface **516** of the first lateral edge support portion **512** against a lateral edge **904** of a portion of a first module **906** adjacent to a second module **908**. The first flange **520** is clamped against an upper surface **910** of the first module **906** in coordination with the first lateral edge support portion **516**.
(43) The first surface **528** of the second lateral edge support portion **526** is disposed against a lateral edge **912** of a portion of the second module **908** and the second flange **524** is clamped against an upper surface **914** of the second module **908** in coordination with the second lateral edge support portion **526**.
(44) Similar to the embodiment in FIG. **8**, FIG. **9** also illustrates a slot **916** in the rail segment **902**. As discussed above, the head **602** of the connection member **508** is shaped such that, in a first orientation, the head **602** is accommodated passage through the slot **916** in the rail segment **902**, and in a second orientation, the head **602** is prevented from passage through the slot **916** in the rail segment **902**. Because the head **602** of the connection member **508** has a rhomboidal cross-section, a portion of the head **602** is trapped in the slot **916** in the rail segment **902** to prevent passage of the head through the slot **916**. The one or more protrusions of the head of the connection member **508** may puncture or compromise an anodized layer, a galvanized layer, a painted layer, etc. of a bottom portion of one or more opposing lips **918**(**1**) and **918**(**2**) that define the slot **916** of the rail segment **902** to electrically bond with the rail segment **902**.
(45) Before tightening the bolt **510** with the nut **506**, the mid clamp **502** may be slideably displaced along the slot **916** of the rail segment **902** to position the mid clamp **502** on the rail segment **902** to accommodate the first module **906** and/or the second module **908**. Subsequent to positioning the mid clamp **502** to accommodate the accommodate the first module **906** and/or the second module **908**, the bolt **510** may be tightened with the nut **506**. The nut **218** may then be tightened to clamp the first and second flanges **520** and **524** against the upper surfaces **910** and **914** of the first and second modules **906** and **908** to adjust a height of the clamp **502** to accommodate heights of the first and second modules **906** and **908**.
CONCLUSION
(46) Although several embodiments have been described in language specific to structural features and/or methodological acts, it is to be understood that the claims are not necessarily limited to the specific features or acts described. Rather, the specific features and acts are disclosed as illustrative forms of implementing the claimed subject matter.

Claims

1. An end clamp comprising: an L-shaped element including: a flange, a first aperture through the flange, and an extension extending away from the flange; a U-shaped element that is accommodated under the flange of the L-shaped element such that the extension falls outside of the U-shaped element, the U-shaped element including: a first wall having an inside surface, a second wall, a bridge connecting the first wall and the second wall, and a second aperture through the bridge; a nut that extends between the first wall and the second wall of the U-shaped element, the nut having an outside surface, wherein the inside surface of the first wall and outside surface of the nut engage planarly to prevent rotation of the nut; and a fastener that engages the nut through the first aperture and the second aperture.
2. The end clamp according to claim 1, wherein the flange is configured to clamp onto a top surface of a solar panel module, and an inside surface of the extension is configured to couple with an outside surface of the second wall of the U-shaped element.
3. The end clamp according to claim 1, wherein: the first wall includes: an inside surface configured to engage with an outside surface of the nut, and an outside surface opposite the inside surface configured to engage with a side surface of a solar panel module; and the second wall

includes: an inside surface configured to engage with the outside surface of the nut, and an outside surface opposite the inside surface, the outside surface having at least two teeth configured to engage with the extension of the L-shaped element.
4. The end clamp according to claim 1, wherein, when assembled, the fastener extends through the first aperture, and the second aperture, and couples with a first end of the nut, the nut having an outer surface configured to engage with the first wall and the second wall to prevent rotation of the nut.
5. The end clamp according to claim 1, wherein, when assembled, the fastener connects to the nut such that, via rotational movement between the fastener and the nut, a height of the L-shaped element is adjustable to accommodate a height of a solar panel module.
6. The end clamp according to claim 1, wherein: the nut includes: a first end configured to couple to the fastener, and a second end opposite the first end; and the end clamp further comprises a connection member extending from the second end of the nut, the connection member shaped such that, in a first orientation, the connection member may pass through a slot in a rail member, and in a second orientation, the connection member is prevented from passing through the slot in the rail member.
7. An end clamp comprising: an L-shaped element including: a flange, and an extension extending away from the flange; a first end cap configured to cover a left side of the L-shaped element; a second end cap configured to cover a right side of the L-shaped element; a U-shaped element that is accommodated under the flange such that the extension falls outside of the U-shaped element, the U-shaped element including: a first wall, a second wall, and a bridge connecting the first wall and the second wall; a nut that extends between the first wall and the second wall of the U-shaped element; a T-shaped connection member extending from the nut; and a fastener that engages the nut through a first aperture and a second aperture.
8. The end clamp according to claim 7, wherein: the first end cap includes: a first surface configured to clamp against a top surface of a solar panel module, and a second surface configured to contact a side surface of the solar panel module; and the second end cap includes: a first surface extending configured to clamp against the top surface of the solar panel module, and a second surface configured to contact the side surface of the solar panel module.
9. The end clamp according to claim 7, wherein the nut is connected to the fastener such that, via rotational movement of the fastener within the nut, a height of the end clamp is adjustable to accommodate a height of a solar panel module.
10. The end clamp according to claim 7, wherein the nut is hexagonal.
11. The end clamp according to claim 7, wherein: the first wall includes: an inside surface configured to engage with an outside surface of the nut, and an outside surface opposite the inside surface configured to engage with a side surface of a solar panel module; and the second wall includes: an inside surface configured to engage with the outside surface of the nut, and an outside surface opposite the inside surface, the outside surface having at least two teeth configured to engage with the extension of the L-shaped element.
12. The end clamp according to claim 11, wherein the outside surface of the second wall of the U-shaped element includes at least one row of teeth extending across a width of the second wall.
13. The end clamp according to claim 11, wherein: the flange includes a first aperture; and the bridge connecting the first wall to the second wall includes a second aperture.
14. An end clamp comprising: an L-shaped element including: a flange, a first aperture through the flange, and an extension having at least one row of teeth, the extension extending away from the flange; a U-shaped element that is accommodated under the flange such that the extension falls outside of the U-shaped element, the U-shaped element including: a first wall including: an inside surface, and an outside surface configured to engage with a solar panel module; a second wall including: an inside surface, and an outside surface having at least one row of teeth configured to engage with the at least one row of teeth of the extension; a bridge connecting the first wall and the

second wall, and a second aperture through the bridge; a nut having a multi-sided outer surface that extends between the first wall and the second wall of the U-shaped element wherein the inside surface of the first wall and the multi-sided outer surface of the nut engage planarly to prevent rotation of the nut, the nut including a first end and a second end; and a fastener that engages the nut through the first aperture and the second aperture.

15. The end clamp according to claim 14, wherein the flange and the bridge include a through hole, respectively, via which the fastener passes upon assembly of the end clamp.

16. The end clamp according to claim 14, wherein the nut has a multi-sided outer surface including: a first side configured to abut against the inside surface of the first wall, a second side parallel to the first side and configured to abut against the inside surface of the second wall, and wherein, when the first side of the nut abuts against the inside surface of the first wall and the second side of the nut abuts against the inside surface of the second wall, the nut is unable to rotate.

17. The end clamp according to claim 14, wherein the nut is a hexagonal sleeve.

18. The end clamp according to claim 14, further comprising a T-shaped element extending from the second end of the nut, the T-shaped element shaped such that: in a first orientation, the T-shaped element may pass through a slot in a rail member, and in a second orientation, the T-shaped element is prevented from passing through the slot in the rail member.

19. The end clamp according to claim 18, wherein the T-shaped element is fixed to form a predetermined angle with respect to a pair of opposing parallel sides of the multi-sided outer surface of the nut.

20. The end clamp of claim 19, wherein the predetermined angle is about 17° to about 37°.