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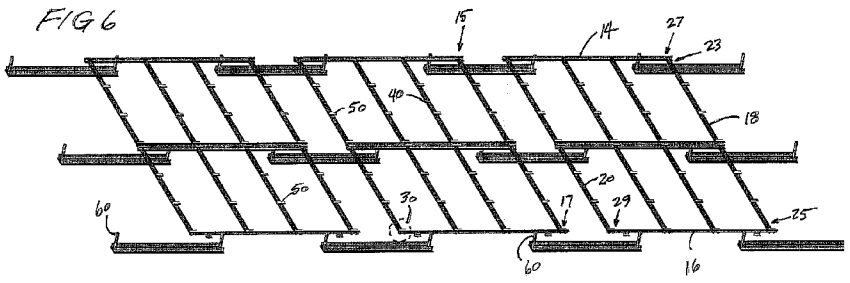

(57) Abstract: A solar panel support includes a frame for receiving and supporting at least one solar panel. The frame includes a top, a bottom, a pair of opposite sides, and at least one support member extending between the top and bottom to support the at least one solar panel within an opening defined by the frame. Risers are provided for supporting the frame. The frame snap fits onto the risers. Fasteners are connected to the frame for fastening the solar panels to the frame. The fasteners include a Z-shaped profile, and a resilient insert is biased between a portion of the fastener and the frame to prevent damage to the solar panel. The frames include stacking angles, which enable the frames to be stacked during shipment

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SOLAR PANEL SUPPORTS AND METHOD

REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. Provisional Application No. 61/212,212, filed April 8, 2010, which is hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] The invention generally relates to an improved solar panel mounting table, and more particularly, to solar panel supports and a method for installing solar panels in the construction of large utility scale solar energy harvesting fields.

BACKGROUND

[0003] Solar panels harvest sunlight and actively convert it to electricity. Most solar panels are silicone based and heavy and thus must not only be directed toward the sun, but they must be adequately supported. Solar panel support systems, therefore, are typically formed from heavy gauge steel flat bar, square tubing, or other ASTM Standard compliant mechanical tubing; and these systems are expensive to transport and handle due to their weight. It is also common for such prior panel support devices to include numerous parts such as frames, mounting sleeves, elevation pivots, strongbacks, rails and so forth. Accordingly, all parts must be assembled, welded, ground, coped, sanded and plated. The man hours and expense makes solar energy—an otherwise inexpensive source of energy—oftentimes cost prohibitive.

[0004] Contractors currently use site customized mounting systems for labor intense installations. Some prior designs include top-of-pole and side-of-pole mounts. Pole mounts typically involve supporting only one or two panels and fail to provide a cost effective means for harvesting power on a larger scale. Large utility scale solar energy harvesting fields are increasingly desirable. The costs for these systems, however, can be substantial using prior methods. It would be advantageous, therefore, to provide a new solar panel support assembly that can snap-fit together for ease of construction. Such an assembly should be sufficient to support the solar panels and be convenient to handle and assemble. It would be further

advantageous to provide such a device with built-in features that would accommodate automated construction of utility scale solar power harvesting fields.

SUMMARY OF THE INVENTION

[0005] The disadvantages heretofore associated with the prior art are overcome by the inventive design for a solar panel support and method. When compared with previous supports and systems, the inventive design provides advantages including cost-effectiveness, installation efficiencies and the strength necessary for operatively supporting a plurality of solar energy collection panels.

[0006] In one aspect of the invention, a solar panel support includes a frame for receiving and supporting at least one solar panel. The frame includes a top, a bottom, a pair of opposite sides, and at least one support member extending between the top and bottom to support the at least one solar panel within an opening defined by the frame. Risers are provided for supporting the frame. Each of the risers has a portion that interlocks with a mating portion carried by the frame so that the frame snap fits onto the risers.

[0007] In another aspect, an elongate base with a ballast tray may connect two risers.

[0008] Fasteners may be connected to the frame for fastening the solar panels to the frame. The fasteners may have a Z-shaped profile, and a resilient insert may be biased between a portion of the fastener and the frame.

[0009] In still another aspect, a lower bracket or an upper bracket may be connected to the frame. The upper or lower bracket may include downward extending guides. The upper and the lower bracket may connect along the same axis to a top of the riser by way of a snap fit configuration.

[0010] In another aspect, the frame may include a central support rail extending between the sides.

[0011] In another aspect of the invention, the riser may include a bottom spade for penetrating the ground surface. The riser may include a top end configured to receive a cover, and the cover may be configured to snap fit on the top end of the riser.

[0012] In yet another aspect of the invention, a method is provided for populating an area with solar panel supports. The supports include a frame and risers for supporting the frame. The method includes:

(1) placing a plurality of frames on a carrier. The carrier may have automated means for automated handling and positioning of the frames on and off the carrier and onto the risers. Stabilizing members are mounted for rotation to the carrier for stabilizing the carrier, and a drive is connected to the stabilizing members for moving the carrier on a surface along a path;

(2) anchoring the risers into the ground so that said risers can receive the frame. Each riser includes an anchor end for penetrating the ground surface and a top. The top is configured for receiving a portion of the frame so that adjacent frames may be supported by a single riser;

(3) transferring the frames from the carrier onto the risers by way of the automated means so that at least a portion of a frame is supported by a riser;

(4) covering the top of the riser with a cover or cap. The cover matingly engages the top of the riser in snap-fit fashion to form a lock so that the frame may not be freely lifted from the top of the riser; and,

(5) incrementally moving the carrier and repeating the steps as desired until the area along the path is covered by solar panel supports.

[0013] In yet another aspect of the invention, an anchor vehicle is provided for anchoring solar panel support risers into the ground surface, one riser a predetermined space apart from another. The vehicle includes a frame, stabilizing members mounted for rotation to the frame for stabilizing the frame with respect to the ground surface, and a drive connected to the stabilizing members for moving the vehicle on a surface along a path. Also included are at least one riser transfer device and at least one anchor driver. The riser transfer device transfers risers from a plurality of risers carried by the vehicle to the anchor driver for driving a first riser into the ground.

[0014] In one aspect, the anchor vehicle may include at least one alignment locator with a gripper for gripping the first riser that is in the ground to halt forward movement of the vehicle until another riser is driven into the ground such that the space between the first riser and the other riser consistently equals said predetermined space as desired.

[0015] In yet another aspect of the invention, the anchor vehicle may include an automated guide and riser install means, which may include a plurality of sensors for measuring a distance of travel of the vehicle, the at least one riser transfer device, and the at least one anchor driver. A programmable logic controller for receiving signals from the plurality of sensors may be in communication with a processor that may execute instructions for:

(i) transferring risers from a plurality of risers carried by the vehicle to the anchor driver;

(ii) driving a riser into the ground a predetermined depth; and

(iii) triggering a gripper of an alignment locator to grip the riser that is in the ground with a gripper to halt forward movement of the vehicle until another riser is driven into the ground such that the space between the first riser and the other riser consistently equals the predetermined space and the depth of the risers in the ground surface such that the top of the risers define a plan irrespective of the unevenness of the ground surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The details of the invention, both as to its structure and operation, may be obtained by a review of the accompanying drawings, in which like reference numerals refer to like parts, and in which:

[0017] FIG. 1 is a perspective exploded view of an embodiment of the roof top mount solar panel support of the invention;

[0018] FIG. 2 is a side plan view showing embodiments of the riser, lower bracket, and upper bracket disassembled;

[0019] FIG. 3 is a side plan view showing a pair of risers connected by an elongate base with a frame supported therebetween;

[0020] FIG. 4 is an elevated perspective view like the view of FIG. 1 shown enlarged;

[0021] FIG. 5 is a perspective view showing embodiments of the upper bracket, lower bracket and riser of the invention assembled;

[0022] FIG. 6 is an elevated perspective view of an embodiment of the roof top mount solar panel support of the invention, and FIG 6b shows another embodiment of the ballast of the ground mount panel support of the invention suitable for framing a cement ballast;

[0023] FIG. 7 is an enlarged perspective view of a riser, including a base and ballast tray of the invention;

[0024] FIG. 8 is a perspective view showing a plurality of stacked frames carrying solar panels;

[0025] FIG. 9 is an elevated perspective view of an embodiment of the ground mount panel support of the invention;

[0026] FIG. 9B is a perspective view of an embodiment of the riser and cover of the invention showing two frames connected to a riser;

[0027] FIG. 10 is an elevated perspective view of an embodiment of the ground mount panel support showing two frames sharing a single riser;

[0028] FIG. 11 is an enlarged view of FIG. 10 showing the frames, attachment hooks, and cover;

[0029] FIG. 12 is a side view of an embodiment of the ground mount panel support of the invention that carries six solar panels;

[0030] FIG. 13 is an elevated perspective view of an embodiment of the ground mount solar panel support of the invention;

[0031] FIG. 14 is a perspective view showing a plurality of stacked frames of the ground mount embodiment of the invention;

[0032] FIG. 15 is a perspective view showing a plurality of stacked frames carrying solar panels of the ground mount embodiment of the invention.

[0033] FIG. 16 is a perspective view of embodiments of the anchor vehicle and carrier of the invention;

[0034] FIG. 17 is a perspective view an embodiment of the anchor vehicle of the invention;

[0035] FIG. 18 is a top plan view of the embodiment of the anchor vehicle of FIG. 17;

[0036] FIG. 19 is a side plan view of the embodiment of the anchor vehicle of FIG. 17;

[0037] FIG. 20 is an elevated perspective view of an embodiment of the carrier of the invention;

[0038] FIG. 21 is a perspective view of an embodiment of the carrier of the invention;

[0039] FIG. 22 is a perspective view of the embodiment of the carrier shown in FIG. 21; and

[0040] FIG. 23 is a perspective view showing the anchor vehicle and carrier assembling a large scale solar harvesting field using the method of the invention.

DETAILED DESCRIPTION

[0041] The solar panel supports of the invention are useful for roof top applications and on the ground surface accordingly. To disclose potential commercial embodiments of the invention, provided herewith are copies of certain drawings and promotional materials for Applicants' solar panel support assemblies and a method for installing at least one of the embodiments. The disclosure of these commercial embodiments is not intended to be limiting with respect to the potential commercial application of other aspects of the invention.

[0042] Generally, there are two embodiments of the solar panel support **10**, one may be installed on roof tops of building structures and the other is generally for ground installations where it may be desirable to install large scale solar energy harvesting fields. The frame **10** is universal. To appreciate the manufacturing, shipping, and installation conveniences provided by Applicant's invention, it is helpful to consider the frame **10** of the invention as a "cartridge" onto which solar panels **100** may be interchangably installed and replaced. As later described, the frame **10**, with or without solar panels, may be stacked one on top of the other in an interlocking fashion as well, which eliminates the need for containerized shipping. Depending upon the particular application, the panel support **10** may be installed manually or by way of the automated installation method described below.

[0043] With reference to figures 1-8, a solar panel support **10** includes a frame **12** for receiving and supporting at least one solar panel. The frame includes a top **14**, a bottom **16**, and a pair of opposite sides **18, 20**. In one embodiment, each of the sides has a portion **23, 25** at each end that mates with a corresponding portion **27, 29** at each end of the top and bottom so that a releasable snap fit is formed, respectively, at each location where the top **14**, bottom **16**, and sides **18, 20** come together to form an interlocking arrangement. The frame **12**, therefore, requires no tools and quickly snaps together for easy assembly. Support members **40** extend between the top and bottom to provide additional support for the solar panel. Each frame may

also be equipped with wire carrier holes (not shown) formed in the top, bottom, and/or support members, through which electrical wire may be neatly threaded for connecting the panels to the appropriate grid.

[0044] In another embodiment, the top **14**, bottom **16**, and sides **18, 20** of the frame may be connected using known means such as spot welding, rivets, machine screws, or other appropriate fasteners. In some applications the portions where the top **14**, bottom **16**, and sides **18, 20** come together, Applicant has employed pre-threaded rivet systems for locking the frame into place. As such, fewer fasteners are needed and site installation is less labor intensive as a result.

[0045] Referring to figures 2 and 6, the frame **12** carries a plurality of Z-shaped fasteners **50** for matingly attaching solar panels **100** to the frame **12**. Fasteners **50** include a resilient insert **52** biased between a portion of the fastener and the frame, which prevents damage to solar panels when installed onto the frame **12**. The solar panels, which may be pre-installed onto the frame during manufacture of the frame or installed on-site accordingly, carry male fasteners (not shown) that are received by the opening **51** formed by the resilient insert. Fasteners **50**, preferably formed from extruded aluminum, are secured along the length of the support members **40** during manufacture and assembly of the frame using means known by skilled artisans, such as welding, bolts, rivets or the like. Preferably, pre-threaded rivets lock fasteners **50** to frame **12**. Frames **12** may be pre-assembled with or without solar panels, which dramatically reduces installation time and labor. Frame **12** may be sized to carry between one and six solar panels. Embodiments like the one shown in figure 8, where each frame supports six solar panels, a central support rail **34** is provided for added strength.

[0046] Upstanding hollow risers **60** support the frame **12** and solar panels to produce an overall generally plan solar panel table, as shown in figure 3. The risers include several different base configurations or anchoring systems that allow the assembly to be mounted on surfaces such as the ground, a flat roof, or a pitched roof.

[0047] The risers **60** may be sized to produce a sloped orientation of the panels as desired. Generally, the riser is an elongate hollow tube **62** disposed in an upstanding attitude. A bore **63** and a stop **65** are formed in the tube **62**. In one embodiment, a pair of risers may be connected by an elongate base **64**. The base may include a ballast tray **66**, as shown in figures 1-3, for containing ballast materials such as bricks, aggregate, or the like (not shown) to prevent unintentional movement of the panel table and frame in those applications where the riser is otherwise unsecured to the ground surface, roof top installations for example. Seismic padding **68** may be installed on the underside of the base to prevent damage to EDPM sealed flat roofs, roof membranes, or other non-penetrable roof surfaces.

[0048] The frame **12** and risers **60** may be formed from a rigid material such metal or plastic. More preferably, the frame is formed from carbon steel and high strength low-alloy steel and G60 galvanized so that its lifetime exceeds beyond fifty years. Risers **60** are preferably formed from the same steel and galvanized so they too have a 50-year or greater lifetime.

[0049] Figures 1-3 show an embodiment of a solar panel support assembly comprising two risers **60** connected to a frame **12**, which extends between the risers. Each of the risers includes two tubes **62** connected with an elongate base **64** and ballast tray **66**, as described above. The panel support shown in figure 6 shows three frames assembled on risers in a ground mount application. This assembly only serves as an example. It will be readily understood by those skilled in the art that the frames may be interlocked, as described in the following paragraph, upon the risers to produce any size of panel support desirable.

[0050] Depending upon its position relative to another frame, the frame **12** carries a lower bracket **54** or an upper bracket **70**, as shown in figure 2. Guided by guides **55**, the lower bracket telescopingly engages the tube **62** of the riser **60** until lips **56** seat at stops **65**. The other frame **12**, illustrated at the top of figure 2, is also guided by guides **75** downward and brought to rest upon lower bracket **54** until it is secured in place by the extension of the rivet head of the U-shaped spring clip **80** through bore **73** of the upper bracket **70**. The cooperation, axial alignment, and interlocking of the riser and the lower and upper brackets is shown in detail in figure 5.

[0051] The panel support structure is a snap together structure that can be used as a single structure or connected adjacently to define a solar panel row. The assembly may be assembled by hand or for large installs, the assemblies may be connected using the new automated method described below.

[0052] With reference to figures 9-15, risers **60** may include a spade design at their bottom end, which may be in the form of an auger **92**, tapered spike, or other design for penetrating and anchoring in the ground surface. The spaded anchor design may be used in all geographic areas where the solar panel support is fastened to the ground. Large utility scale solar fields serve as an example. Once the assembly is in place the anchor is driven into the ground. The depth and spade size may be determined by site conditions.

[0053] Like the risers of the roof top or free-standing panel support embodiments described above, the risers **60** may also be formed in a predetermined size so that the resulting solar panel table is pitched, as shown in figure 9, for example. In one embodiment, the elongate riser **60** includes a top portion **94** crimped to a lower portion **96** for added strength. With reference to figures **9b** and **11**, the top end of the riser **60** has a pair of recesses **98** for cradling an attachment hook **99** carried by the frame 12. The attachment hook(s) **99** are connected to the top and bottom of the frame **12** by known means, preferably riveting, as above described with respect to the frame **12**. Cutouts **113** extend through the top of the riser, as shown in figures 11 and 9b.

[0054] A cap, or cover **110** includes a pair of indentions **112** and a pair recesses **114**. Hence, when the cap **110** is positioned on the top of the riser, as illustrated in figures 9b and 11, and a downward force is applied to the cover, it snap fits to the riser (see figures 12 and 13). The cutouts **113** in the top of the riser receive indentions **112**, and the recesses **114** cradle the attachment hook(s) so that the cover **110** snap fits on top of the riser **60** so that the frame **12** may not be freely lifted from the top of the riser.

[0055] Ground anchors permit the solar panel support to "ride" with a frost heave and thus prevent damage to the panel table and assembly. In areas where soil erosion may occur, the panel stand will be secure to the full depth of the anchor.

[0056] With reference to Figures 16-21, a large area solar field harvesting site may be populated by rows of the disclosed solar panel supports using the new method of the invention. An anchor vehicle **120** and a carrier **200** are provided for handling and installing the panel supports. The embodiments of the anchor vehicle **120** (two commercial embodiments are illustrated) and carrier **200** are examples only. Embodiments of the vehicle **120** and carrier **200** may be automated using various control means such as laser guided and GPS technology. Different automated means for operating the particular on-board devices and assemblies may be suitable for carrying out the invention as well. The anchor driver and carrier are provided to supplement applicant's disclosure along with the accompanying drawings and written description of the invention. The particular embodiments of the anchor driver **120** and carrier **200** should in no way be construed as limiting.

[0057] Referring to FIGS. 16-19, the anchor vehicle **120** is preferably a self-propelled motor vehicle and may include an integral hydraulic drive and pump system **121**, for example see embodiment of FIG. 16), connected to robotic arms and other hydraulic and/or electronic operating system for driving on-board automated devices and assemblies. A vehicle frame **122** includes a cross bar **123** extending along the longitudinal axis of the vehicle. Frame **122** carries a plurality of risers **60** for the panel supports **10**. Stabilizing members **124**, preferably tracks, belts, wheels or the like are mounted for rotation beneath the frame for stabilizing the frame on the ground surface and for moving the frame along a path. Preferably tires **124** include independent suspension assemblies **125** to maintain the frame **122** at a substantial plan attitude during operation so that, as will be described below, a substantially plan solar panel table is achieved regardless of its slope or pitch.

[0058] The drive **121** is connected to the stabilizing members **124** for moving the vehicle. At least one riser transfer device **128** and at least one upstanding anchor driver **130** are supported by the frame. The riser transfer device **128** transfers risers from a plurality of risers 60 carried by

the vehicle **120** to the anchor driver **130** for driving a first riser **60'** into the ground. Preferably, a pair of anchor drives **130** are supported on the frame of the vehicle. The space **132** between the anchor drives is adjustable, as shown by the arrows. This provides flexibility with respect to differently sized OEM solar panels **100**.

[0059] In one embodiment, the vehicle **120** includes at least one alignment locator **140** with a gripper **141** for gripping the first riser **60'** that is in the ground to halt forward movement of the vehicle until another riser is driven into the ground such that the space between the first riser **60'** and the other riser **60''** consistently equals a predetermined space as desired, which ensures the solar panels and frames match-up precisely with the tops of the risers so the previously mentioned snap-fit of the cap or cover **110** onto the top of the riser securing the panels onto the riser is achieved flawlessly. Like the space **132** between the anchor drives, the space **142** between the anchor drives **130, 131** and the alignment locator **140** is adjustable accordingly. Once the spaces **132, 142** are adjusted as desired, the anchor drives and the alignment locator **140** move as a single unit to and fro along the longitudinal axis of the frame **123**.

[0060] The anchor vehicle **120** may optionally include an automated guide and riser install means. In that embodiment, a plurality of sensors **140** for measuring a distance of travel of the vehicle **120**, the at least one riser transfer device **128**, and the at least one anchor driver **130** are each in communication with a controller, as shown schematically in FIG. 20. A programmable logic controller (PLC) receives signals from sensors. The controller is in communication with a processor executing instructions to the automated devices and assemblies to transfer and install the risers into the ground, as previously described above. Optionally, the controller may instruct gripper 141 of the alignment locator 140 to grip the riser 60' that is in the ground with a gripper to halt forward movement of the vehicle 120 until another riser is driven into the ground such that the space between the first riser 60' and the other riser 60'' consistently equals the desirable predetermined space and the depth of the risers in the ground surface such that the top of the risers define a plan irrespective of unevenness of the ground surface.

[0061] With reference to FIGS. 16 and 20, the carrier **200** is also preferably a self-propelled motorized vehicle and includes an integrated hydraulic drive and pump system for driving operation of robotic arms and other on-board hydraulic and/or electronic automated devices and assemblies that move the frames (with or without solar panels installed) from the staged, or in-queue, position (see FIG. 20) to the installed position, as shown in FIG. 21. The carrier includes a steel frame **233** with a centrally located lift **237** with a gripper device **238** that moves individual panel/frames into position above the risers **60**. A linear device **250** is also operably connected to the carrier's hydraulic system to change the height of the stack of panels and frames after each frame is removed. The side shift device **260** sets the width when a frame is lowered downward onto the risers. The gripper device **266** includes fingers for holding the stack of frames as a single frame is separated and lowered from the stack.

[0062] Stabilizing members **234** such as tracks or wheels, which are driven by the system's hydraulics, are mounted for rotation beneath the frame for stabilizing the frame on the ground surface and for moving the frame along a path. A climate controlled elevated cab **235** provides operator comfort and clear observation of system operations. The carrier **200** may be lighted for night operation as well.

[0063] The carrier **200** may be optionally equipped with power rotational attachments **228**, and these may serve the same function as the alignment locator **140** on the anchor vehicle **120** so that the accuracy in anchoring the risers **60** may be repeated with respect to the lowering of the panels onto the tops of the risers.

[0064] Solar panels may be prefabricated and installed into the frames **12**, preferable two panels wide by three panels high, off-site and delivered by way of suitable means desired, such as a truck or other vehicle. Stacking angles **42** have protruding portions that are received by cutouts formed in the frame that enable the frames to be stacked with or without panels, as shown in figures 15, 16 and 20, for example. The frames **12** carrying the solar panels **100** are positioned in stacks at the in-queue positions located on the top level of the frame **233**. Gripper device **238** on each side of the frame lifts the solar panel frames **12**. The gripper device is mounted to a transfer system that moves down, allowing the lowest panel frame **12** to be released

to a set of pick and place tooling **266, 238** that lowers the panel frame to its assembly height and attitude so that the attachment hook **99** comes to rest in the recess **98** formed in the top of the riser **60**.

[0065] Optional tooling (not shown) preferably positions the cap or cover **110** (see FIGS. 9-11), as previously mentioned, above the top of the corresponding riser **60** forcing it downward. As the engagement portions meet, they're snap fitted together to define a lock, as previously described so that the frame may not be freely lifted from the top of the risers. Once done, the panel finger tooling is retracted into its preassembly position, and the anchoring steps, the transferring steps, and the securing steps are repeated as desired until the area is covered by solar panels.

[0066] After the last frame **12** in a stack has been used, the second in-queue stack is moved laterally toward the central portion of the frame accordingly. The simultaneous movement of the stacks and the incremental movement of the vehicles **120, 200** insure that the assembly operation is continuous.

[0067] An operator inside the cab may oversee operation of the carrier and assembly of the rows of solar panel tables, as shown in figure 22. The vehicle **120** and/or carrier **200** may be guided by laser points predetermined at the installation cite or via GPS. Either or both vehicle and carrier of the invention may be powered by gasoline, diesel fuel, electronic fuel cells or other known means and include a hydraulic pump or generator, which may provide power for the wheels or tracks as well as the automated means and transfer assemblies. The stabilizing members, operator cabin, and parts elevator may each be removed for transport.

[0068] For the purposes of promoting an understanding of the principles of the invention, specific embodiments have been described. It should nevertheless be understood that the description is intended to be illustrative and not restrictive in character, and that no limitation of the scope of the invention is intended. Any alterations and further modifications in the described components, elements, processes, or devices, and any further applications of the principles of the invention as described herein , are contemplated as would normally occur to one skilled in the art

to which the invention relates.

WHAT IS CLAIMED IS

1. A solar panel support, comprising:

a frame for receiving and supporting at least one solar panel, said frame includes a top, a bottom, a pair of opposite sides, and at least one support member extends between the top and bottom to support the said at least one solar panel within an opening defined by the frame; and

risers for supporting the frame, each of the risers has a portion that interlocks with a mating portion carried by the frame so that the frame snap fits onto the risers.

2. The support of claim 1, wherein an elongate base with a ballast tray connects two risers.

3. The support of claim 1, wherein fasteners are connected to the frame for fastening the solar panels to the frame, the fasteners have a Z-shaped profile, and a resilient insert biased between a portion of the fastener and the frame.

4. The support of claim 1, wherein a lower bracket or an upper bracket is connected to the frame, said upper or lower bracket includes downward extending guides, the upper and the lower bracket connect along the same axis to a top of the riser by way of a snap fit configuration.

5. The support of claim 2, wherein the frame includes a central support rail extending between the sides, fasteners are connected to the support rail for fastening the solar panels to the frame, the fasteners have a Z-shaped profile, and a resilient insert is biased between a portion of the fastener and the frame.

6. The support of claim 1, wherein the riser includes a bottom spade for penetrating the ground surface.

7. The support of claim 6, wherein the riser includes a top end configured to receive a cover, the cover is configured to snap fit on the top end of the riser.

8. The support of claim 6, wherein the riser includes a top end having a pair of recesses for receiving an attachment hook carried by the frame.

9. The support of claim 7, wherein the top end of the riser includes cutouts.

10. The support of claim 9, further comprising a cap having at least one indention, the cutouts in the top of the riser receive the at least one indention in the cap and the cover snap fits on the top end of the riser when the cap is positioned on top of the riser and a downward force is applied to the cap.

11. An automated method of populating an area with solar panel supports having a frame and risers for supporting the frame, the method comprising:

(i) placing a plurality of frames on a carrier, said carrier having automated means for automated handling and positioning of said frames on and off the carrier and onto the risers, stabilizing members mounted for rotation to the carrier for stabilizing the carrier, and a drive connected to the stabilizing members for moving the carrier on a surface along a path;

(ii) anchoring the risers into the ground so that said risers can receive the frame, each riser includes an anchor end for penetrating the ground surface and a top, the top is configured for receiving a portion of the frame so that adjacent frames may be supported by a single riser;

(iii) transferring the frames from the carrier onto the risers by way of said automated means so that at least a portion of a frame is supported by a riser;

(iv) covering the top of the riser with a cover or cap, the cover matingly engaging the top of the riser in snap-fit fashion to form a lock so that the frame may not be freely lifted from the top of the riser; and,

(v) incrementally moving the carrier and repeating the steps as desired until the area along the path is covered by solar panel supports.

12. The method of claim 11, wherein each frame carries at least one solar panel.

13. The method of claim 12, wherein each of the frames includes at least one stacking angle so that the plurality of frames may be stacked on the carrier.

14. The method of claim 13, wherein the riser includes a top end having a pair of recesses for receiving an attachment hook carried by the frame.

15. The method of claim 14, wherein the top end of the riser includes cutouts.

16. The method of claim 15, wherein the cap includes at least one indention, the cutouts in the top of the riser receive the at least one indention in the cap, and the cover snap fits on the top end of the riser when the cap is positioned on top of the riser and a downward force is applied to the cap.

17. An anchor vehicle for anchoring solar panel support risers into the ground surface, one riser a predetermined space apart from another, the vehicle comprising:

a frame;

stabilizing members mounted for rotation to the frame for stabilizing the frame with respect to the ground surface;

a drive connected to the stabilizing members for moving the vehicle on a surface along a path;

at least one riser transfer device; and

at least one anchor driver, said riser transfer device transfers risers from a plurality of risers carried by the vehicle to the anchor driver for driving a first riser into the ground.

18. The vehicle of claim 17, wherein the vehicle includes at least one alignment locator with a gripper for gripping the first riser that is in the ground to halt forward movement of the vehicle until another riser is driven into the ground such that the space between the first riser and the other riser consistently equals said predetermined space as desired.

19. The anchor vehicle of claim 17, wherein the vehicle comprises an automated guide and riser install means including a plurality of sensors for measuring a distance of travel of the vehicle and the at least one riser transfer device and the at least one anchor driver;

a controller for receiving signals from the plurality of sensors, the controller in communication with a processor executing instructions for:

transferring risers from a plurality of risers carried by the vehicle to the anchor driver;

driving a riser into the ground a predetermined depth; and

triggering a gripper of an alignment locator to grip the riser that is in the ground with a gripper to halt forward movement of the vehicle until another riser is driven into the ground such that the space between the first riser and the other riser consistently equals said predetermined space and the depth of said risers in the ground surface in such that the top of the risers define a plan irrespective of unevenness of the ground surface.

20. The vehicle of claim 19, wherein said controller is a programmable logic controller (PLC).

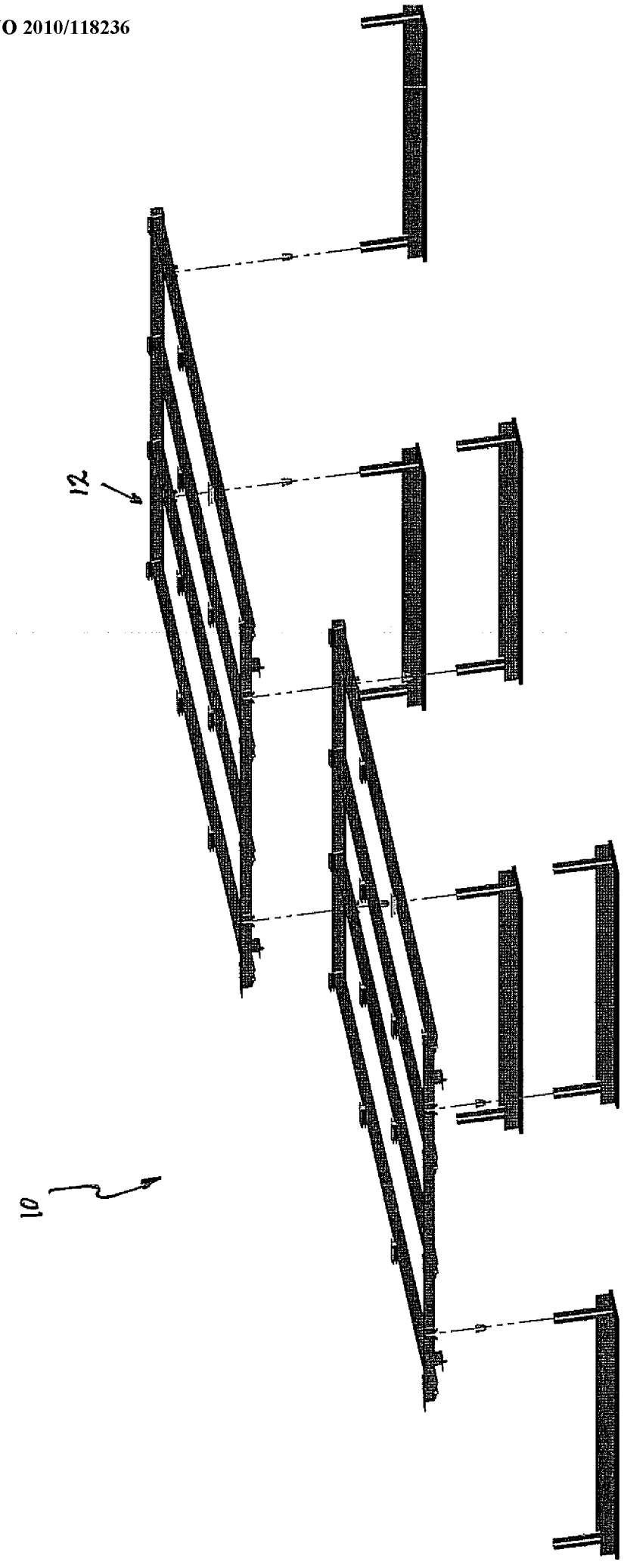


FIG 1

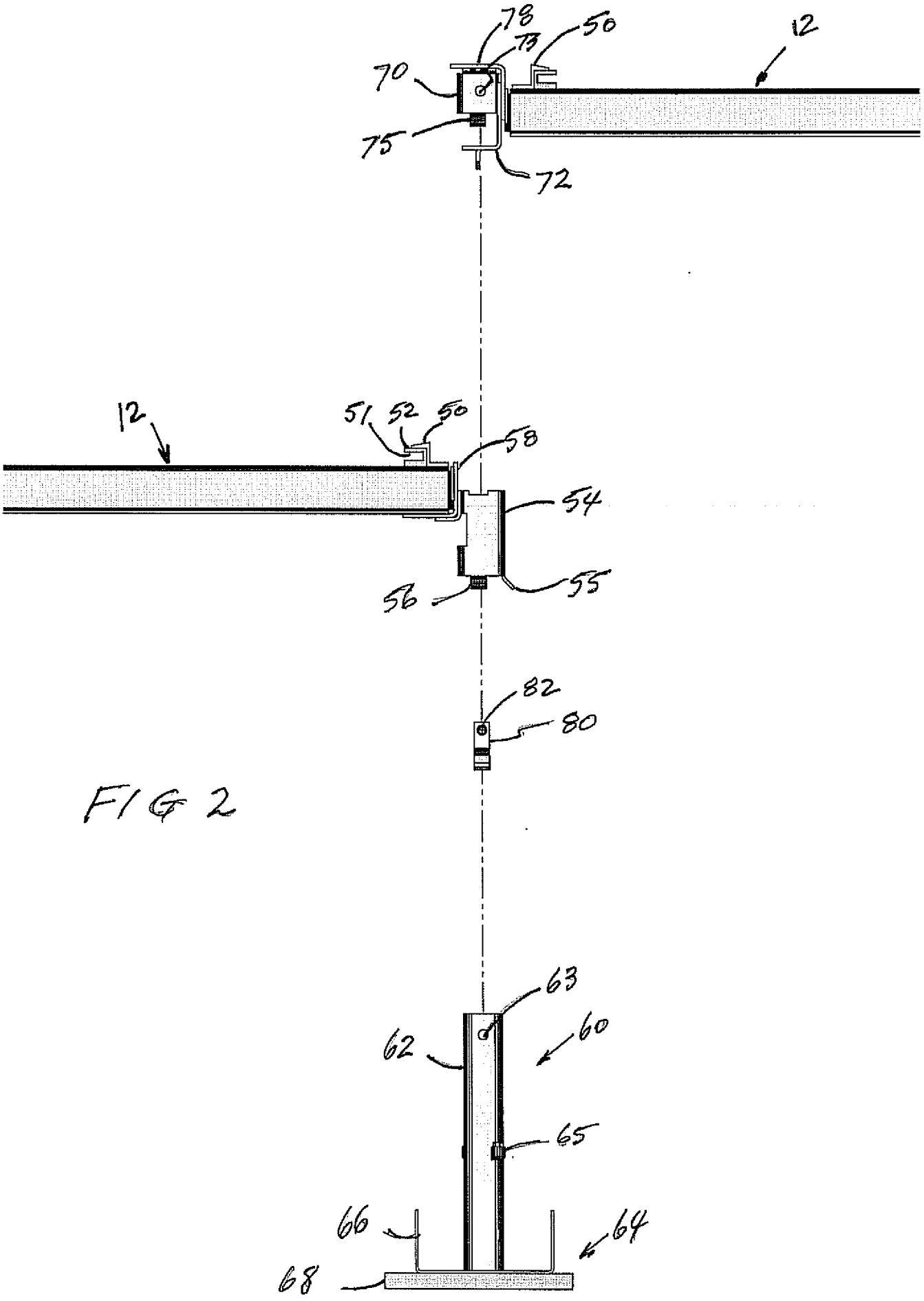


FIG 2

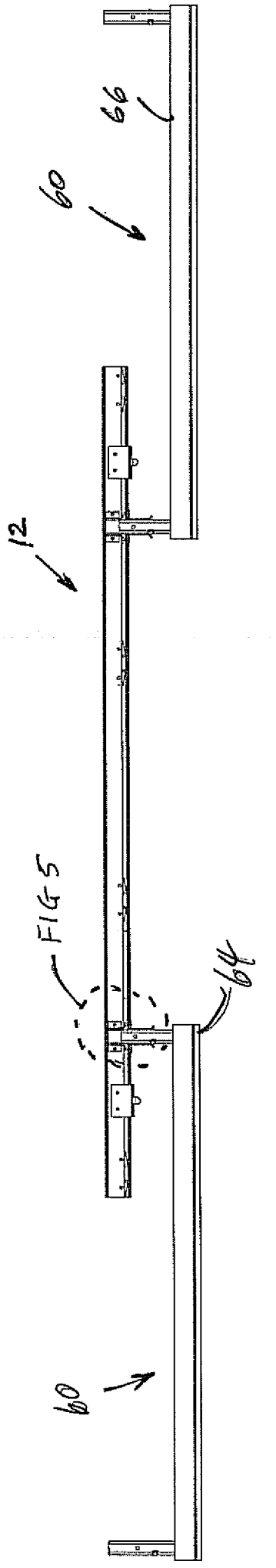


FIG 3

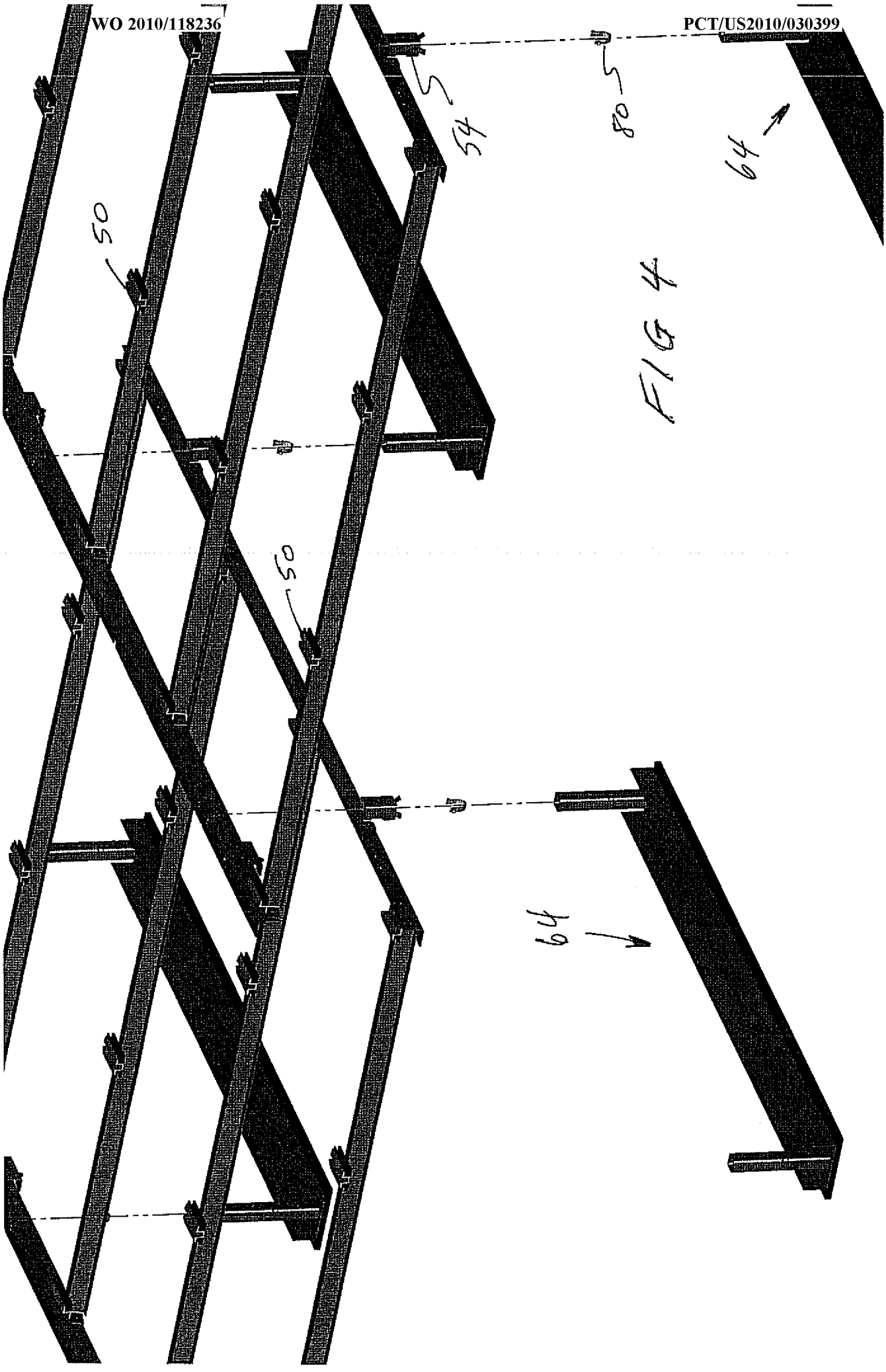


FIG 4

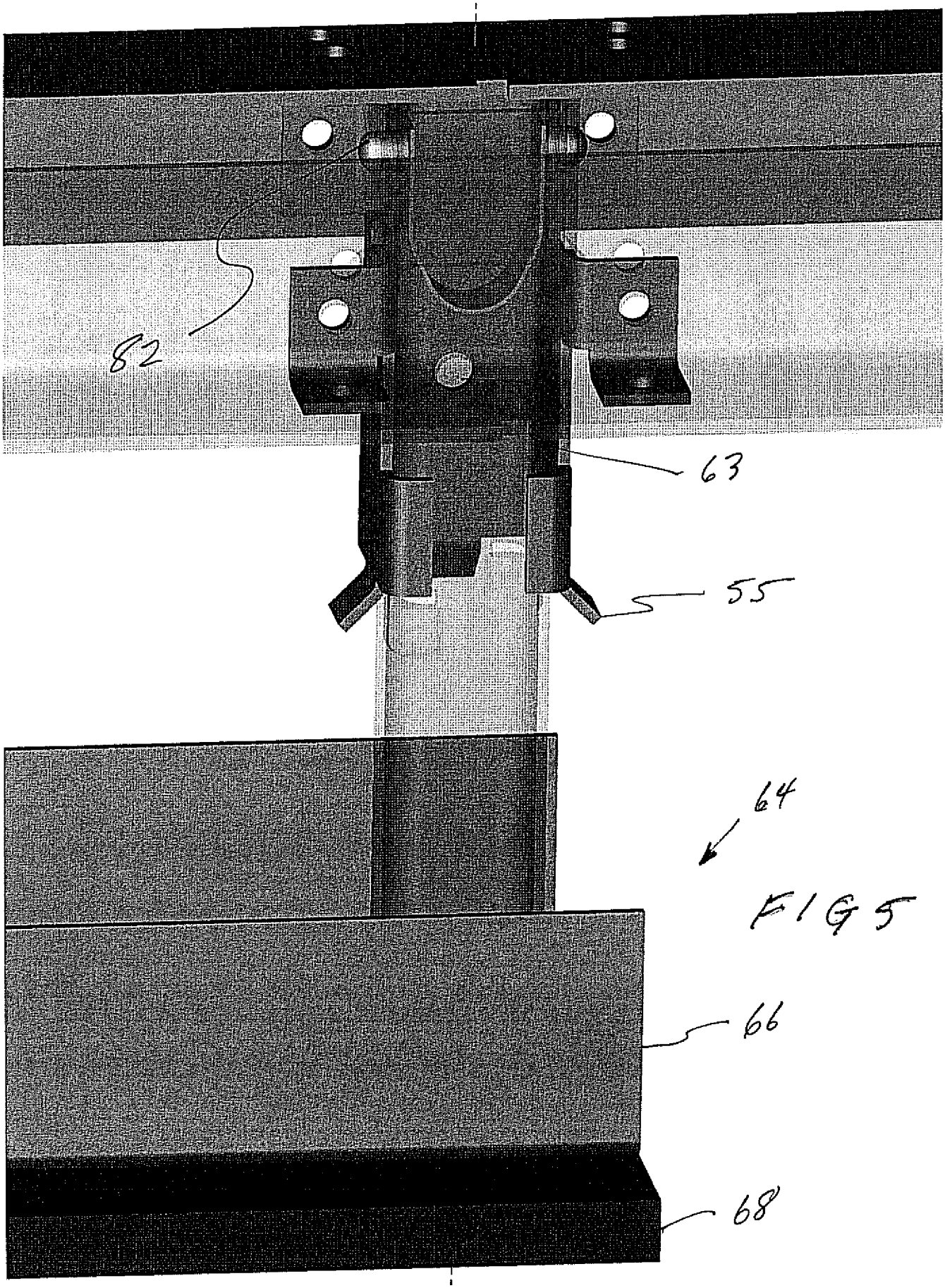


FIG 5

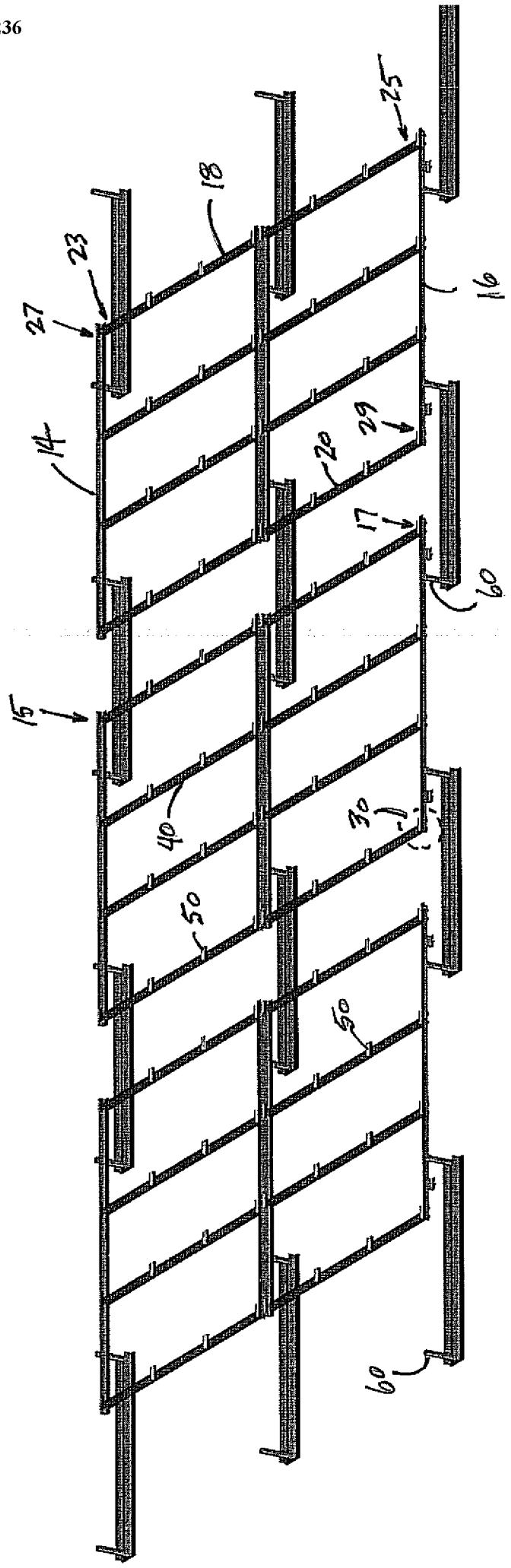


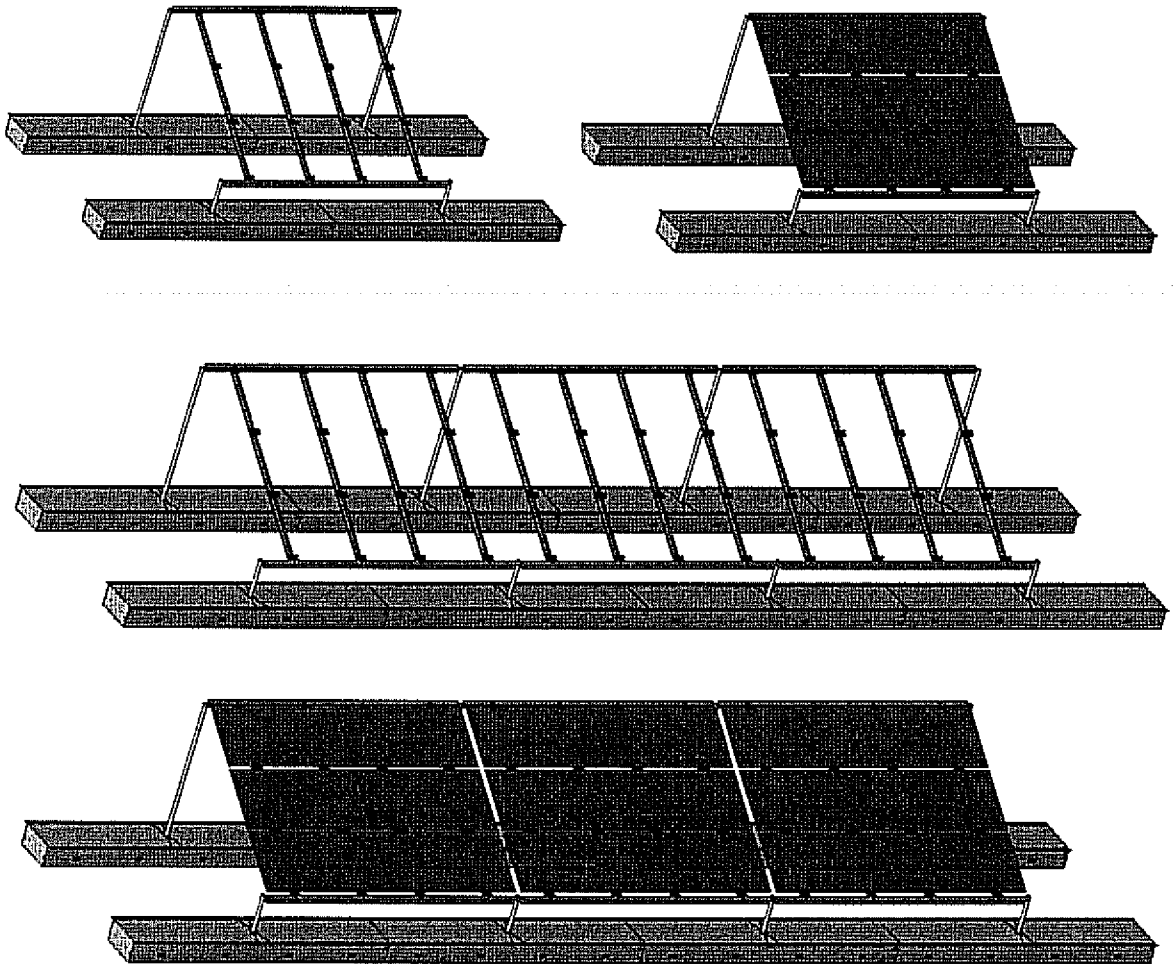
FIG 6

AP ALTERNATIVES
Solar Module Racking Systems

AP Alternatives, LLC
19-911 Road T, P.O. Box 326
Ridgeville Corners, OH 43555
www.apalternatives.com

APA Racking

Ground Mount Racking System FS



(AP Alternatives - Patented Design)*

FIG 6b

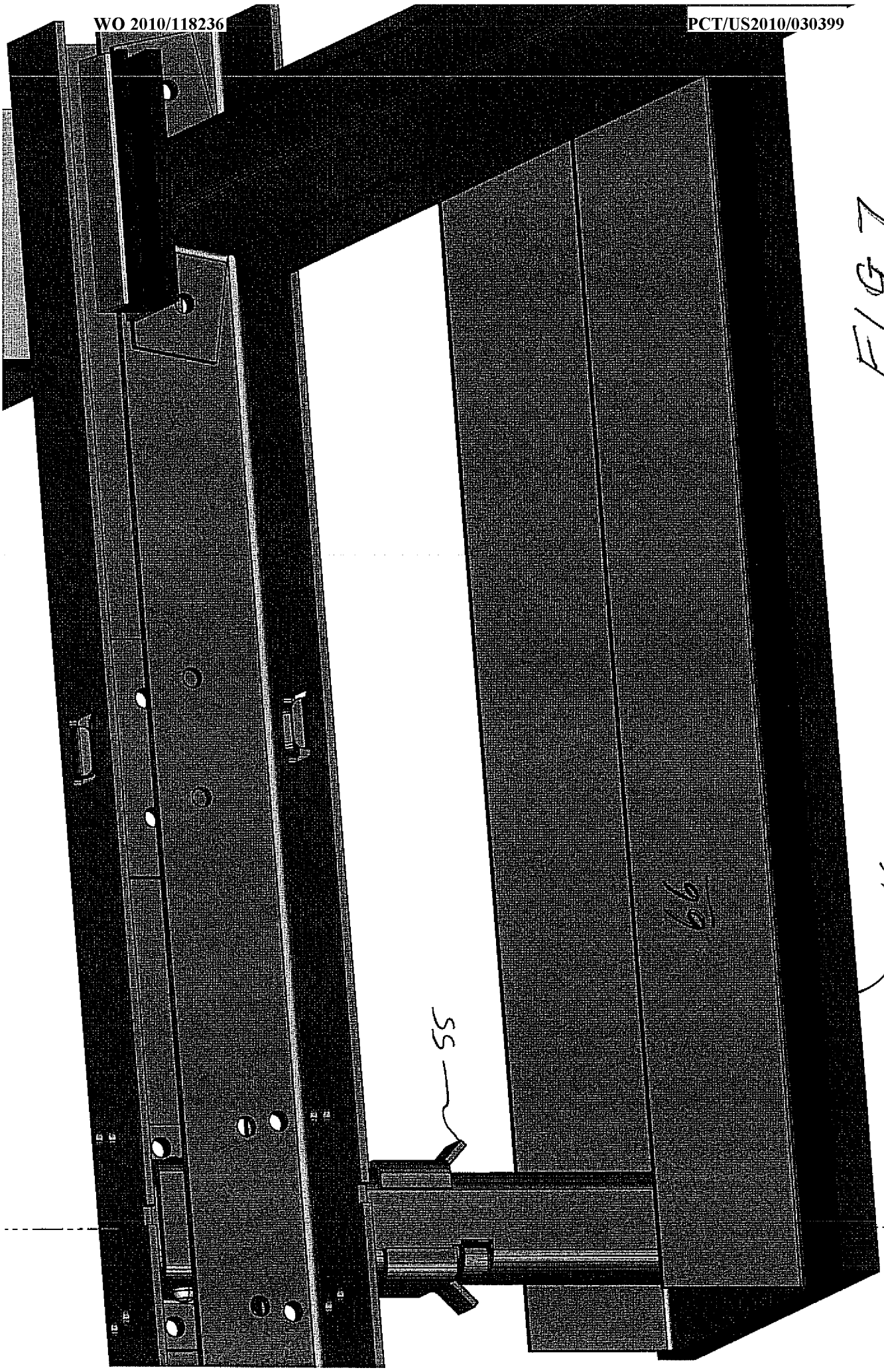


FIG 1

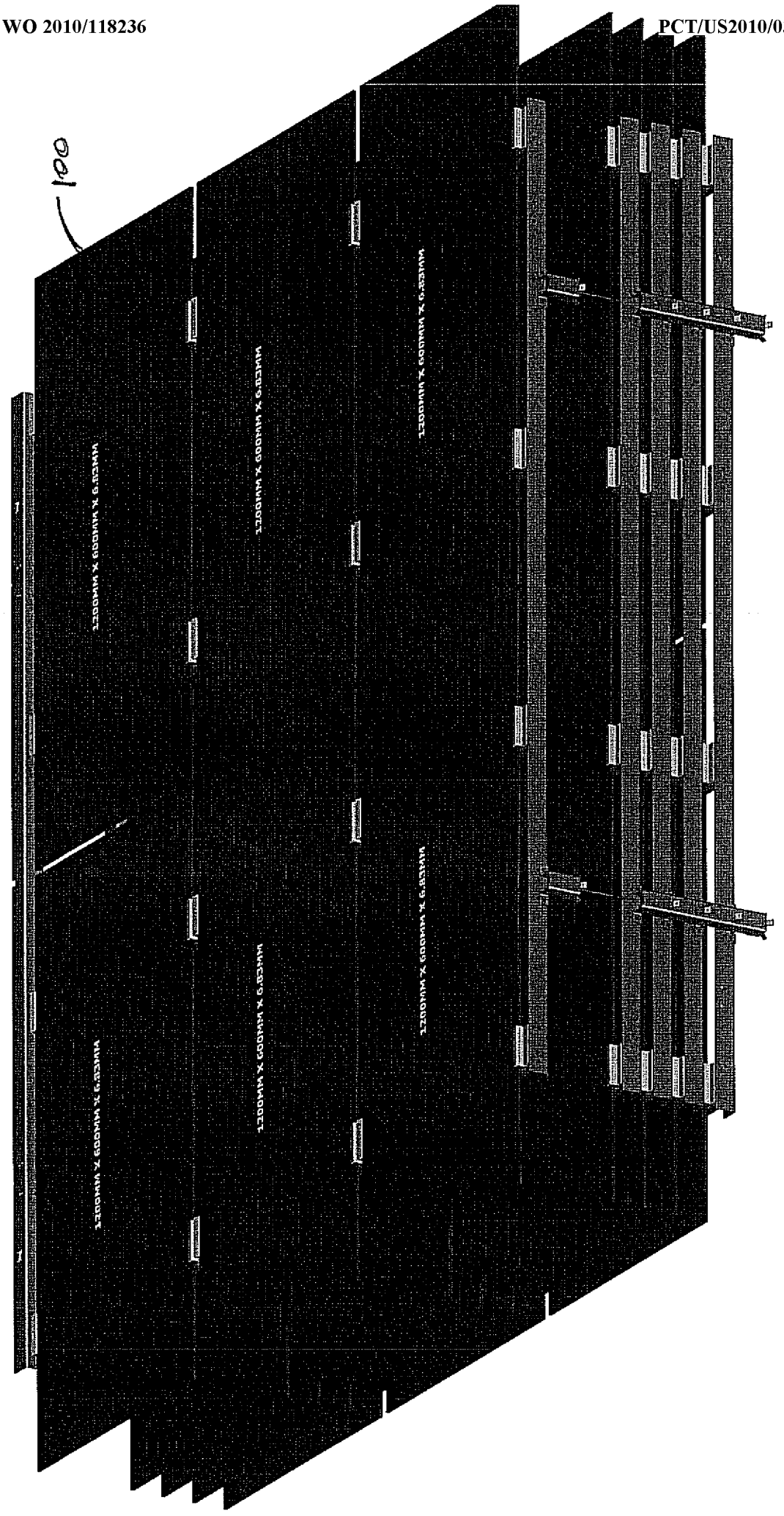

100
1200MM X 600MM X 6.83MM
1200MM X 600MM X 6.83MM
1200MM X 600MM X 6.83MM
1200MM X 600MM X 6.83MM

Fig 8

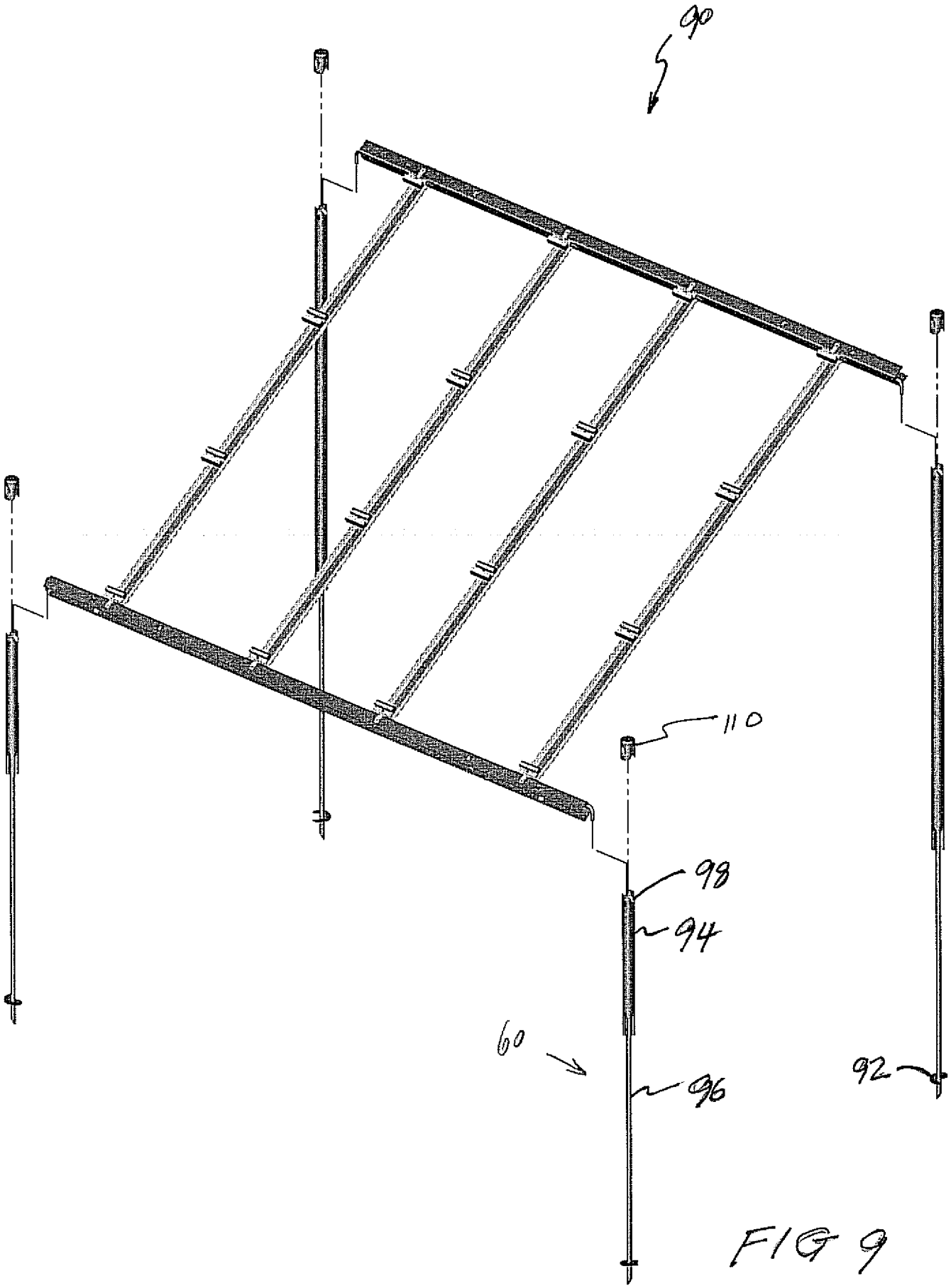


FIG 9

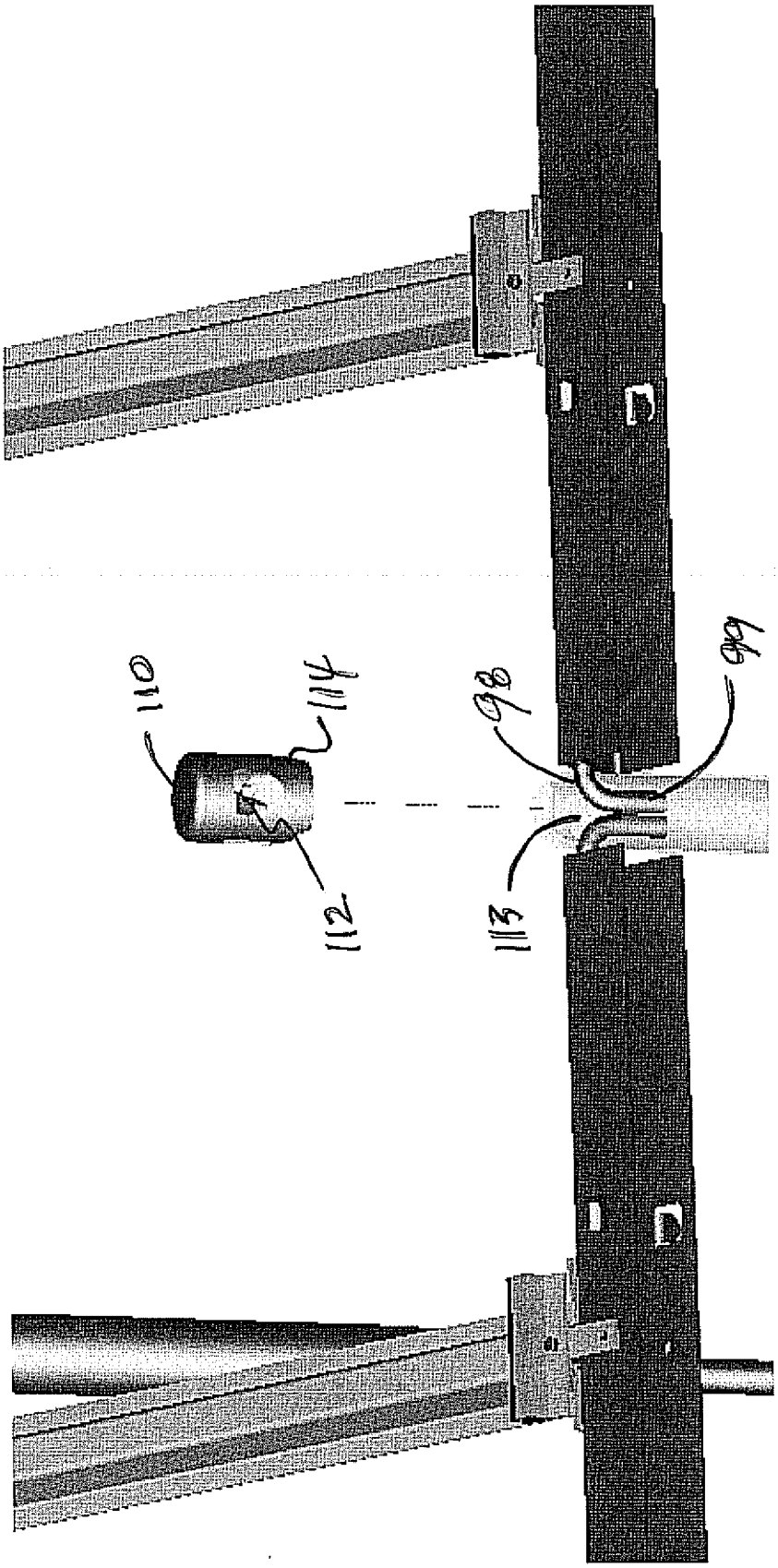


FIG 9b

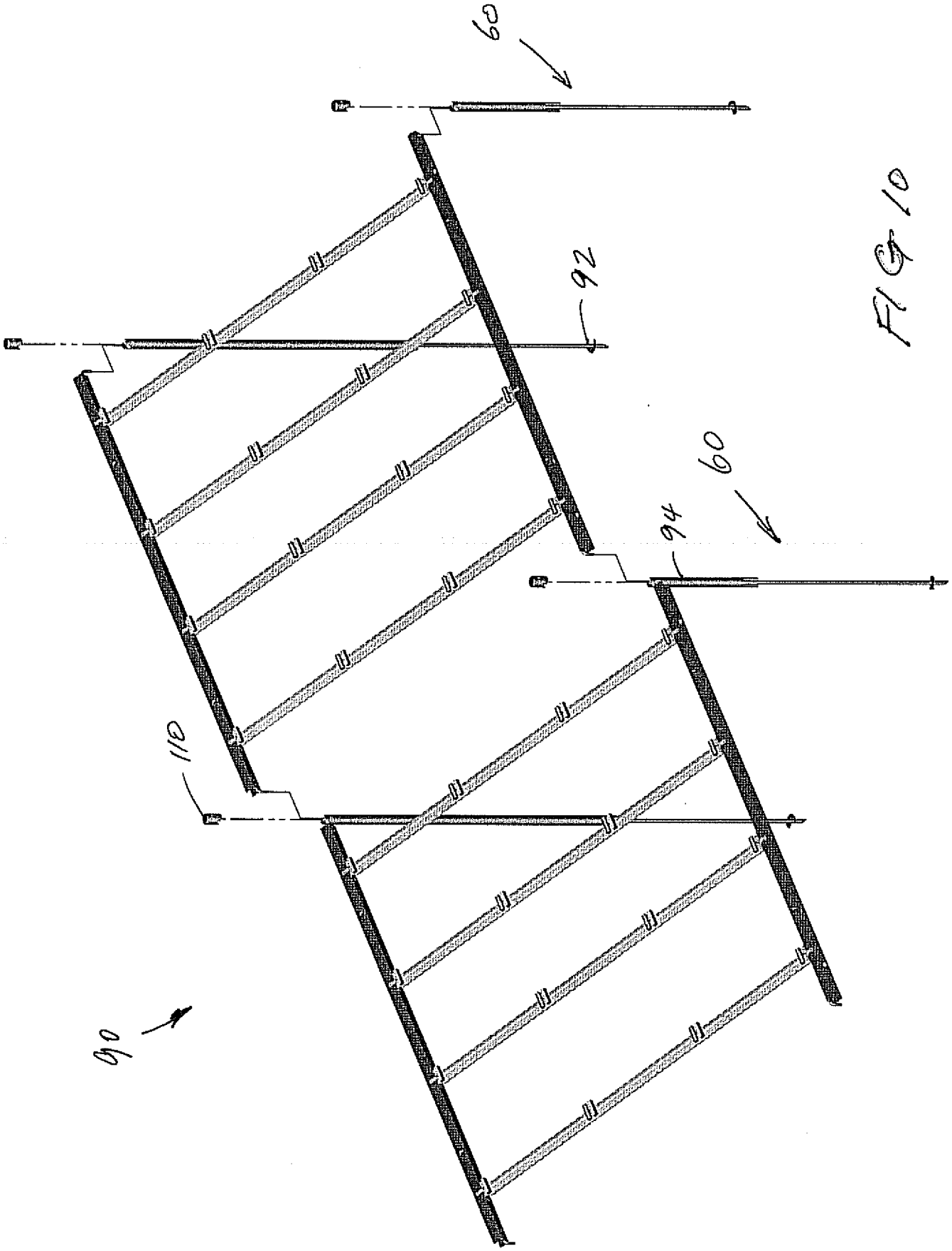


FIG 10

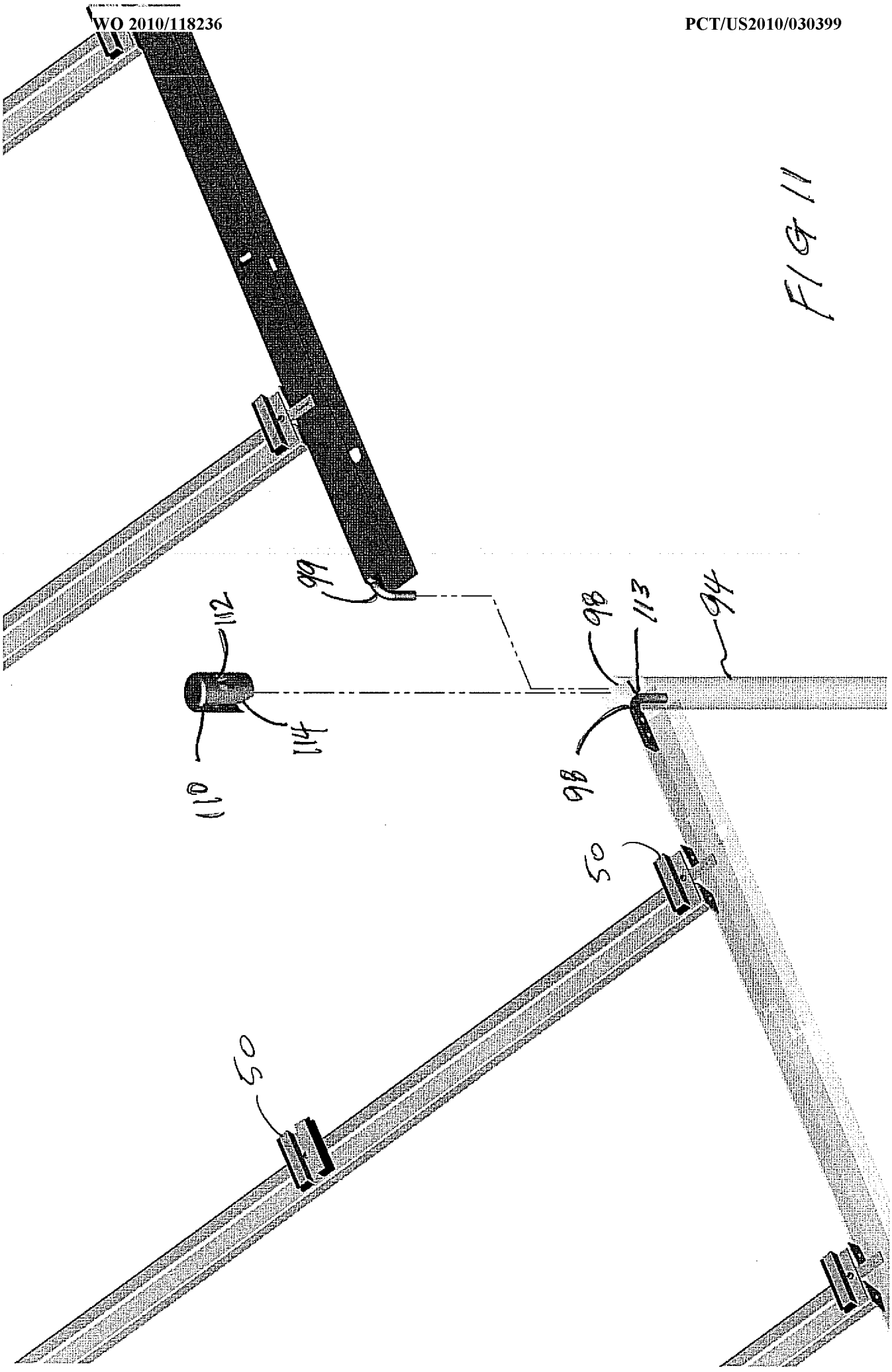
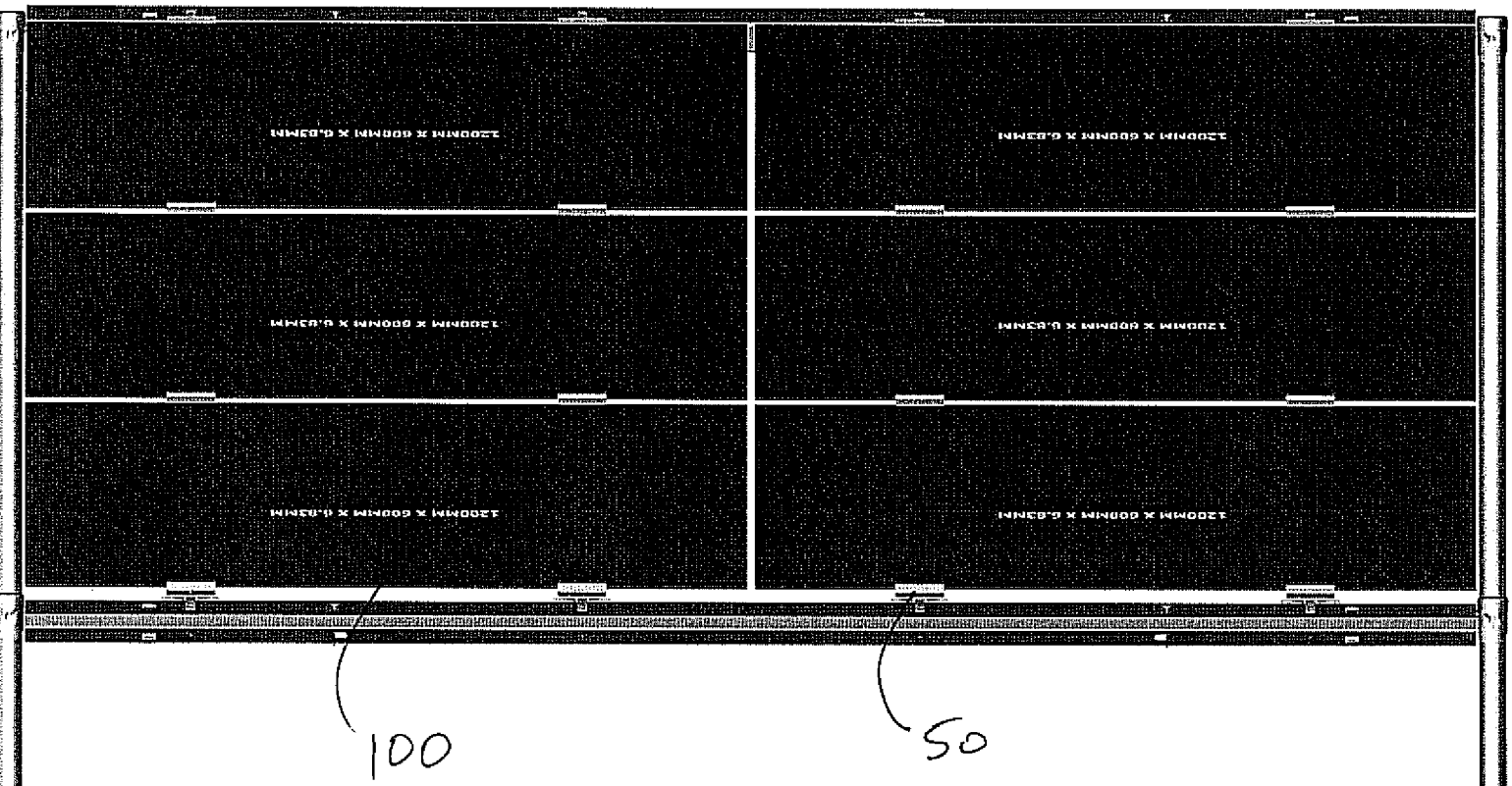


FIG 11



100

50

94

96

92

FIG 12

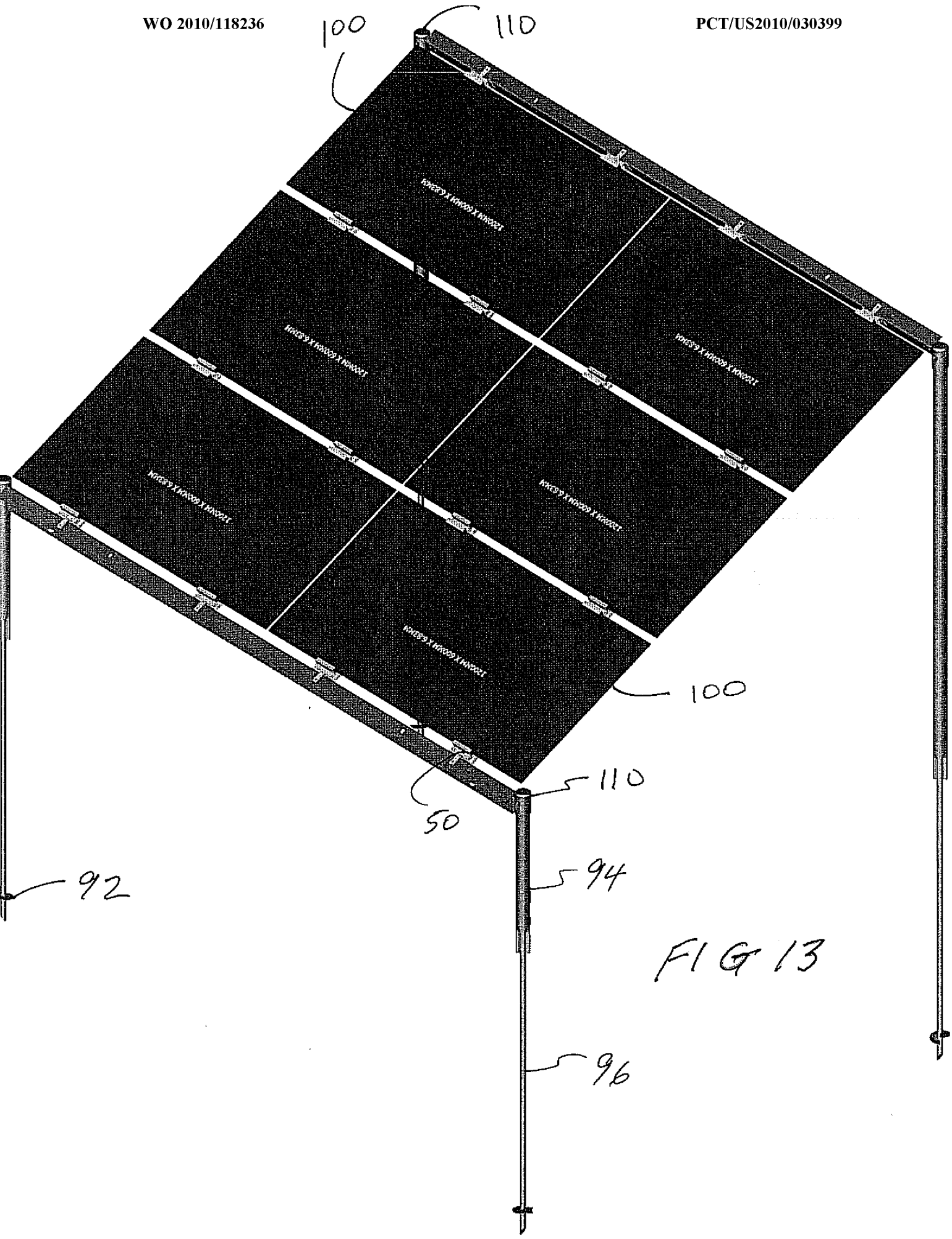


FIG 13

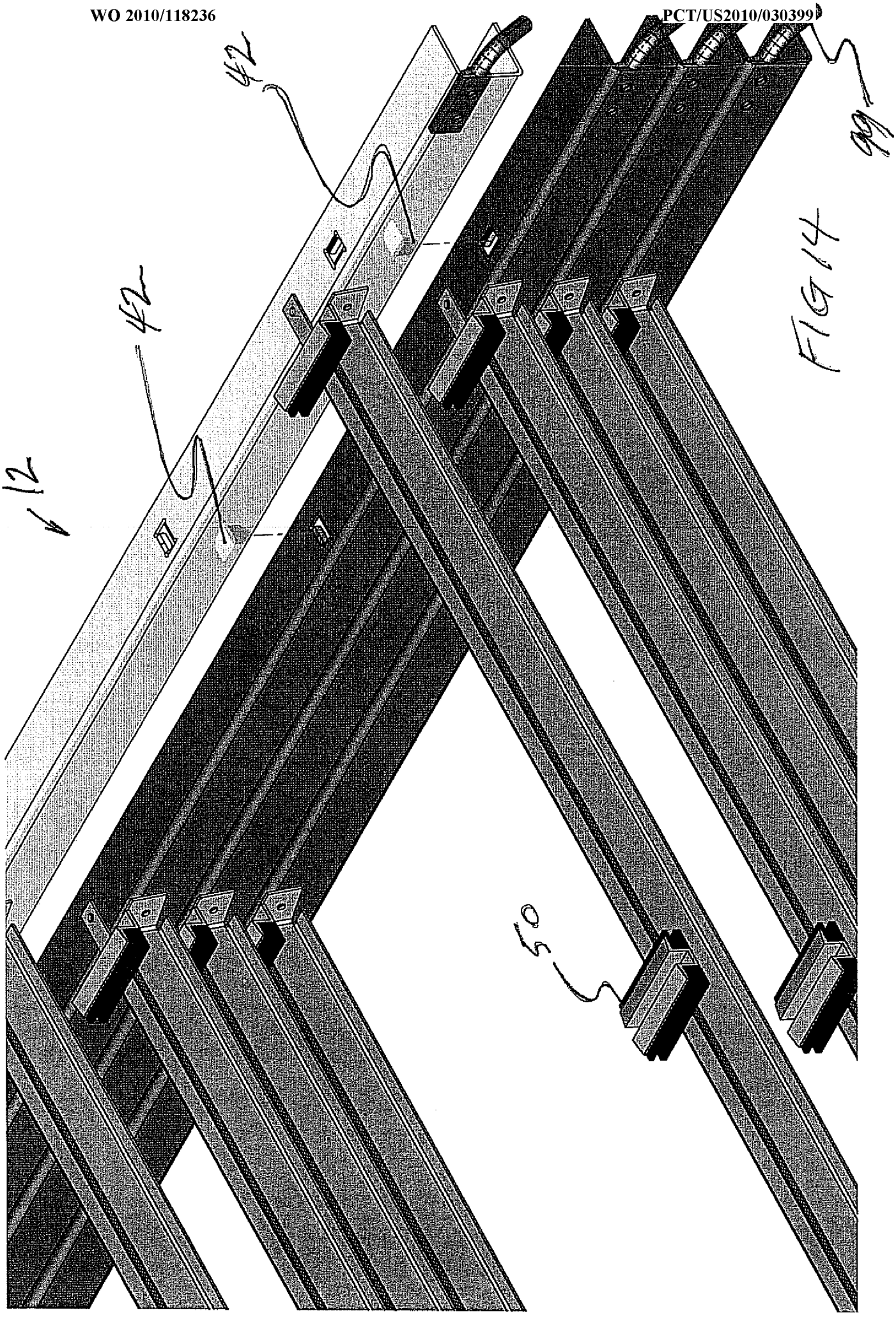


FIG 14

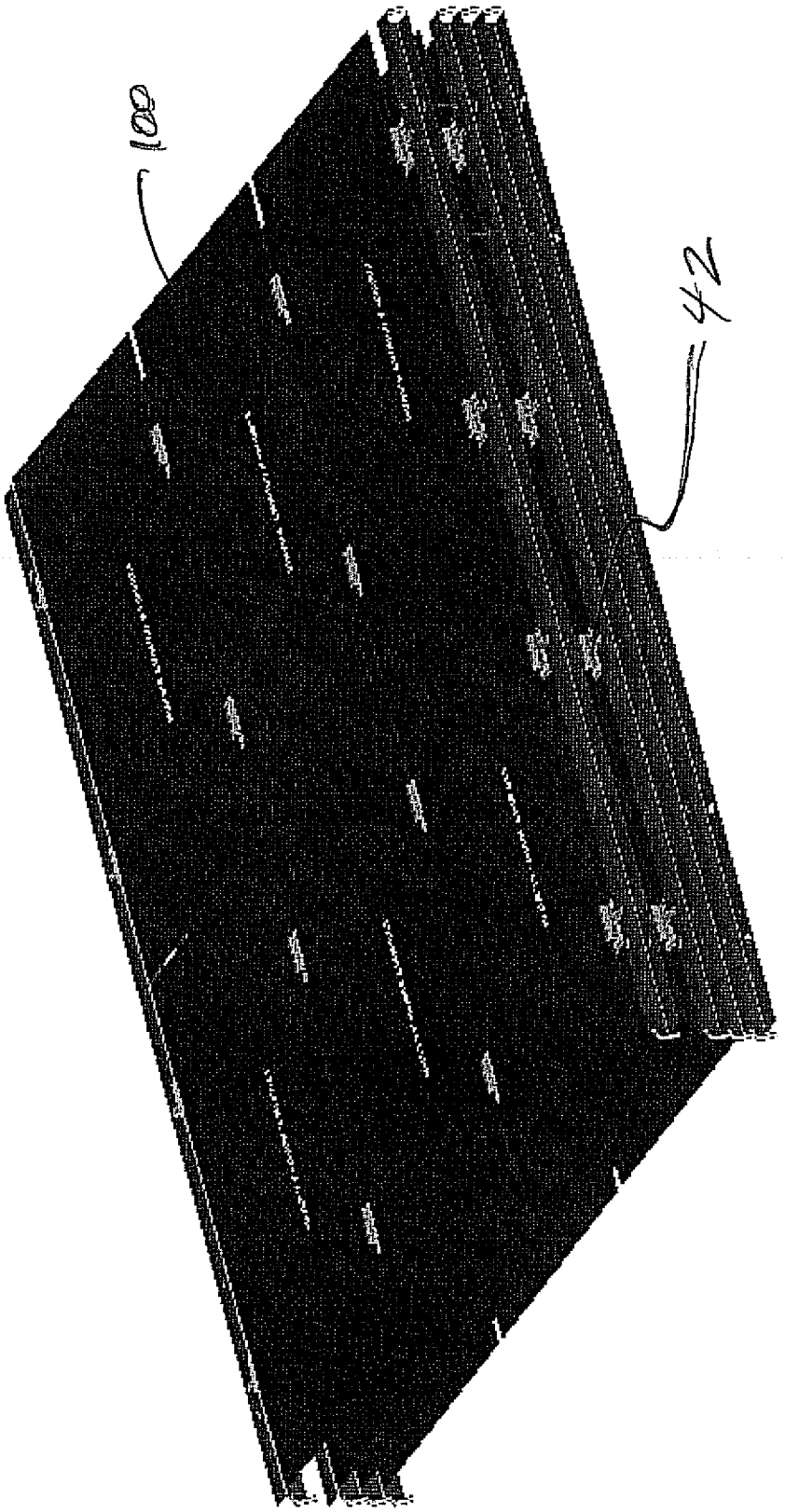


FIG. 15

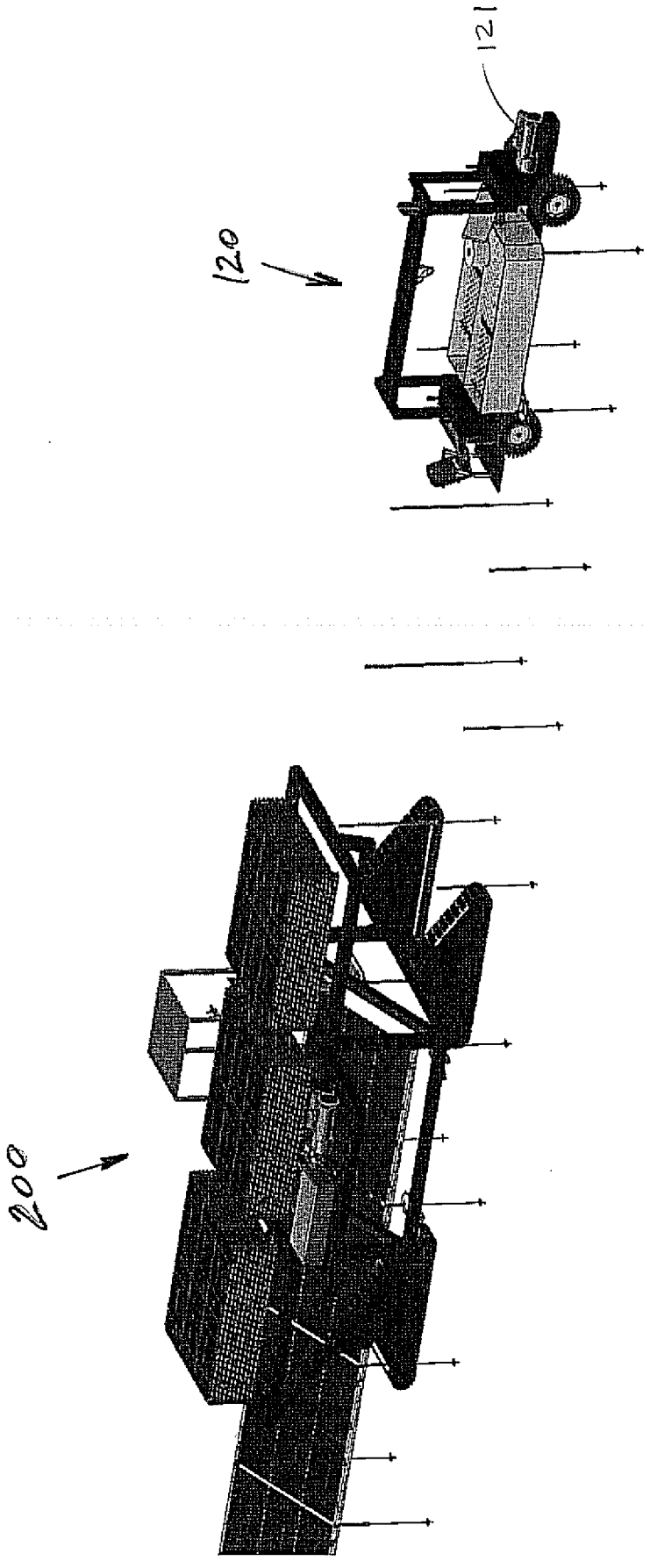


FIG 16

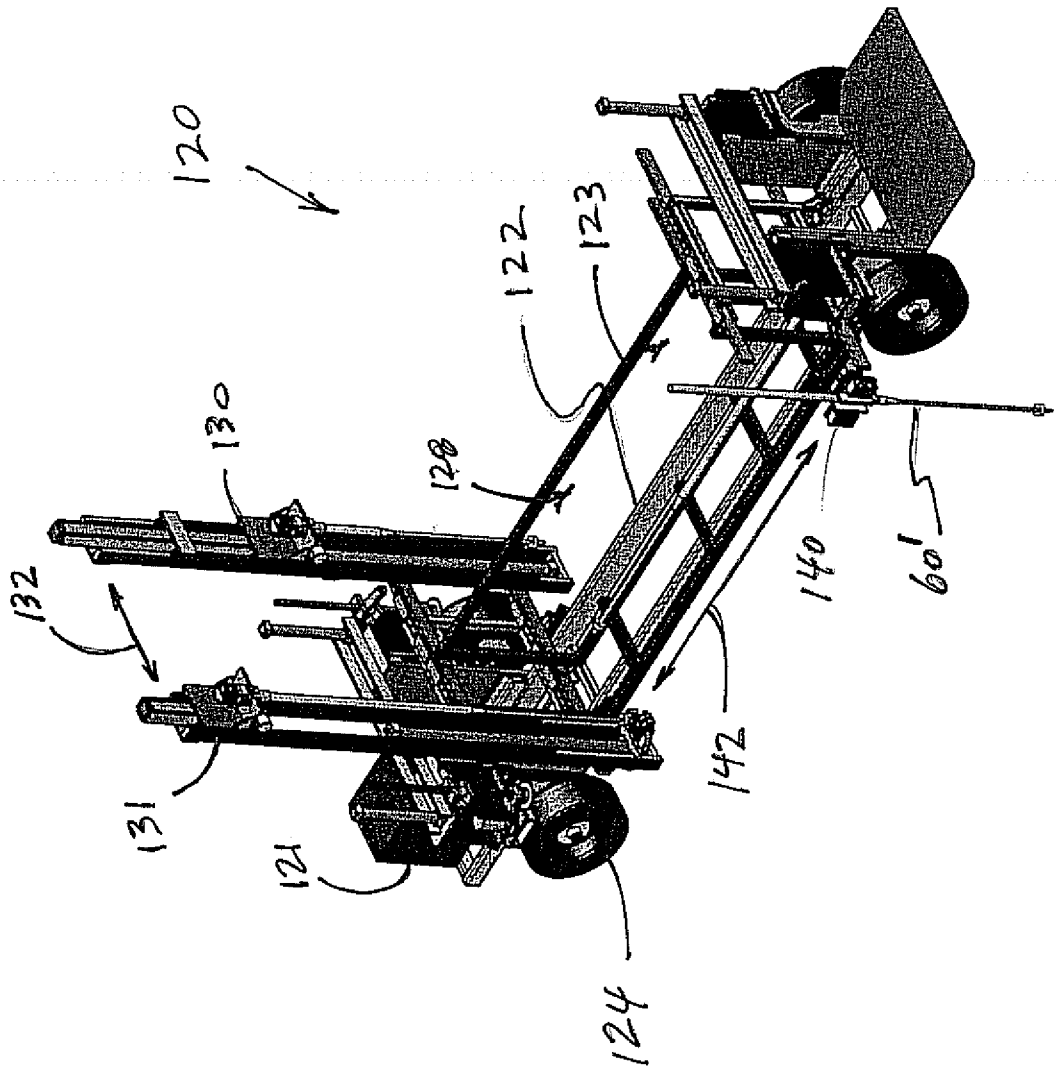


FIG 17

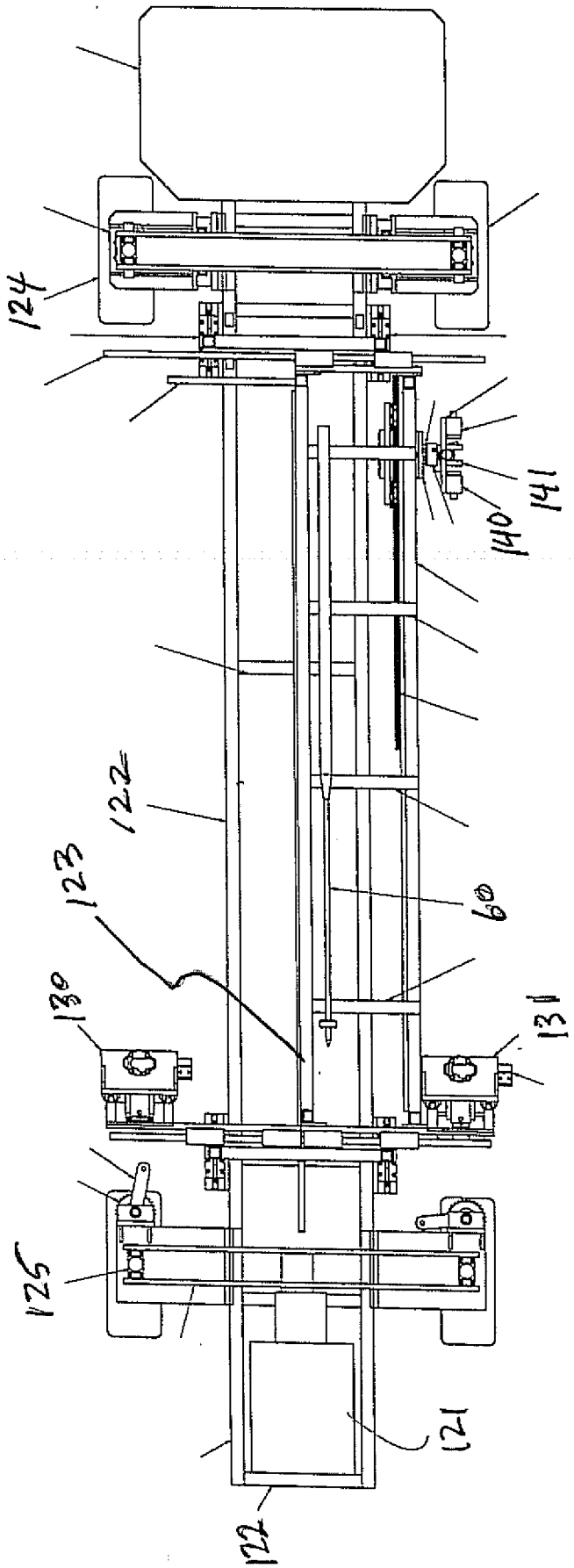


FIG 18

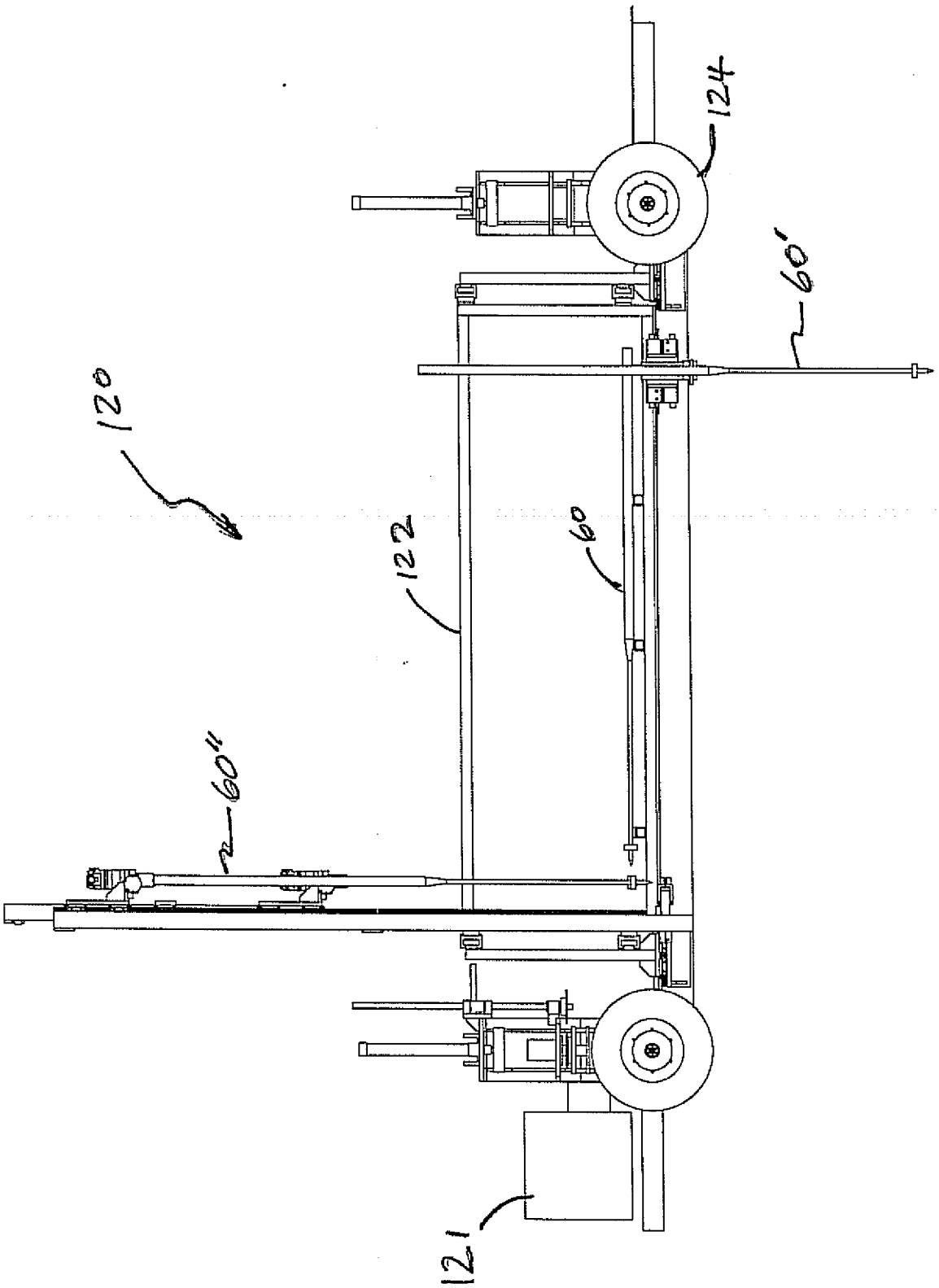


FIG 19

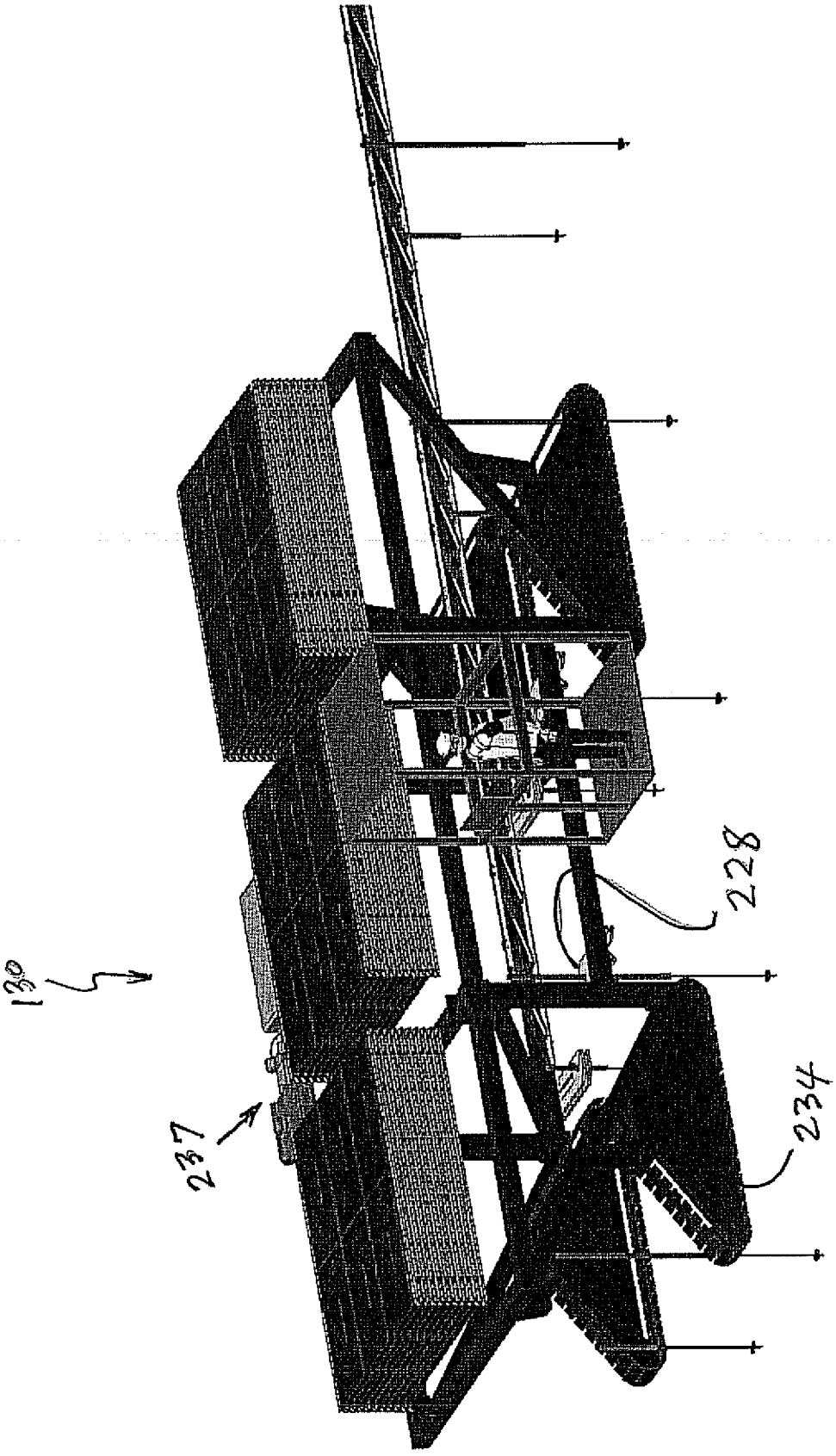


FIG 20

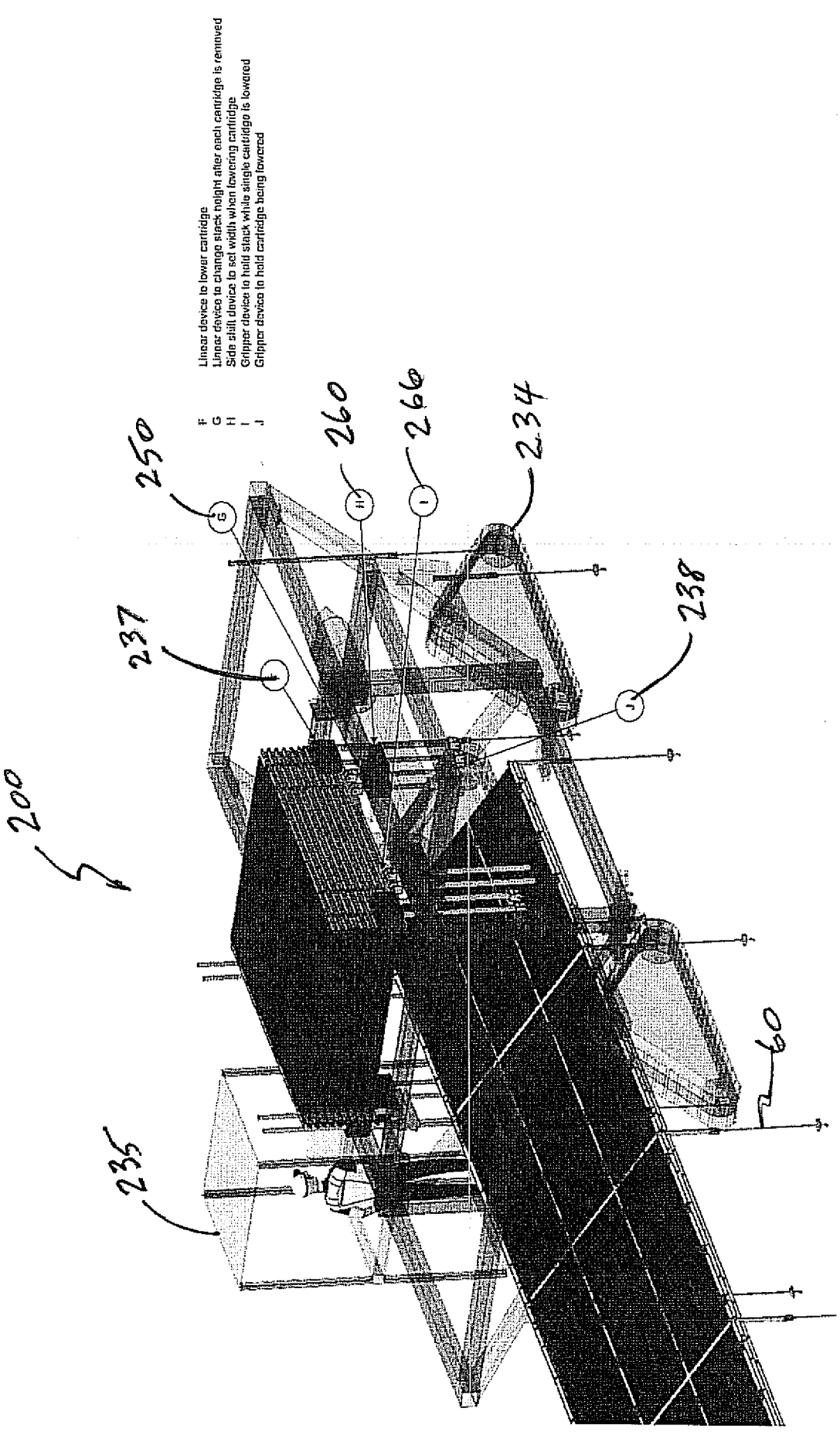

F Linear device to lower cartridge
G Linear device to change stack height after each cartridge is removed
H Side shift device to set width when lowering cartridge
I Gripper device to hold stack while single cartridge is lowered
J Gripper device to hold cartridge being lowered
200
250
260
266
234
237
238
235
60

FIG 21

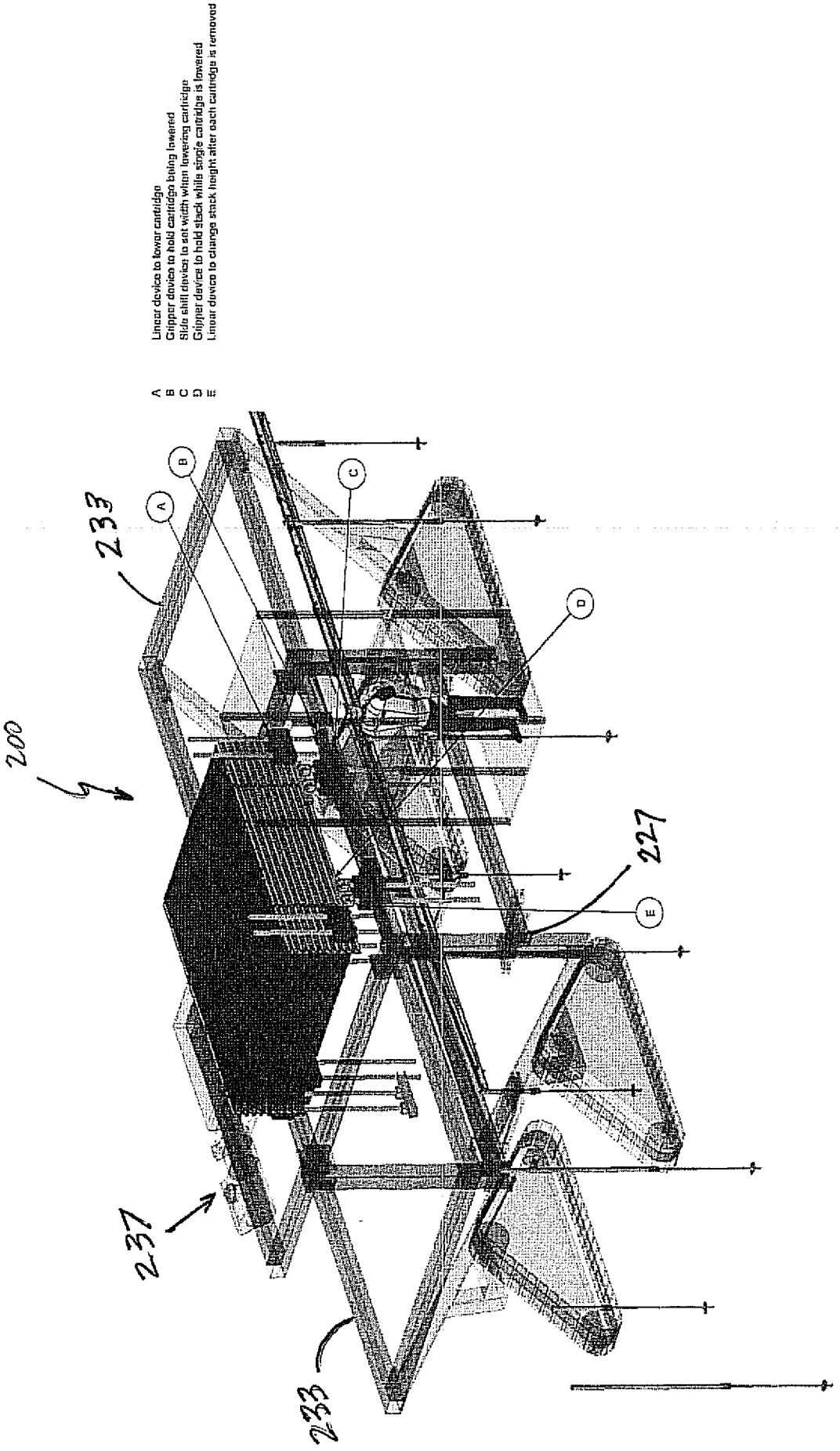

A Linear device to lower cartridge
B Gripper device to hold cartridge being lowered
C Slide shift device to set width when lowering cartridge
D Gripper device to hold stack while single cartridge is lowered
E Linear device to change stack height after each cartridge is removed
200
233
237
233
227

FIG 22

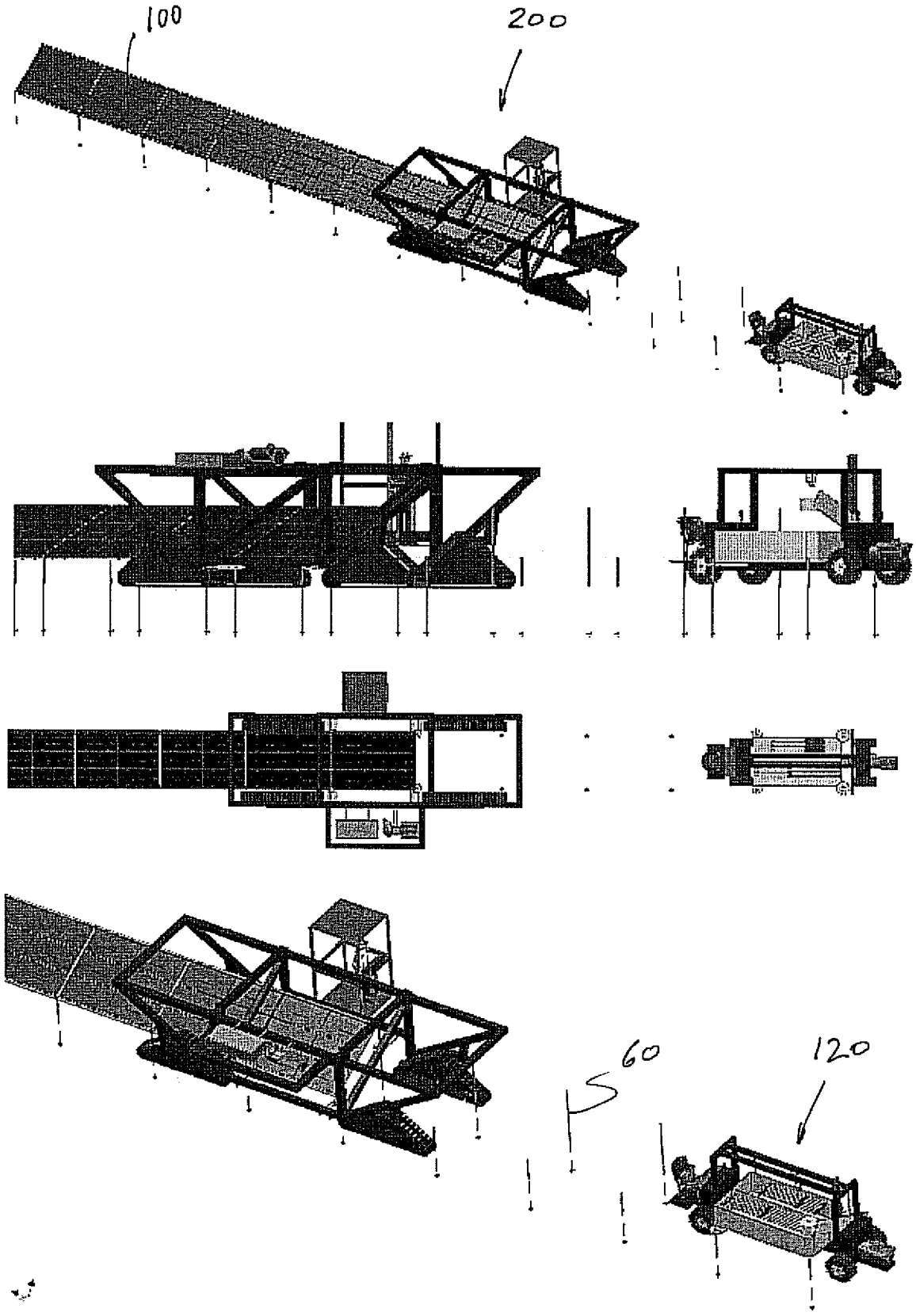


FIG 23

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/30399

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - F24J 2/46 (2010.01)
USPC - 126/704
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 126/704

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 126/569, 600, 704, 705; 108/1, 2, 5-7, 10, 28-34, 144.11; 136/243-245 (keyword limited; terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PUBWEST(PGPB, USPT, EPAB, JPAB); Google
Search Terms Used: z-shape$, z shape$, z, shape$, attach$, connect$, frame, solar, stake, riser, mount, housing, recess, notch, aperture, gap, opening, fasten$3, snap, cap, ballast, rib, indention, tab, photovoltaic, array, support

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,966,631 A (MATLIN et al) 01 September 1992 (01.09.1992) fig 1, col 3, ln 13-16, col 3, ln 44-46	1-10
Y	US 2003/0034029 A1 (SHINGLETON) 20 February 2003 (20.02.2003) fig 1, para [0024, [0042]	1-10
Y	US 2008/0245360 A1 (ALMY et al) 09 October 2008 (09.10.2008) fig 1a, para [0034], [0036]	2, 5
Y	US 4,204,523 A (ROTHE) 27 May 1980 (27.05.1980) col 3, ln 2-10	3, 5
Y	US 2008/0087320 A1 (MAPES et al) 17 April 2008 (17.04.2008) fig 10, para [0064]	4, 7, 9-10
Y	US 2008/0029148 A1 (THOMPSON) 07 February 2008 (07.02.2008) para [0053]	8-10

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 July 2010 (26.07.2010)	09 AUG 2010
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/30399

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Group I: Claims 1-10 are directed to a solar panel support, comprising a frame, risers, and at least one support member extends between the top and bottom of the support.

Group II: Claims 11-16 are directed to an automated method of populating an area with solar panel supports having a frame and risers for supporting the frame using a carrier.

Group III: Claims 17-20 are directed to an anchor vehicle for anchoring solar panel support risers into the ground surface including an anchor driver.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-10

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.