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(54) **PHOTOVOLTAIC MODULE GROUND MOUNT**

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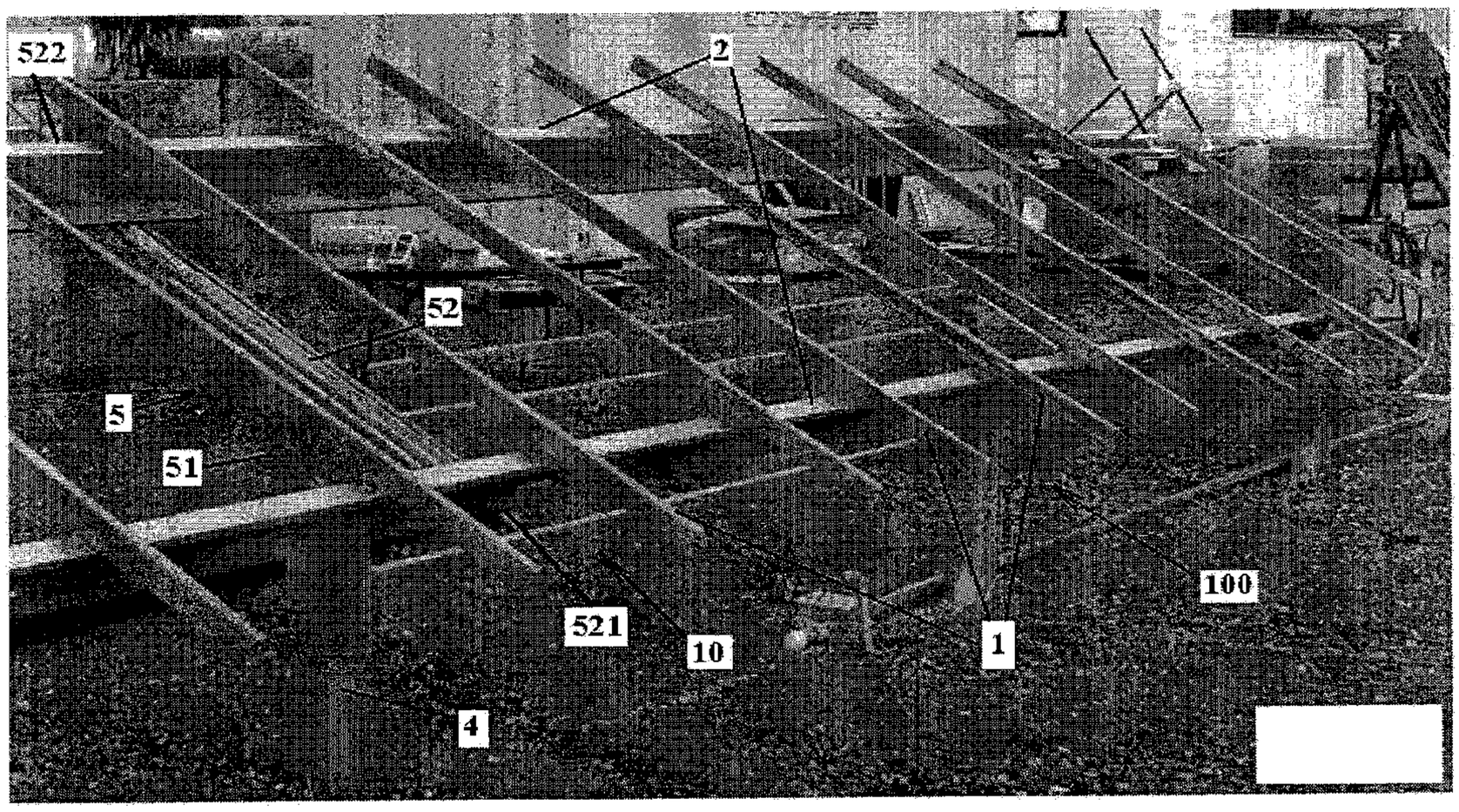
(57) **ABSTRACT**

A collapsible photovoltaic module mounting assembly framework for mounting a plurality of photovoltaic modules thereon, comprising a plurality of module support rails each configured to be attached to a portion of a photovoltaic module and a plurality of supporting beams. A first of the supporting beams is positioned under, and pivotally connected to, a first portion of the rails and a second of the supporting beams is positioned under, and pivotally connected to, a second portion of the rails. The supporting beams can be moved to a relative position adjacent to each other by moving the rails from a first orientation substantially perpendicular to the supporting beams to a second orientation substantially oblique to the supporting beams. Further, each supporting beam has a plurality of openings through which a hardware connector can be passed to connect the supporting beam to a support structure.



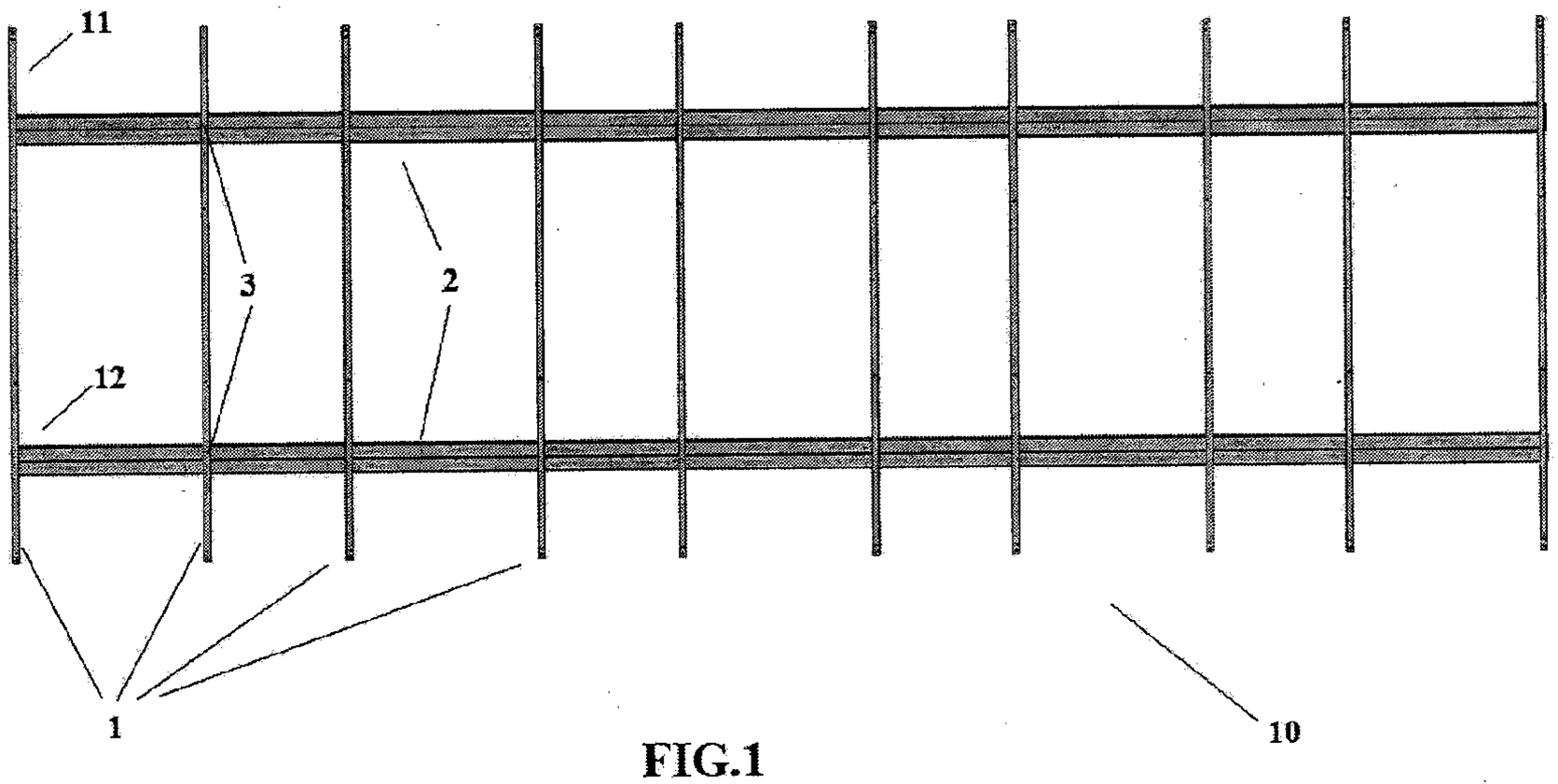


FIG.1

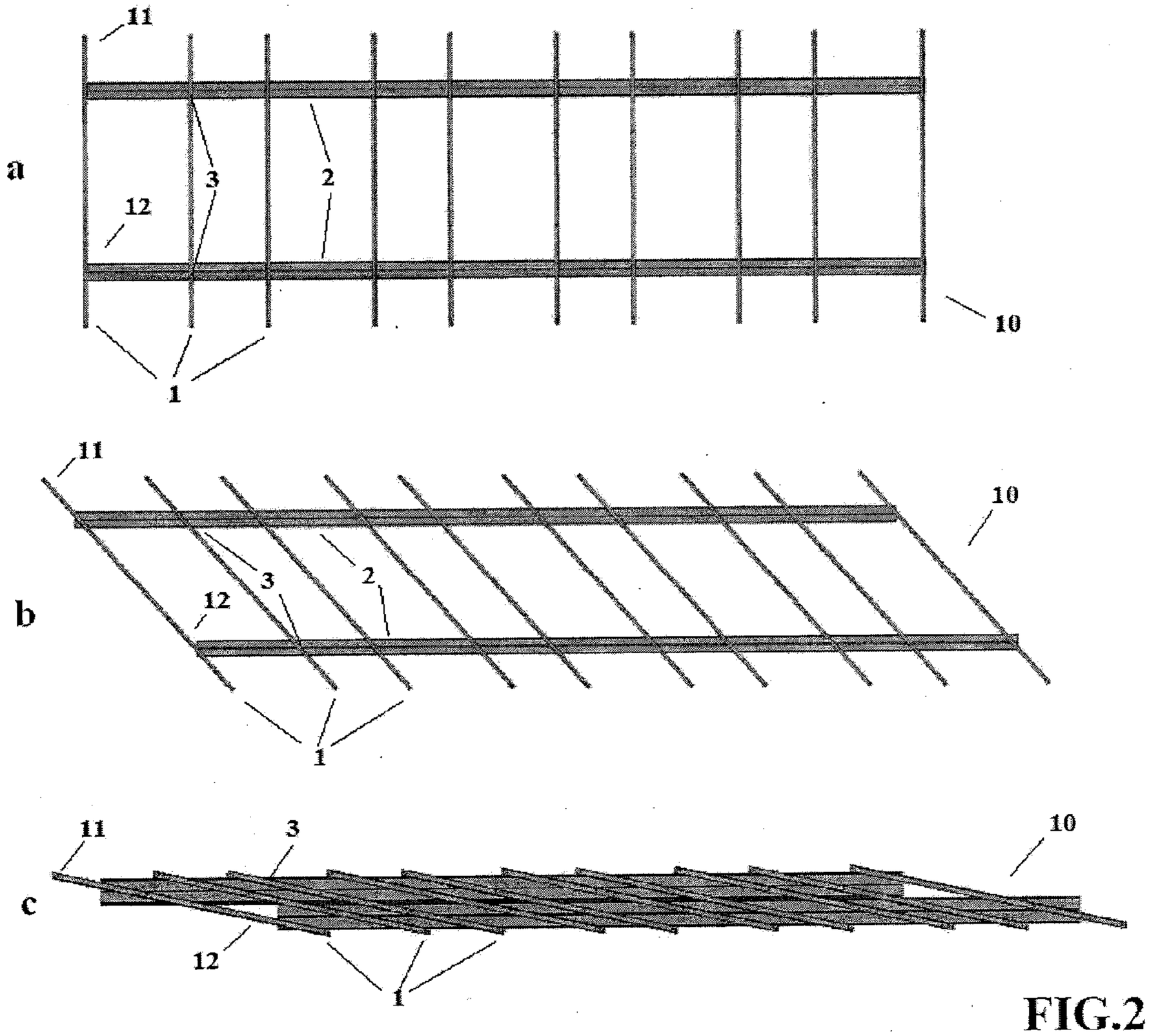


FIG.2

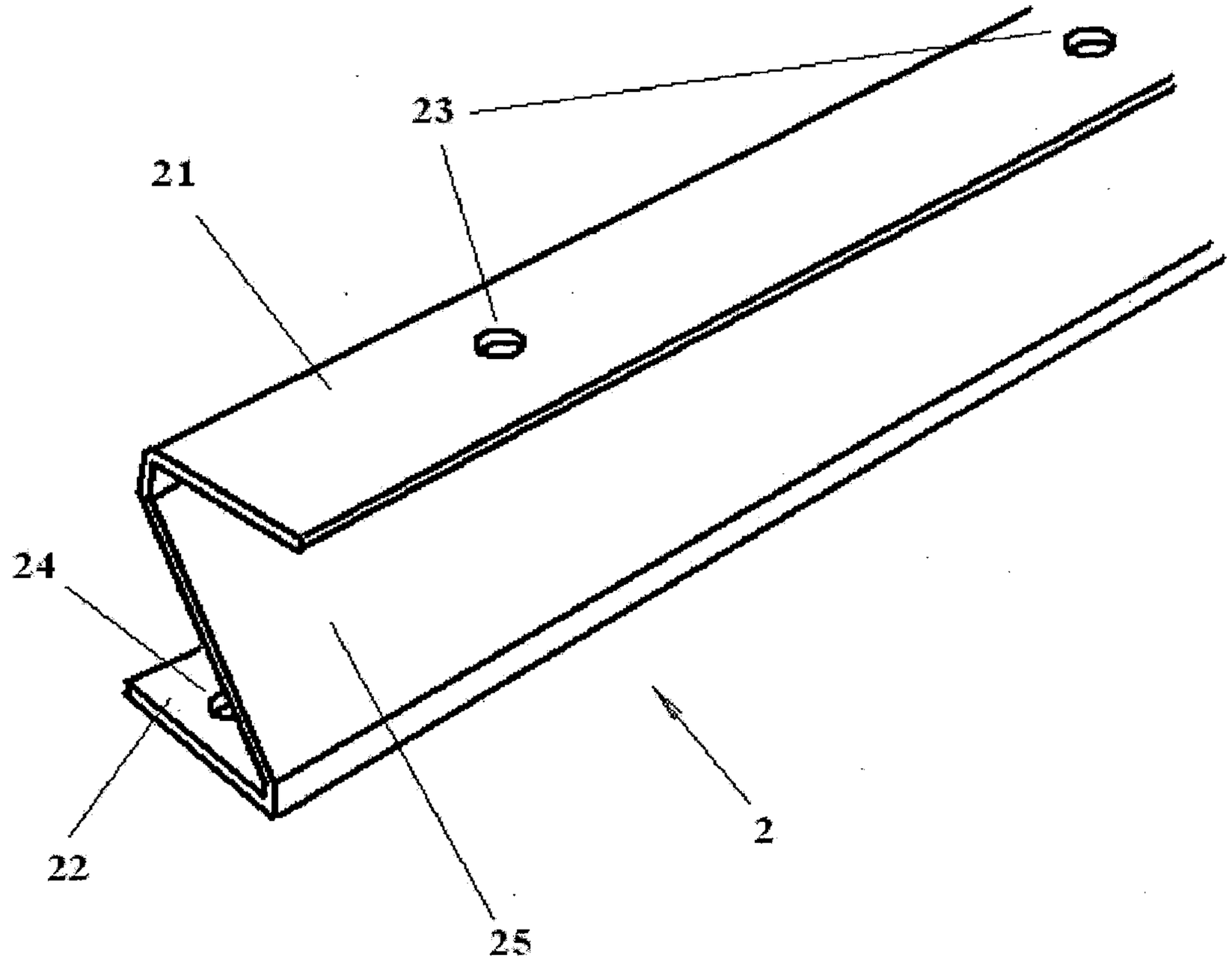


FIG.3

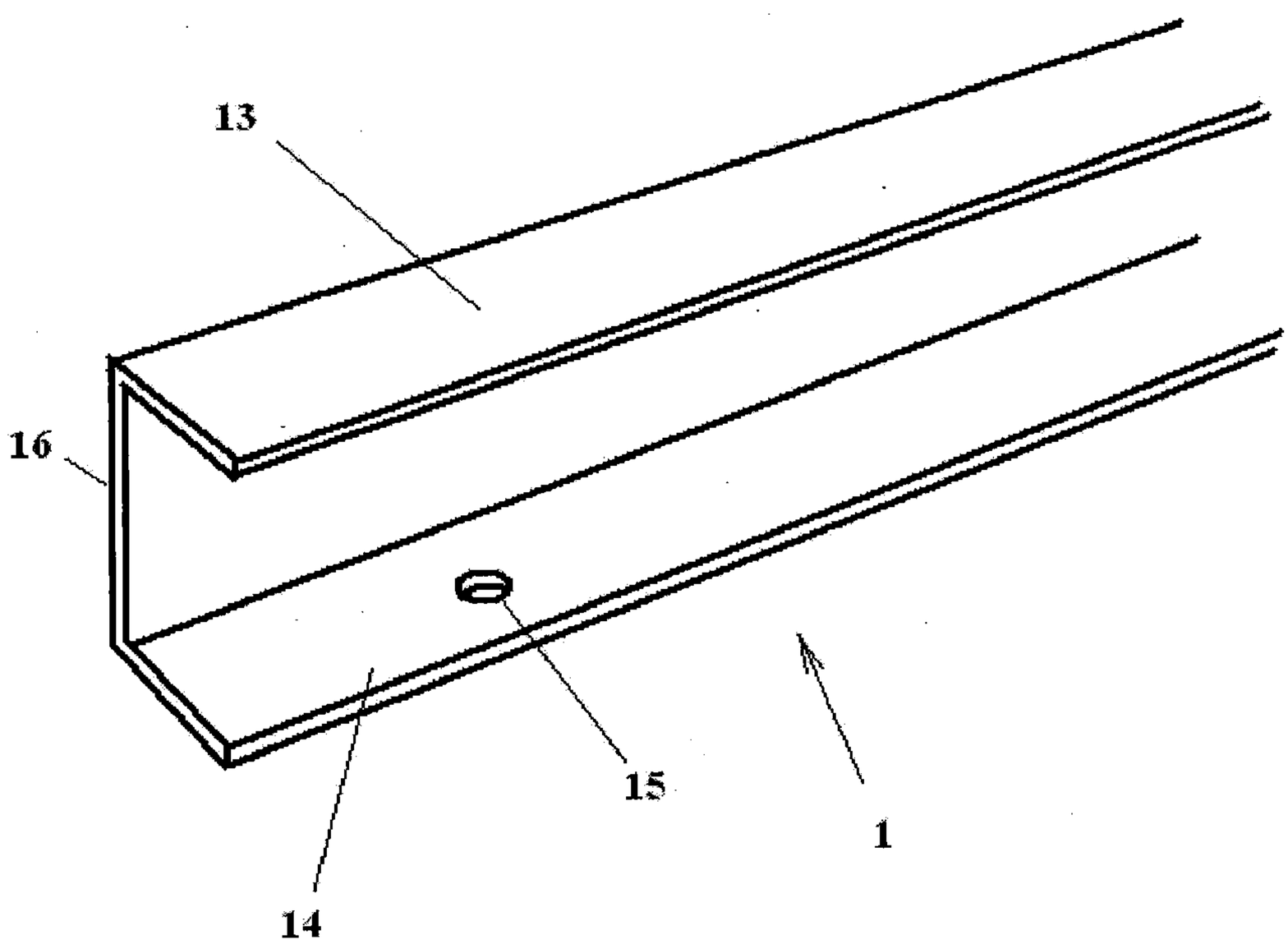
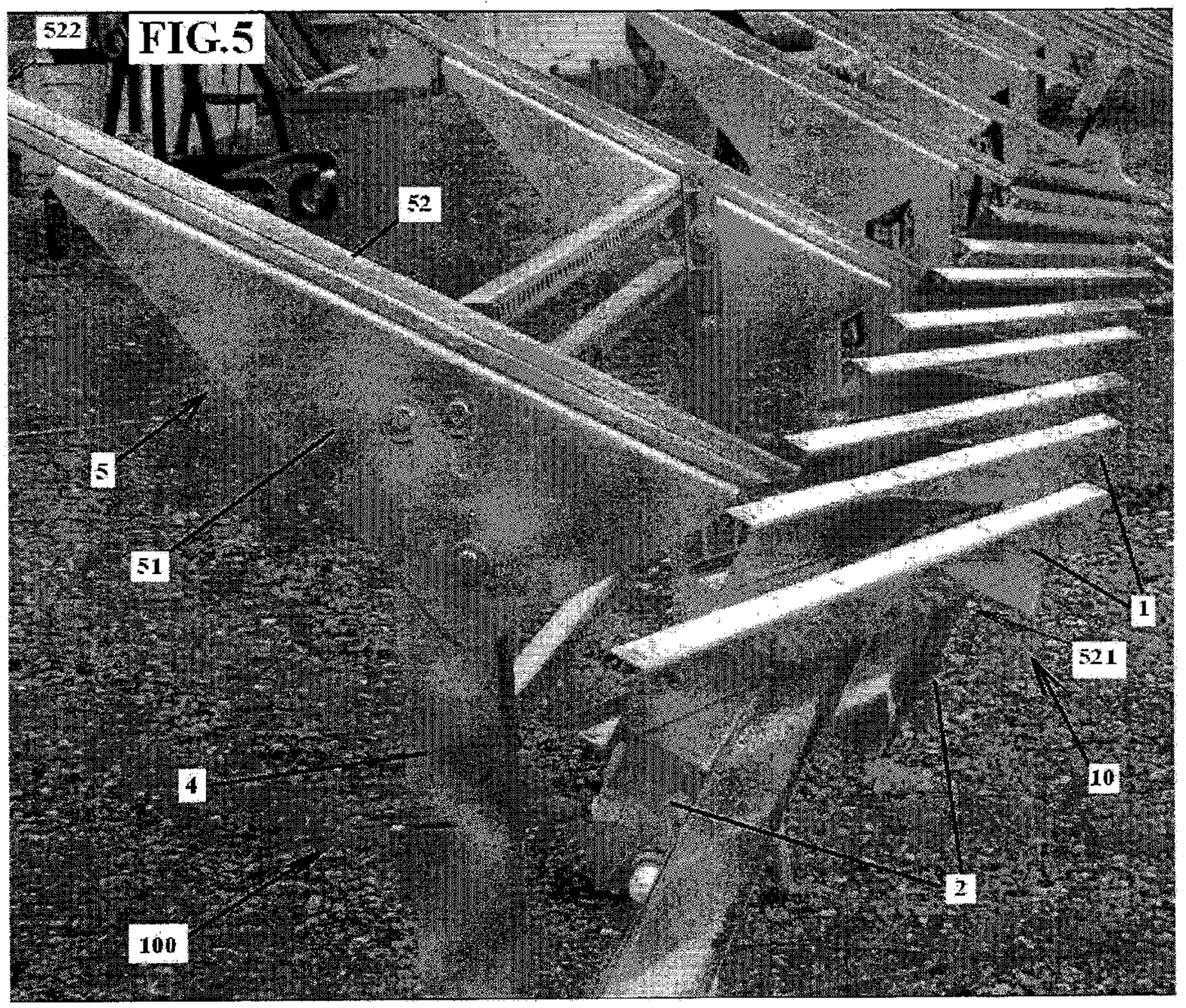


FIG.4

FIG.5



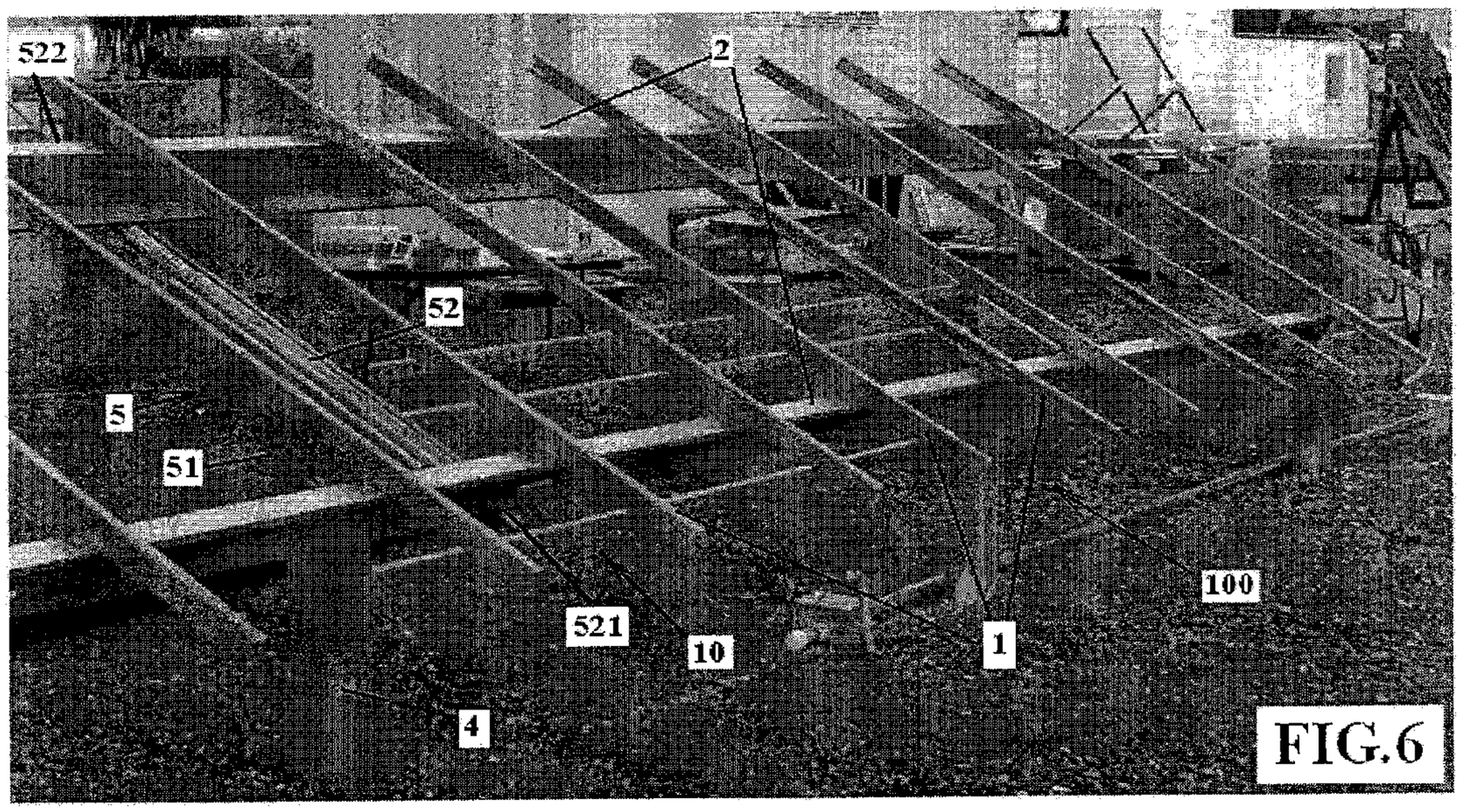


FIG.6

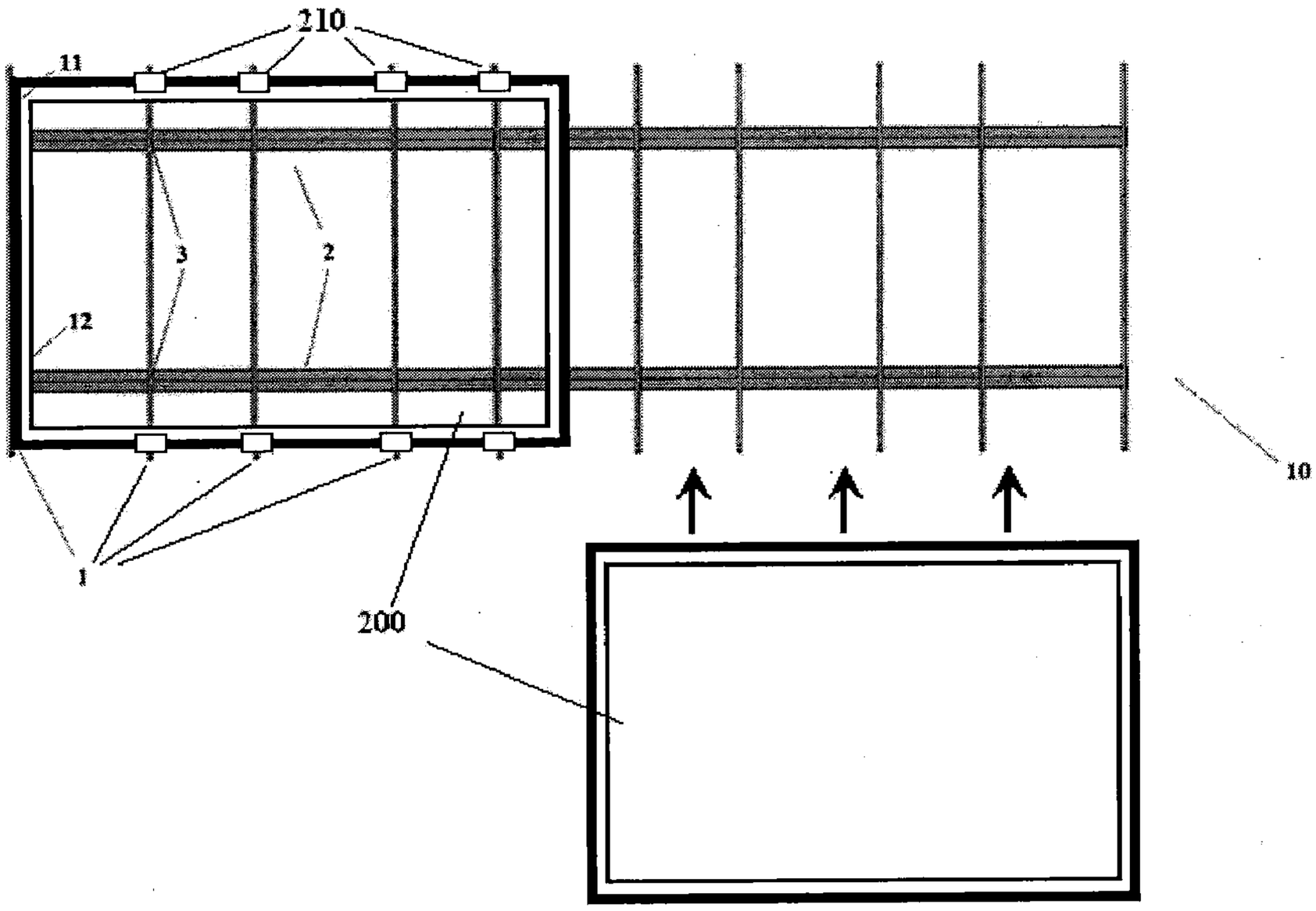


FIG.7

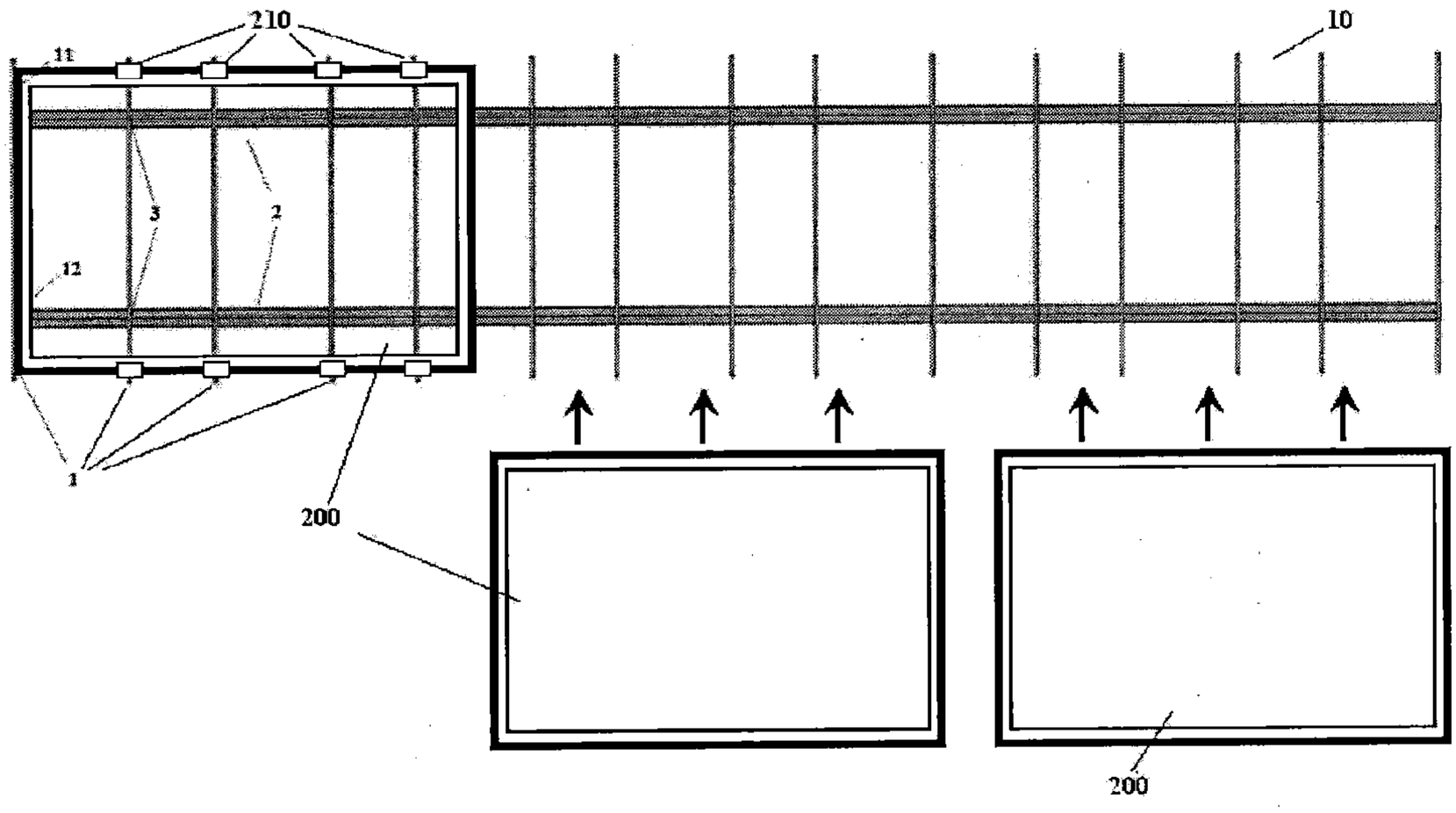


FIG. 8

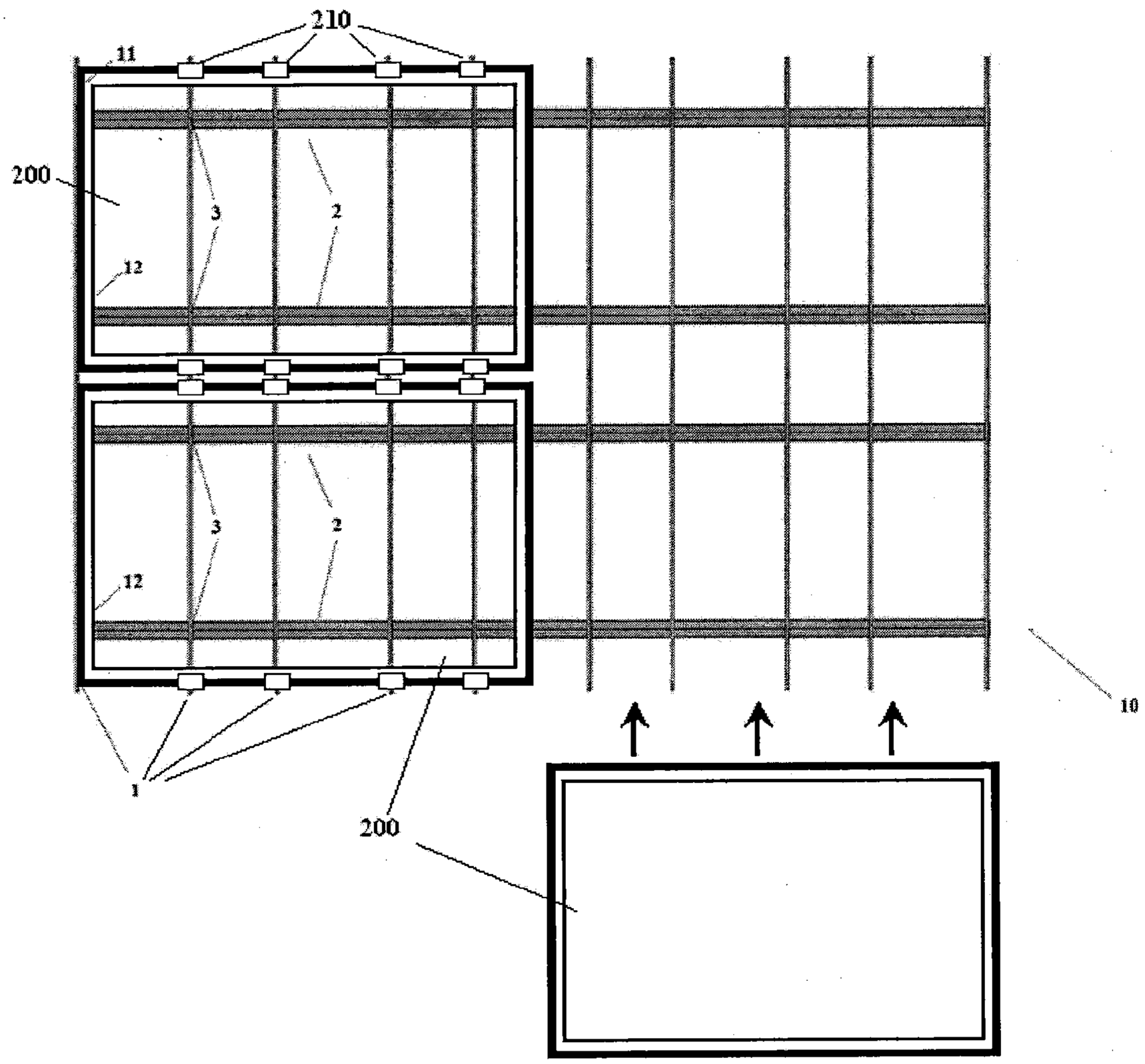


FIG.9

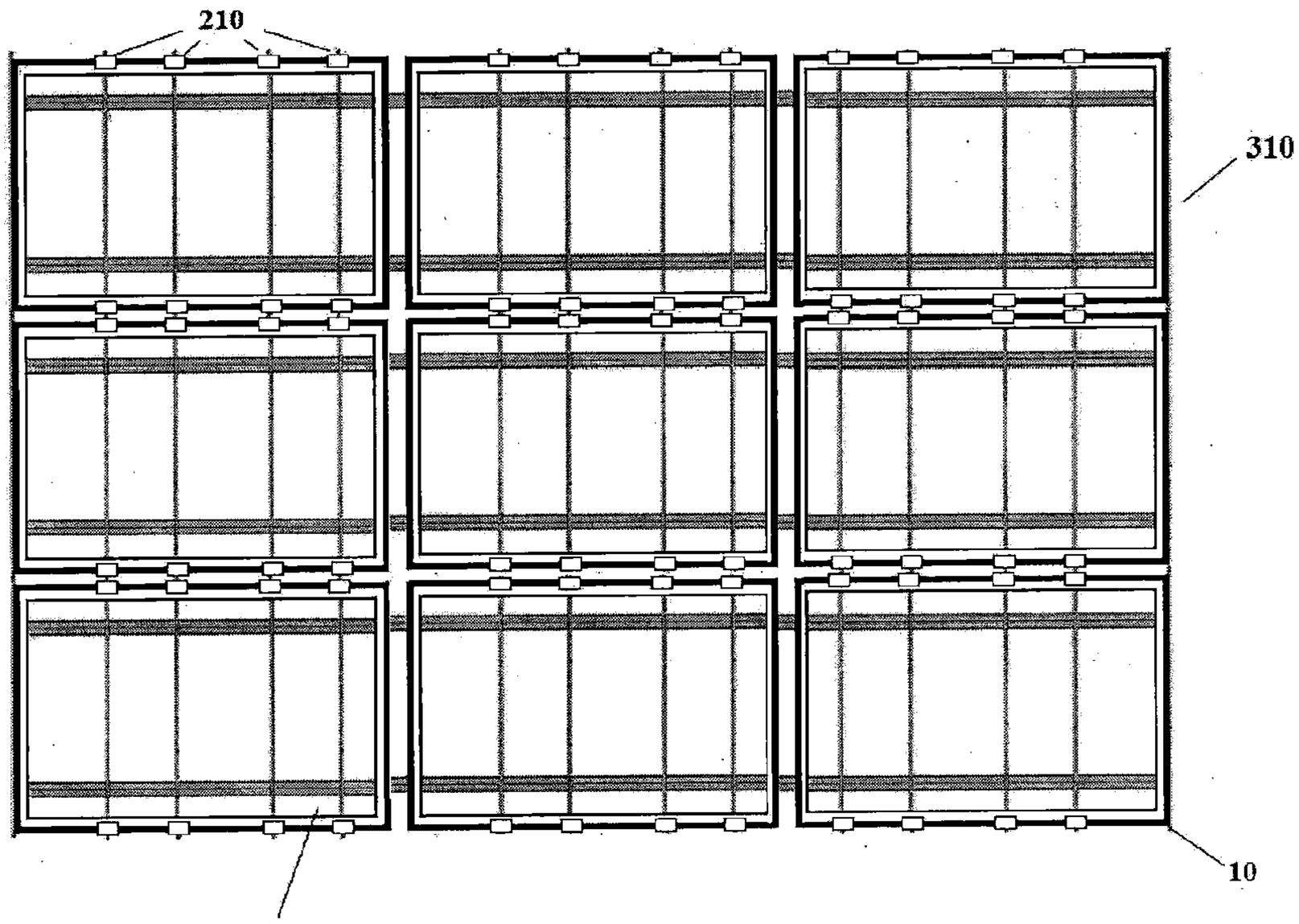


FIG.10

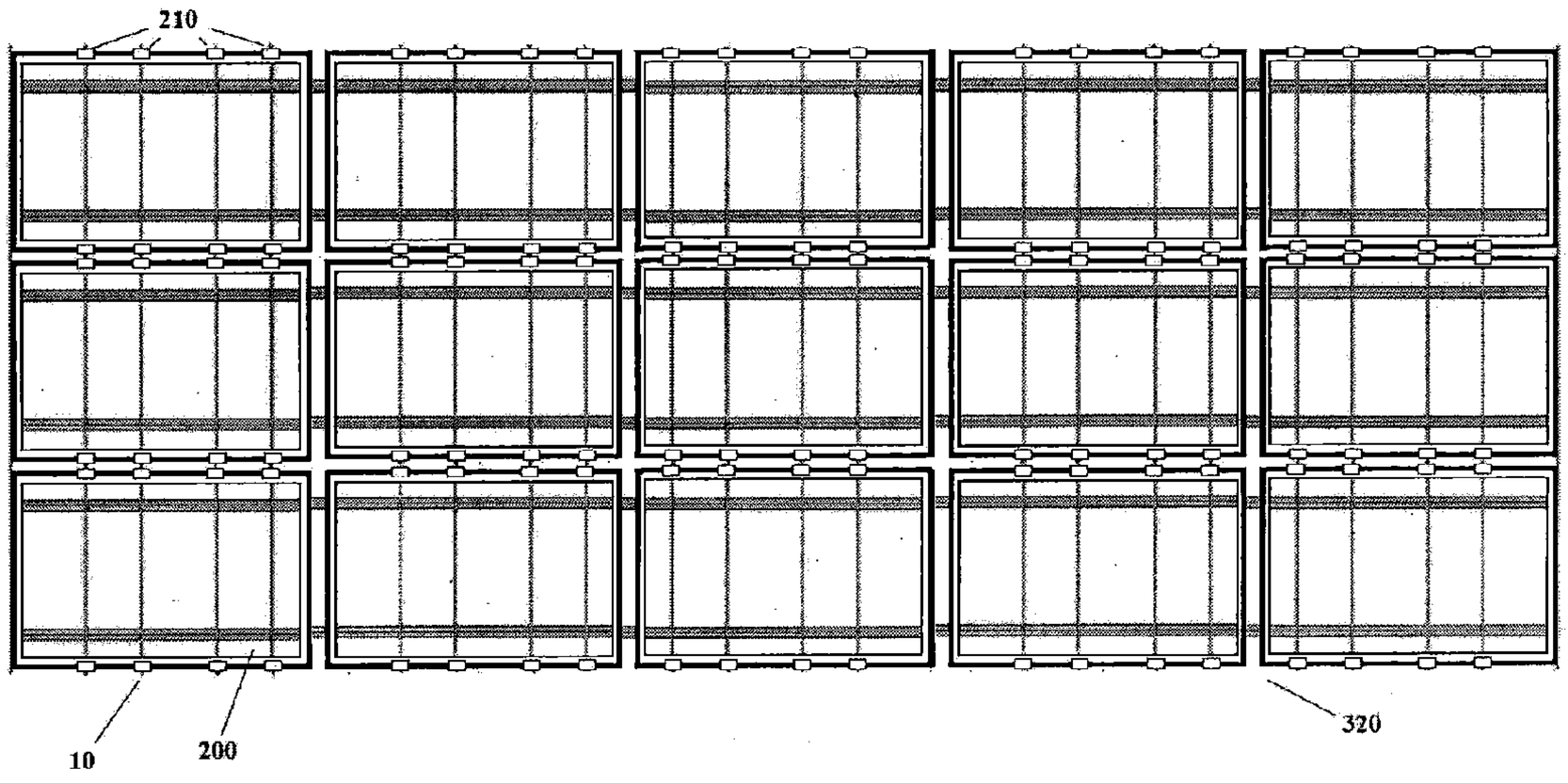


FIG.11

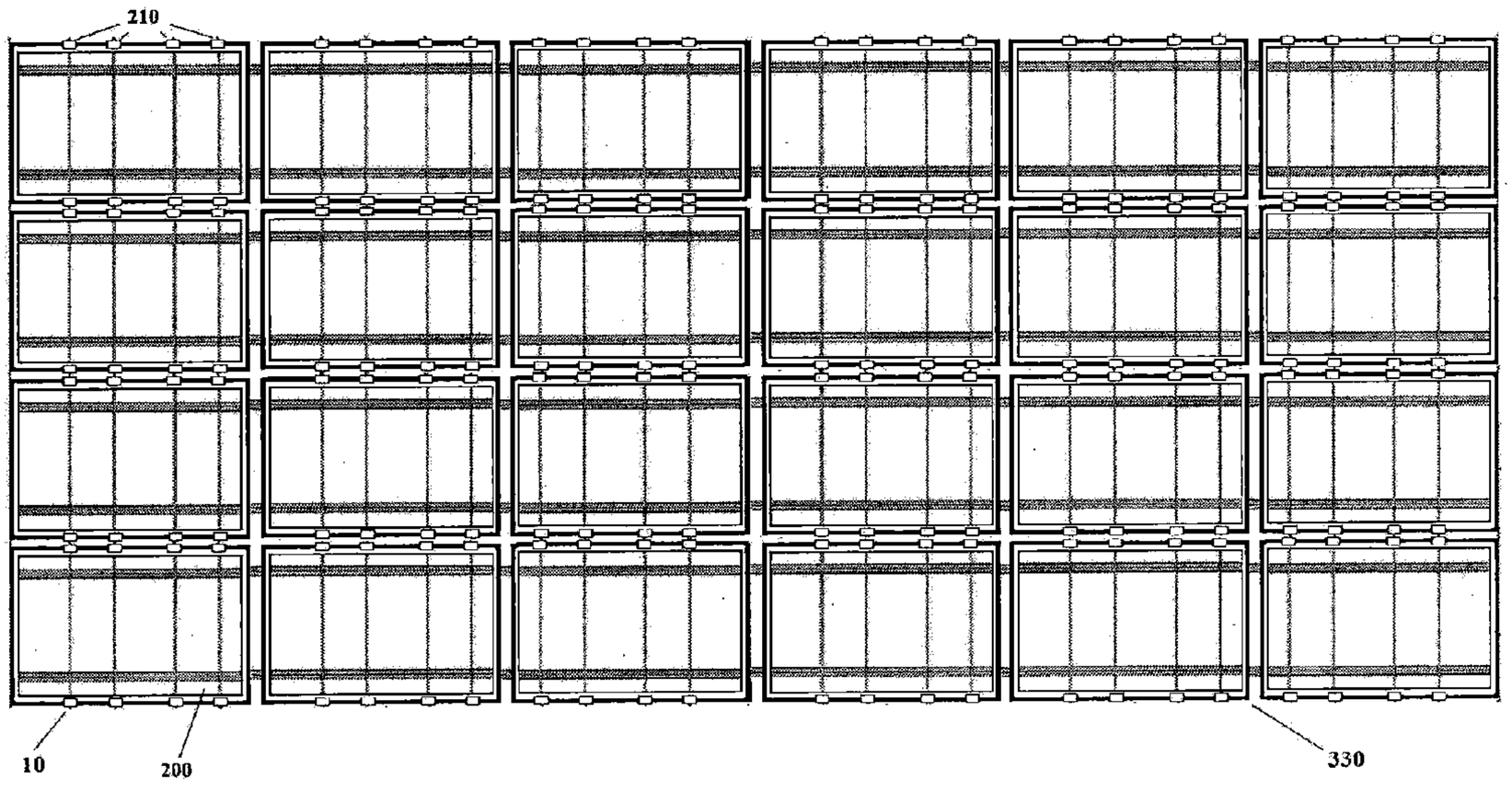


FIG.12

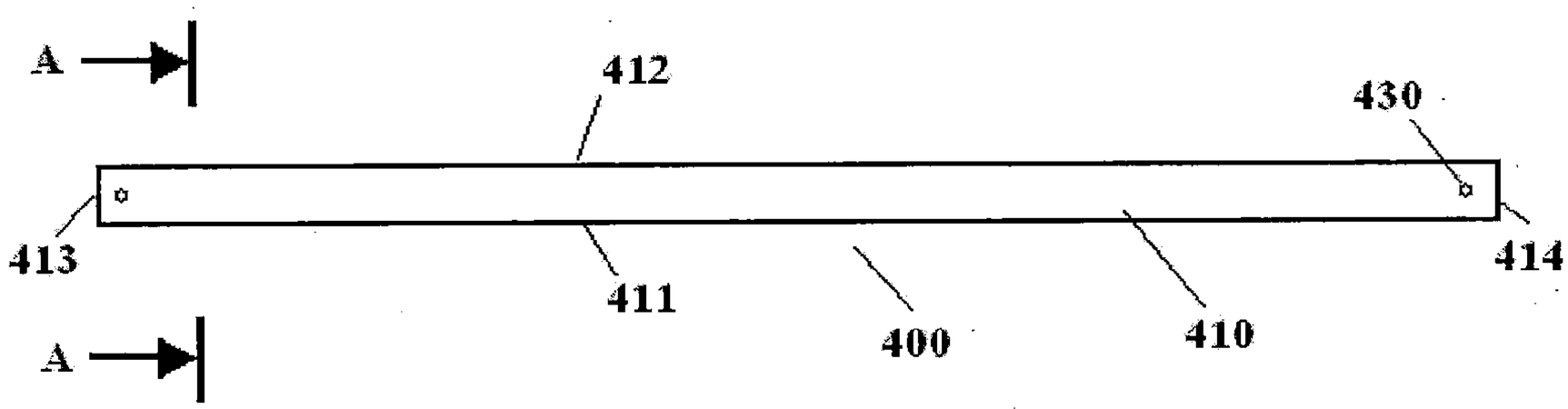
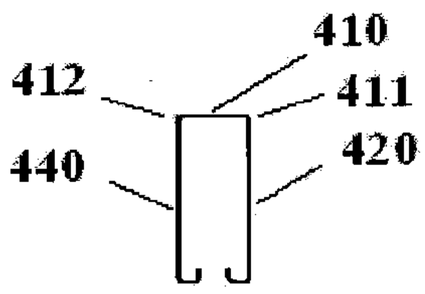


FIG.13



A - A

FIG.13 A

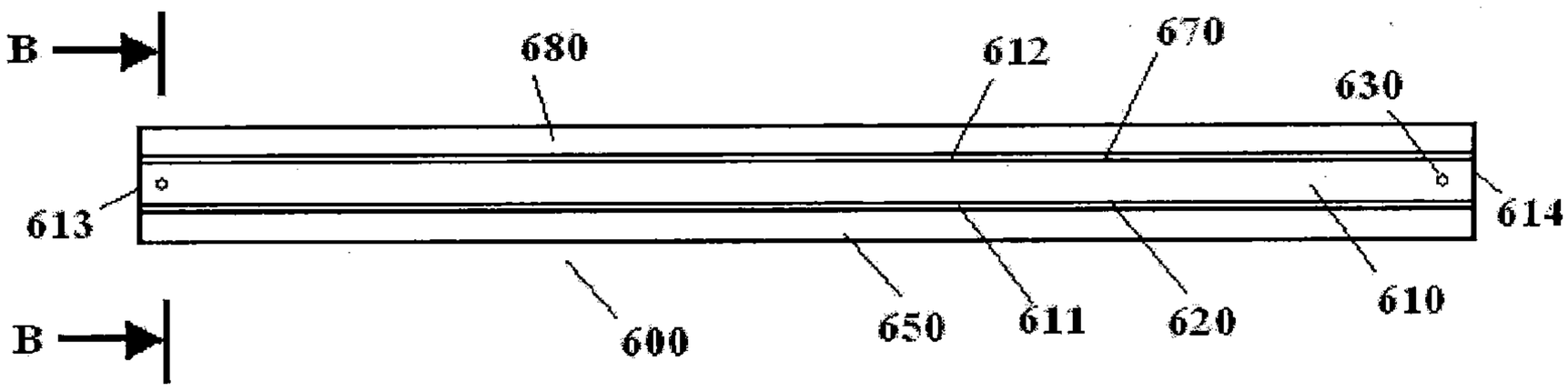
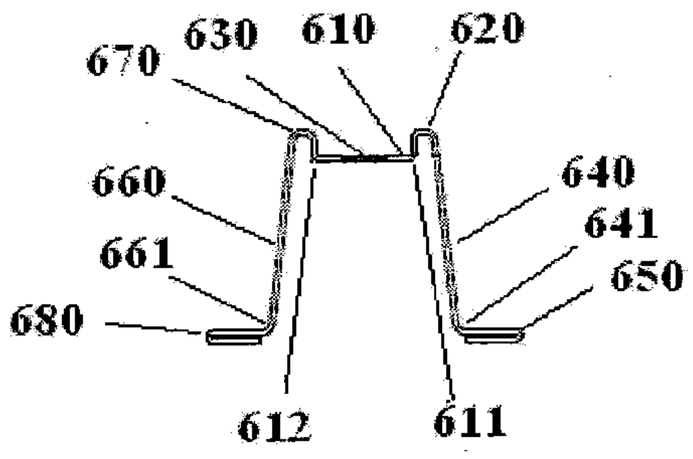


FIG.14



B - B

FIG.14A

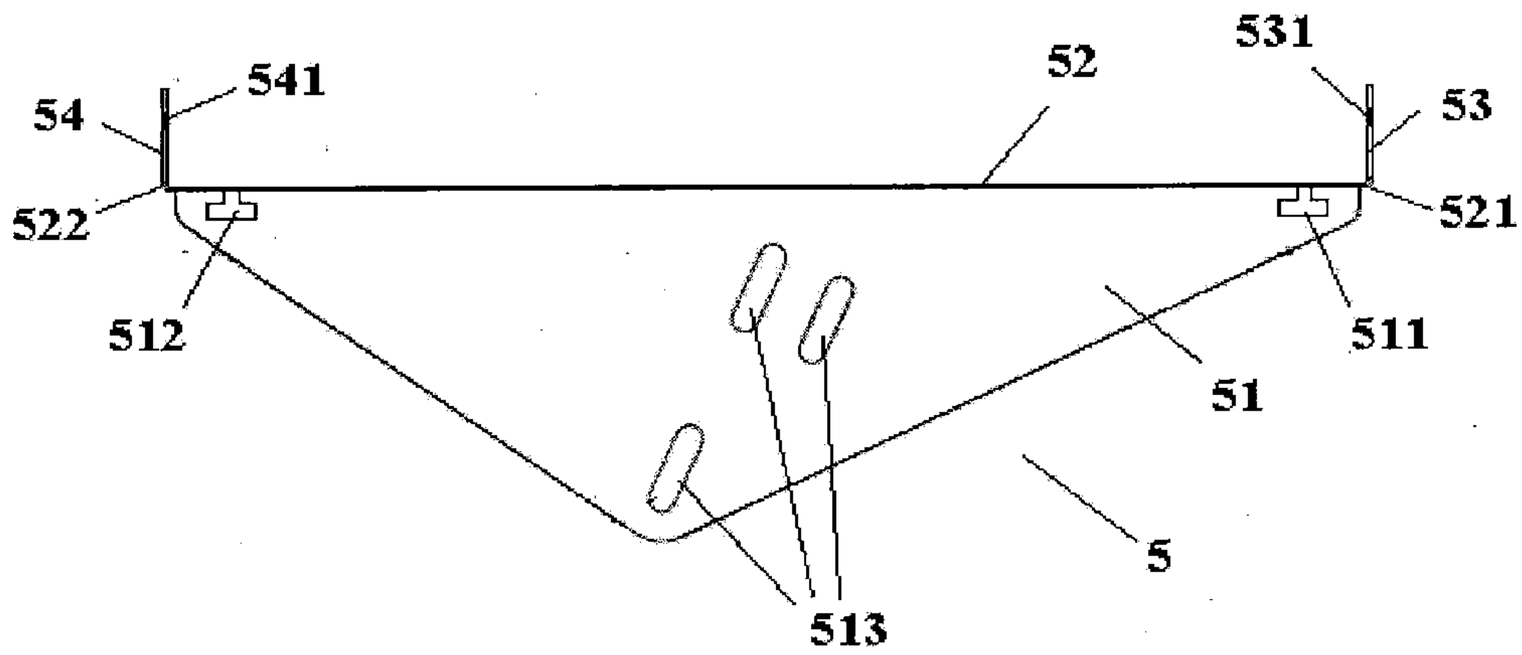


FIG.15

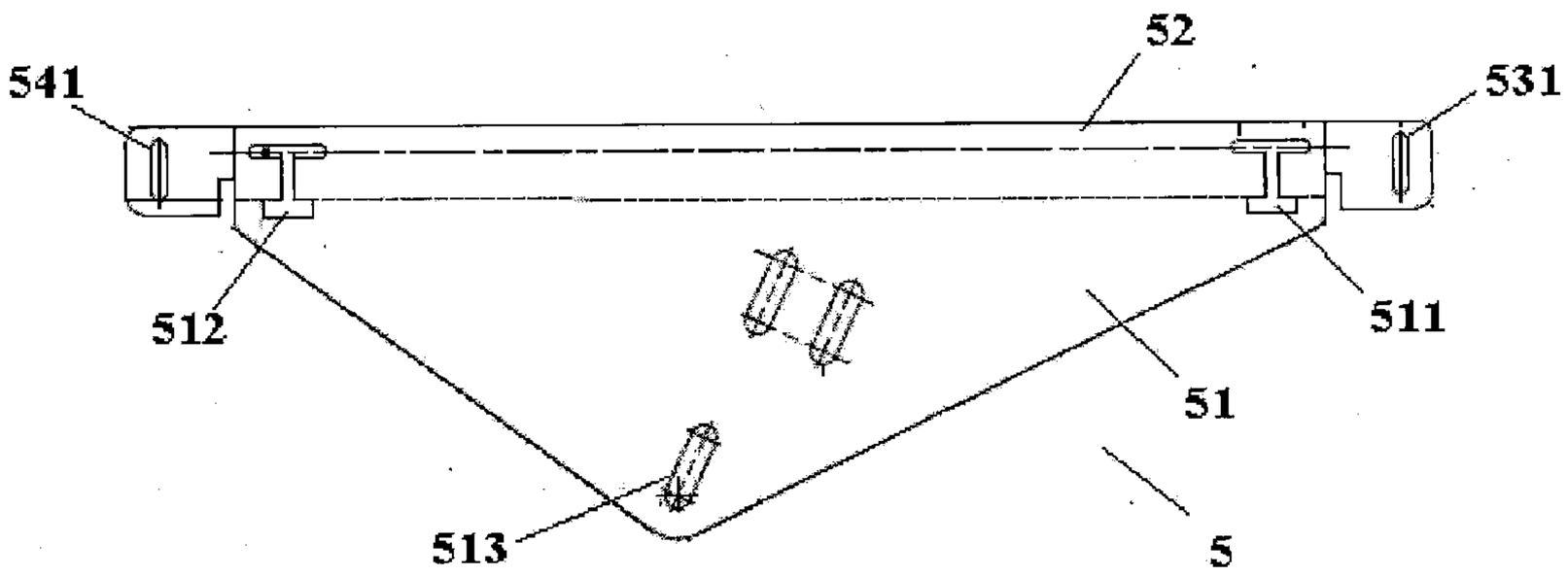


FIG.15A

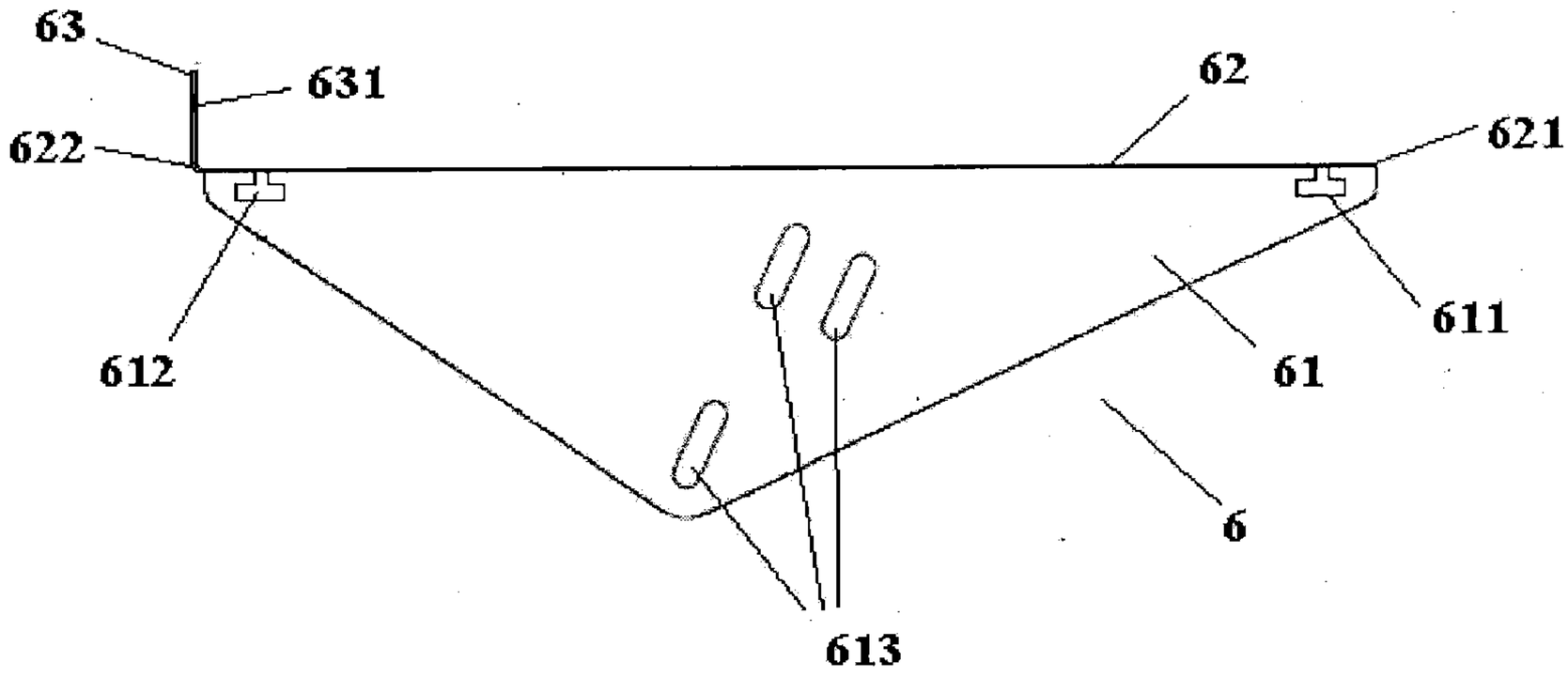


FIG.16

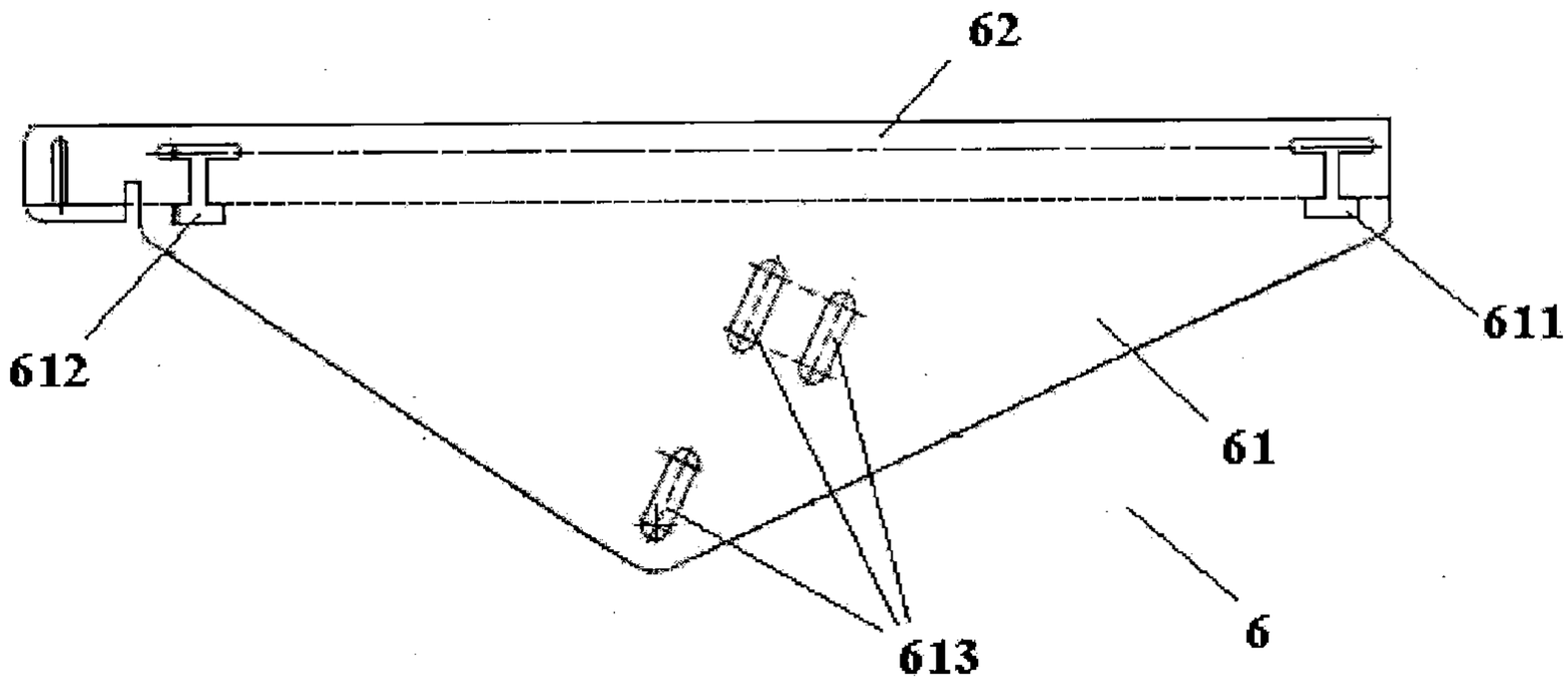


FIG.16A

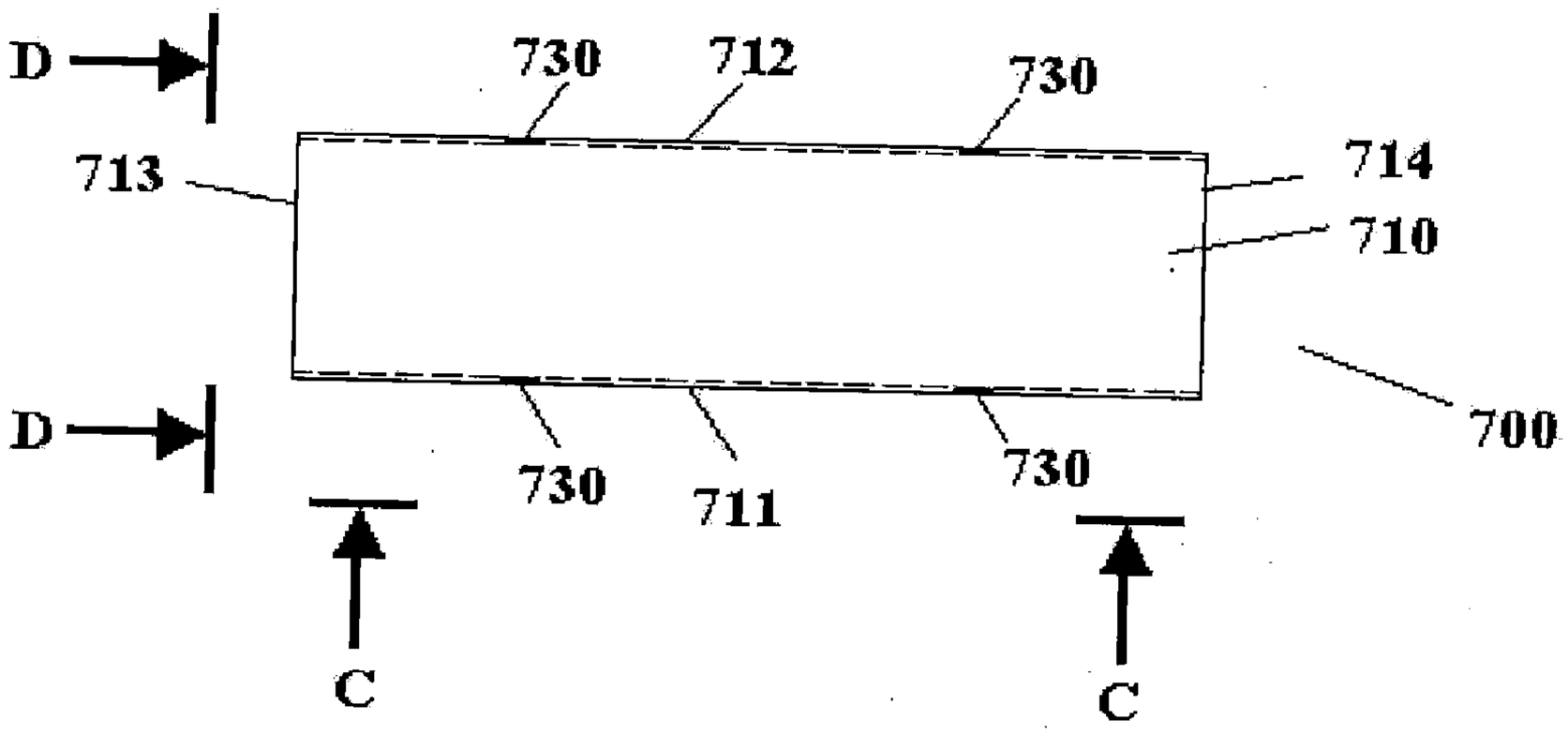
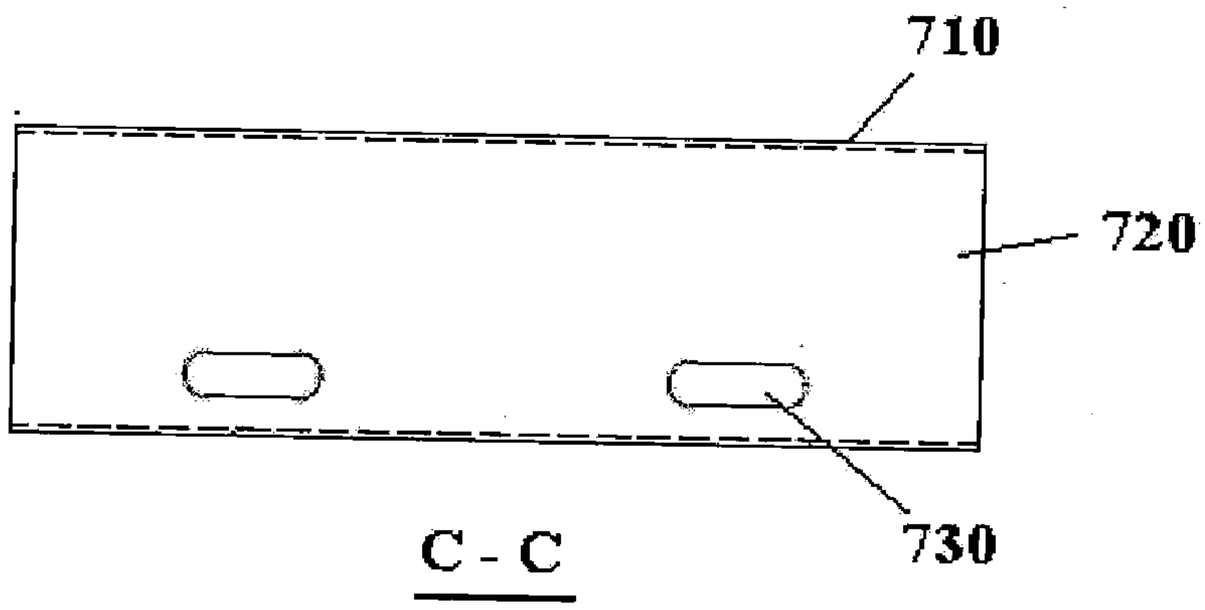
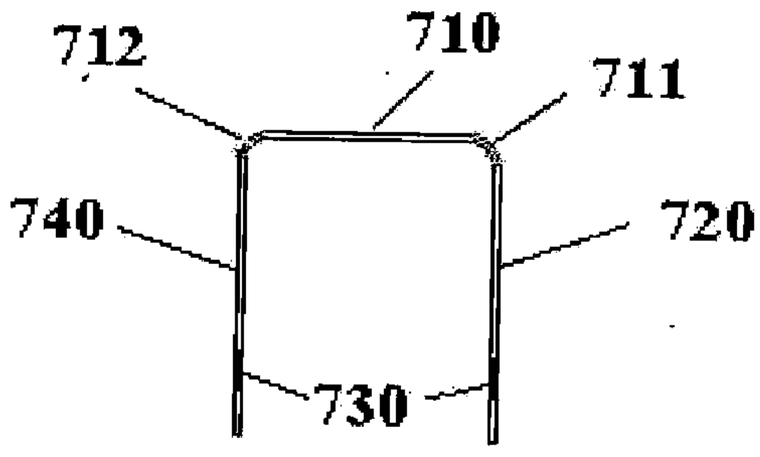


FIG.17



C - C

FIG.17A



D - D

FIG.17B

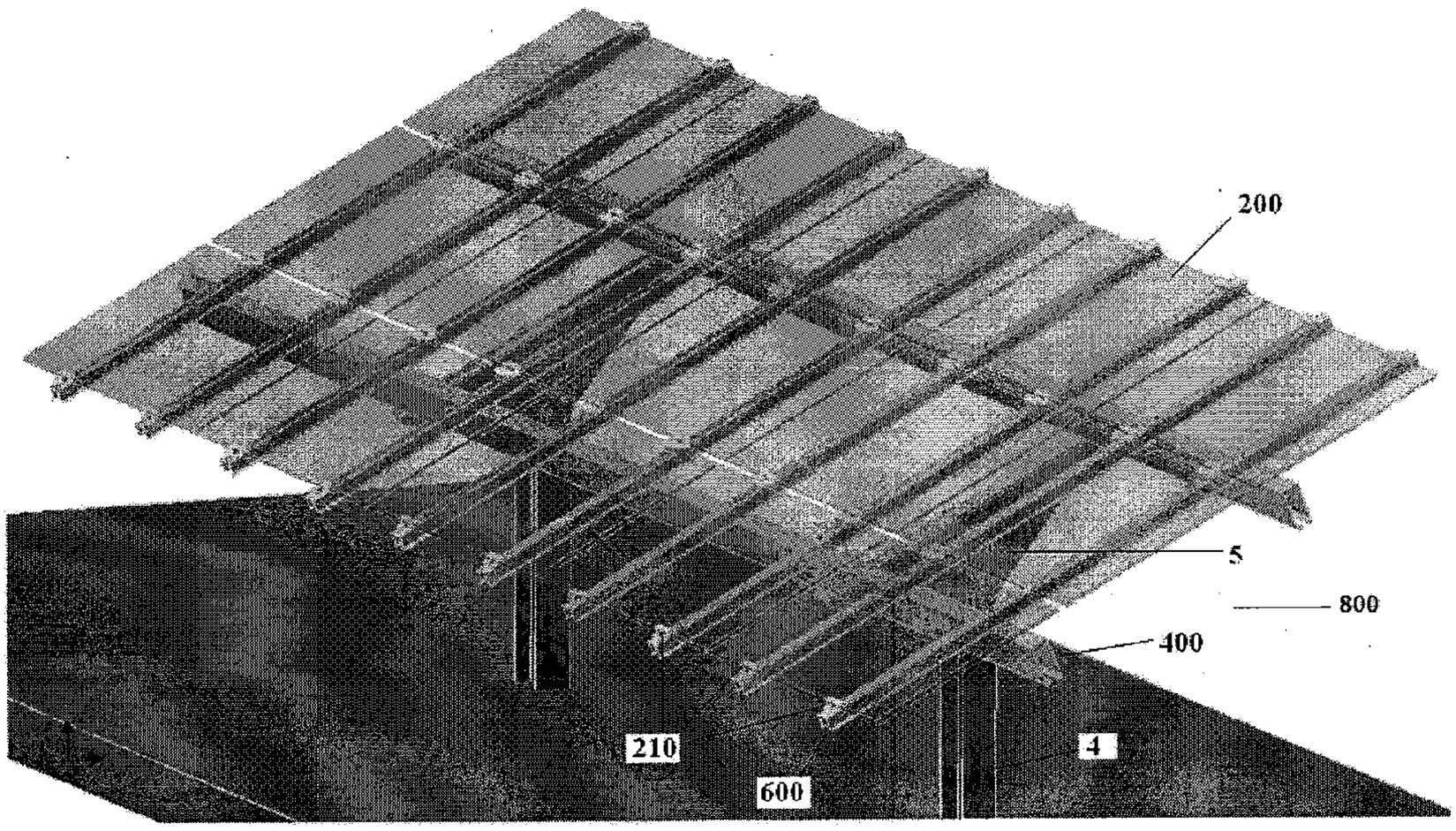


FIG.18

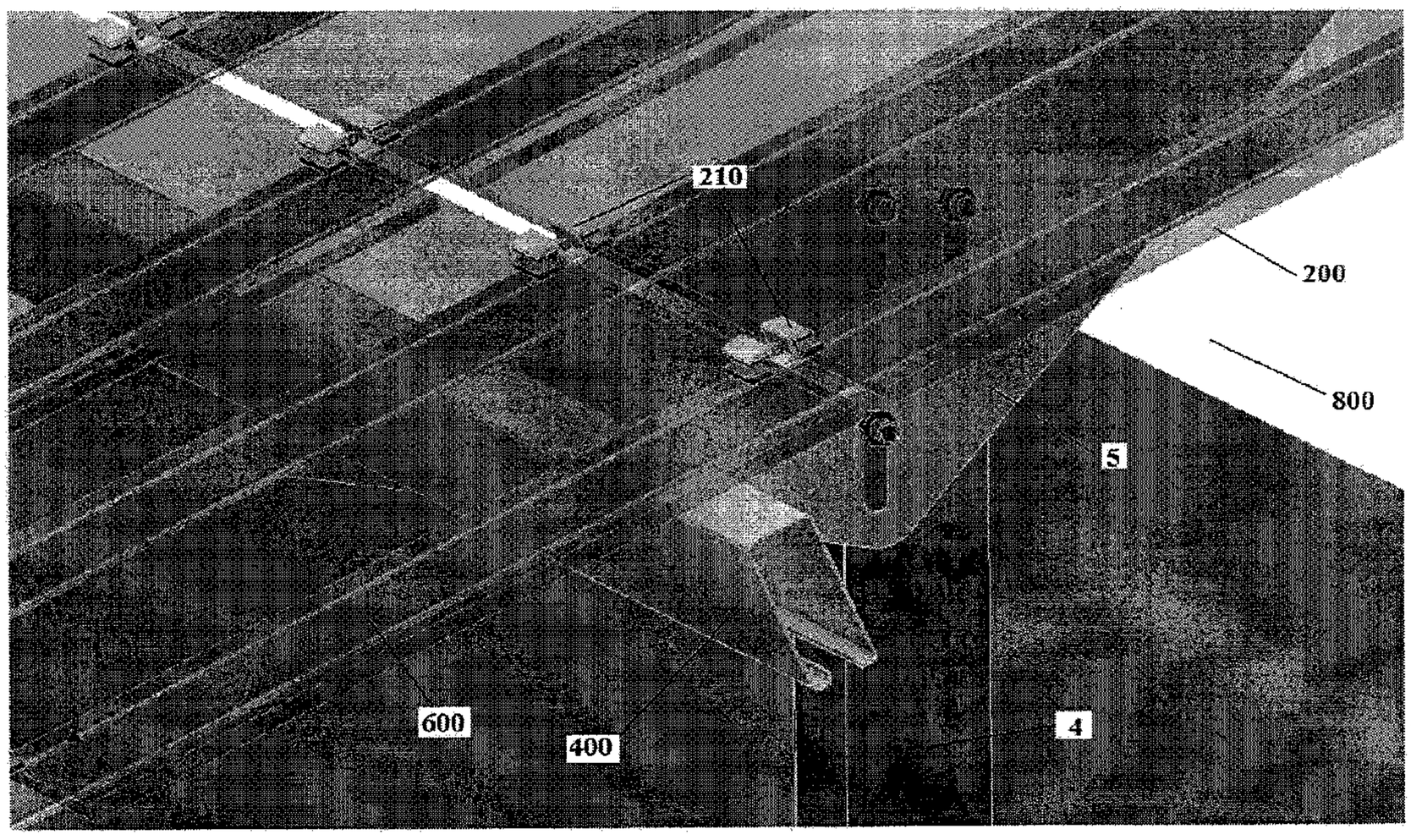


FIG.19

PHOTOVOLTAIC MODULE GROUND MOUNT

RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 12/794,307, filed Jun. 4, 2010, which claims priority to U.S. Provisional Patent Application No. 61/184,618, filed on Jun. 5, 2009, both of which are incorporated by reference in their entirety.

TECHNICAL FIELD

[0002] This invention relates to a photovoltaic module ground mounting system with a collapsible photovoltaic module mounting assembly framework.

BACKGROUND

[0003] Photovoltaic modules can be mounted in an array. However, photovoltaic module arrays can be large and heavy and difficult to transport. Thus, they can be expensive and inefficient to transport.

DESCRIPTION OF DRAWINGS

[0004] FIG. **1** is a view of a collapsible photovoltaic module mounting assembly framework.

[0005] FIG. **2** illustrates the folding steps of the collapsible photovoltaic module mounting assembly framework.

[0006] FIG. **3** is a partial perspective view of an embodiment of a supporting beam of the collapsible photovoltaic module mounting assembly framework.

[0007] FIG. **4** is a partial perspective view of an embodiment of a module rail of the collapsible photovoltaic module mounting assembly framework.

[0008] FIG. **5** is a partial perspective view of a photovoltaic module ground mounting system with folded photovoltaic module assembly framework.

[0009] FIG. **6** is a partial perspective view of a photovoltaic module ground mounting system with expanded photovoltaic module assembly framework.

[0010] FIG. **7** illustrates a configuration of the collapsible photovoltaic module mounting assembly framework with photovoltaic modules.

[0011] FIG. **8** illustrates a configuration of the collapsible photovoltaic module mounting assembly framework with photovoltaic modules.

[0012] FIG. **9** illustrates a configuration of the collapsible photovoltaic module mounting assembly framework with photovoltaic modules.

[0013] FIG. **10** illustrates a 3×3 photovoltaic array supported by the collapsible photovoltaic module mounting assembly framework.

[0014] FIG. **11** illustrates a 3×5 photovoltaic array supported by the collapsible photovoltaic module mounting assembly framework.

[0015] FIG. **12** illustrates a 4×6 photovoltaic array supported by the collapsible photovoltaic module mounting assembly framework.

[0016] FIG. **13** is a top view of an embodiment of a supporting beam of the collapsible photovoltaic module mounting assembly framework.

[0017] FIG. **13**A is a cross-section view taken along line **13**A-**13**A in FIG. **13**.

[0018] FIG. **14** is a top view of an embodiment of a module rail of the collapsible photovoltaic module mounting assembly framework.

[0019] FIG. **14**A is a cross-section view taken along line **14**B-**14**B in FIG. **14**.

[0020] FIG. **15** is a view of an embodiment of a tilt bracket of the collapsible photovoltaic module mounting assembly framework.

[0021] FIG. **15**A is a plate layout view of the tilt bracket in FIG. **15**.

[0022] FIG. **16** is a view of an embodiment of a tilt bracket of the collapsible photovoltaic module mounting assembly framework.

[0023] FIG. **16**A is a plate layout view of the tilt bracket in FIG. **16**.

[0024] FIG. **17** is a top view of an embodiment of a supporting beam connector of the collapsible photovoltaic module mounting assembly framework.

[0025] FIG. **17**A is a side view taken along line **17**C-**17**C in FIG. **17**.

[0026] FIG. **17**B is a cross-section view taken along line **17**D-**17**D in FIG. **17**.

[0027] FIG. **18** illustrates a configuration of the collapsible photovoltaic module mounting assembly framework with photovoltaic modules.

[0028] FIG. **19** is a close-in view of the configuration of the collapsible photovoltaic module mounting assembly framework with photovoltaic modules.

DETAILED DESCRIPTION

[0029] Photovoltaic modules can be installed in an array using a mounting assembly framework installed adjacent to a surface such as the ground or a rooftop. A preassembled framework can save field labor and installation costs. A preassembled and collapsible photovoltaic module mounting assembly framework is developed as a part of a photovoltaic module ground mounting system. Since it is collapsible, the shipping volume can be reduced to maximize the transportation efficiency. After it is distributed onsite, it can be easily unracked and installed.

[0030] A photovoltaic module is a device that converts sunlight directly into electricity by the photovoltaic effect. Assemblies of modules are used to make photovoltaic arrays. Photovoltaic panels are normally made of silicon or thin-film cells. Many currently available solar cells are configured as bulk materials that are subsequently cut into wafers and treated in a "top-down" method of synthesis (silicon being the most prevalent bulk material). Other materials are configured as thin-films (inorganic layers, organic dyes, and organic polymers) that are deposited on supporting substrates. Cadmium telluride solar cell is a solar cell based on cadmium telluride, an efficient light-absorbing material for thin-film cells. Compared to other thin-film materials, CdTe is easier to deposit and more suitable for large-scale production. The photovoltaic module mounting assembly framework can be used to support both silicon and thin-film photovoltaic modules including cadmium telluride solar module.

[0031] In one aspect, a collapsible photovoltaic module mounting assembly framework can include two substantially parallel supporting beams, at least two substantially parallel photovoltaic module rails each configured to secure a portion of a photovoltaic module, wherein each of the module rails is connected to one of the supporting beams at a position on the rail proximate to the first end of the rail and connected to the

other of the supporting beams at a position on the rail proximate to the second end of the rail, wherein the supporting beams can be moved to a relative position adjacent to each other by moving the module rails from a first orientation substantially perpendicular to the supporting beams to a second orientation substantially oblique to the supporting beams. The supporting beams can include steel. The supporting beams can include aluminum. The photovoltaic module rails can include steel. The photovoltaic module rails can include aluminum. The photovoltaic module mounting assembly framework can be configured to position an array of a plurality of photovoltaic modules in a plurality of rows and columns. The photovoltaic module mounting assembly framework can be configured to position an array of 15 photovoltaic modules in a configuration comprising 3 rows of modules and 5 columns of modules. The collapsible photovoltaic module mounting assembly framework can further include a lock that locks the module rails in an orientation substantially perpendicular to the supporting beams. The lock can unlock to allow the module rails to be moved to an orientation substantially oblique to the supporting beams.

[0032] In one aspect, a photovoltaic module ground mounting system can include a supporting column including an upper end, wherein the supporting column can be installed perpendicular to a surface, a bracket adjacent to the upper end of the supporting column, a collapsible photovoltaic module mounting assembly framework configured to be mounted adjacent to the bracket, the module mounting assembly framework including two substantially parallel supporting beams, at least two substantially parallel photovoltaic module rails each configured to secure a portion of a photovoltaic module, wherein each of the module rails is connected to one of the supporting beams at a position on the rail proximate to the first end of the rail and connected to the other of the supporting beams at a position on the rail proximate to the second end of the rail, wherein the supporting beams can be moved to a relative position adjacent to each other by moving the module rails from a first orientation substantially perpendicular to the supporting beams to a second orientation substantially oblique to the supporting beams. The supporting beams can include steel. The supporting beams can include aluminum. The photovoltaic module rails can include steel. The photovoltaic module rails can include aluminum. The photovoltaic module mounting assembly framework can be configured to position an array of a plurality of photovoltaic modules in a plurality of rows and columns. The photovoltaic module mounting assembly framework can be configured to position an array of 15 photovoltaic modules in a configuration comprising 3 rows of modules and 5 columns of modules. The supporting column can include steel. The supporting column can include aluminum. The bracket can include steel. The bracket can include aluminum. The bracket can be positioned to provide a module mounting position tilted with respect to the plane of a surface adjacent to which the supporting column can be installed. The photovoltaic module ground mounting system can further include a shipping cradle configured to conform to and encase the module mounting assembly framework in the collapsed position.

[0033] In one aspect, a method of installing a photovoltaic module mounting system can include the steps of positioning a supporting column including a bracket adjacent to a surface, wherein the bracket is adjacent to the upper end of the supporting column, attaching a collapsible photovoltaic module mounting assembly framework to the bracket, wherein the collapsible photovoltaic module mounting assembly framework can include two substantially parallel supporting beams, two substantially parallel supporting beams, at least two substantially parallel photovoltaic module rails each configured to secure a portion of a photovoltaic module, wherein each of the module rails is connected to one of the supporting beams at a position on the rail proximate to the first end of the rail and connected to the other of the supporting beams at a position on the rail proximate to the second end of the rail, wherein the supporting beams can be moved to a relative position adjacent to each other by moving the module rails from a first orientation substantially perpendicular to the supporting beams to a second orientation substantially oblique to the supporting beams, and mounting a photovoltaic module to the collapsible photovoltaic module mounting framework assembly.

[0034] The supporting beam can include steel. The method can further include the step of attaching a photovoltaic module to a photovoltaic module rail of the module mounting assembly framework. The method can further include the step of adjusting the bracket to provide a module mounting position tilted compared to the surface.

[0035] Referring to FIG. **1**, collapsible photovoltaic module mounting assembly framework **10** can include two supporting beams **2** and plurality of photovoltaic module rails **1**. Supporting beams **2** can be substantially parallel. Photovoltaic module rails **1** can be substantially parallel to each other and can be substantially perpendicular to supporting beams **2**. Module rail **1** can have first end portion **11** and second end portion **12**. First end portion **11** of each of the module rails **1** can be pivotally connected to a supporting beam **2** by a hardware connector **3** (e.g., a rivet or any suitable connector). Second end portion **12** of each of the module rails **1** can be pivotally connected to the other supporting beam **2** by a hardware connector **3** (e.g., a rivet or any suitable connector).

[0036] Photovoltaic module mounting assembly framework **10** can position a plurality of photovoltaic modules in an array. The photovoltaic modules can be positioned by attaching a portion of each module to a module rail **1**. Module rail **1** can be attached to any suitable portion of the photovoltaic module. For example, module rail **1** can be attached to an edge portion of a photovoltaic module. Module rail **1** can form a portion of a framework framing a portion of a photovoltaic module. Multiple module rails **1** can frame a photovoltaic module by framing multiple portions of a photovoltaic module. A module rail **1** can be attached to portions of multiple photovoltaic modules. For example, a single module rail **1** can be positioned between two edges of two photovoltaic modules.

[0037] Module rails **1** and supporting beams **2** can include any suitable material. For example module rails **1** and supporting beams **2** can include metal, such as steel or aluminum, or any other suitable metal. The module rails **1** and supporting beams **2** can be manufactured by any suitable technique including any suitable metalworking technique such as casting, forging, or roll forming.

[0038] As shown in FIG. **2***a* through FIG. **2***c*, photovoltaic module mounting assembly framework **10** can be deployed in an installation configuration, a collapsed configuration, and configurations in between. As shown in FIG. **2***a*, photovoltaic module mounting assembly framework **10** can be in an installation configuration where module rails **1** are substantially perpendicular to supporting beams **2**. In this configuration, photovoltaic modules can be fitted and attached to framework

10. For example, photovoltaic modules can be attached to module rails **1**. Multiple photovoltaic modules can be installed in one or more rows and/or columns for form a photovoltaic array. Photovoltaic module mounting assembly framework **10** can include a lock to lock framework **10** in the installation configuration. When locked, module rails **1** and supporting beams **2** are held substantially perpendicular to each other. The lock can automatically lock framework **10** when framework **10** is changed from collapsed configuration to installation configuration. As shown in FIGS. **2***b* and **2***c*, photovoltaic module mounting assembly framework **10** can be collapsed by unlocking (if locked) and moving supporting beams **2** relative to each other so that they are adjacent to one another. The process of moving supporting beams **2** adjacent to each other can include moving module rails **1** from a first orientation substantially perpendicular to supporting beams **2** to a second position substantially oblique to supporting beams **2**. By comparing

[0039] FIG. **2***a* (mounting assembly framework **10** in installation configuration) to FIG. **2***c* (mounting assembly framework **10** in a fully folded configuration), reduction of volume can be seen.

[0040] Referring to FIG. **3** as a part of supporting beam **2** of the collapsible photovoltaic module mounting assembly framework (**10** in FIG. **1** and FIG. **2**), supporting beam **2** may have a substantially Z-shaped profile and can include tilted support portion **25**. Top panel **21** is attached to the top of support portion **25** and has at least one opening **23** to pivotally connect with the photovoltaic module rail **1**. A bottom panel **22** is attached to the bottom of the support portion **25** and has at least one opening **24** to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) which can be used to secure the assembly framework **10** to other supporting part of mounting system. Supporting beams **2** may be formed of extruded aluminum or steel.

[0041] Referring to FIG. **4** as a part of photovoltaic module rail **1** of the collapsible photovoltaic module mounting assembly framework (**10** in FIG. **1** and FIG. **2**), module rail **1** may include support portion **16**. Top panel **13** is attached to the top of support portion **16** and can be adjacent to a clip, bracket, or any suitable means for securing a photovoltaic module. Bottom panel **14** is attached to the bottom of the support portion **16** and has at least one opening **15** to pivotally connect with supporting beam **2** of the collapsible photovoltaic module mounting framework assembly. Photovoltaic module rail **1** may be formed of extruded aluminum or steel.

[0042] FIG. **5** shows photovoltaic module ground mounting system **100** with folded photovoltaic module mounting framework assembly **10**. Photovoltaic module ground mounting system **100** may include supporting columns **4** and tilt brackets **5**. Supporting column **4** can be configured to be installed adjacent to a surface such as the ground or a rooftop or any other suitable surface. Supporting column **4** can include an upper end configured to be attached to tilt bracket **5**. Tilt bracket **5** can include lower supporting portion **51** and tilted upper mounting portion **52**. Lower supporting portion **51** can be attached to the upper end of supporting column **4**. Lower end **521** of tilted upper mounting portion **52** can be attached to one of two supporting beams **2** of collapsible photovoltaic module mounting assembly framework **10**. The attachment can be done with a hardware connector (e.g., a bolt, screw, nail, rivet, weld, adhesive, or braze joint).

[0043] Support column **4** and tilt bracket **5** can include any suitable material. For example, support column **4** and tilt bracket **5** can include metal, such as steel or aluminum, or any other suitable metal. Support column **4** and tilt bracket **5** can be manufactured by any suitable technique including any suitable metalworking technique such as casting, forging, or roll forming.

[0044] Referring to FIG. **6** as a part of photovoltaic module ground mounting system **100** with expanded photovoltaic module mounting assembly framework **10**, including lower end **521** of tilted upper mounting portion **52** attached to one of two supporting beams **2** of collapsible photovoltaic module mounting framework assembly **10** and mounting assembly framework **10** is fully unfolded, upper end **522** of tilted upper mounting portion **52** can be attached to the other one of two supporting beams **2** to secure collapsible photovoltaic module mounting assembly framework **10** on tilt brackets **5**. The attachment can be done with a hardware connector (e.g., a bolt, screw, nail, rivet, weld, adhesive, or braze joint). Supporting columns **4** can include extruded aluminum or steel. Tilt brackets **5** can include extruded aluminum or steel. Photovoltaic module mounting assembly framework **10** can designed and deployed to install any a photovoltaic module array of any suitable desired size. For example, photovoltaic module mounting assembly framework can support **15** photovoltaic modules, **3** modules high by **5** modules wide. The tilt bracket **5** may be adjustable such that the degree of tilt of bracket **5** can be adjusted to optimize the orientation of tilt bracket **5** with respect to the sun. The photovoltaic module ground mounting system **100** can include a shipping cradle for protecting the racked photovoltaic module mounting assembly framework **10**.

[0045] Based on the design showed in FIG. **1** and FIG. **2**, the photovoltaic module mounting assembly framework can be used with different configurations to mount different size photovoltaic modules, such as 2 feet×4 feet cadmium telluride solar module. Photovoltaic module mounting assembly framework **10** can also be customized to support different size photovoltaic modules. Photovoltaic module mounting assembly framework **10** can also support photovoltaic modules with dimensions of 1 ft×2 ft, 1 ft×1 ft, 2 ft×2 ft, 2 ft×3 ft, 3 ft×3 ft, 3 ft×4 ft, 4 ft×4 ft, or any other available photovoltaic module dimensions.

[0046] Additionally, the photovoltaic module mounting assembly framework can be configured to position an array of a plurality of photovoltaic modules in a plurality of rows and columns. FIG. **7**, FIG. **8**, and FIG. **9** illustrate different configurations of the collapsible photovoltaic'module mounting assembly framework with photovoltaic modules. Referring to

[0047] FIG. **7**, photovoltaic module mounting assembly framework **10** can support two photovoltaic modules, 1 module high by 2 modules wide (1×2). Photovoltaic module **200** can be mounted on module rail **1** with mounting clip **210** or any suitable mounting means (e.g., a mounting bracket, adhesive, or braze joint). Referring to FIG. **8**, photovoltaic module mounting assembly framework **10** can support three photovoltaic modules, 1 module high by 3 modules wide (1×3). Referring to FIG. **9**, photovoltaic module mounting assembly framework **10** can support four photovoltaic modules, 2 modules high by 2 modules wide (2×2).

[0048] Furthermore, photovoltaic arrays of different dimensions can be supported by the collapsible photovoltaic module mounting assembly framework. FIG. **10**, FIG. **11**, and FIG. **12** illustrate photovoltaic arrays supported by the collapsible photovoltaic module mounting assembly framework. FIG. **10** illustrates photovoltaic array **310** supported by

collapsible photovoltaic module mounting assembly framework **10**. Photovoltaic array **310** can include 9 photovoltaic modules, 3 modules high by 3 modules wide (3×3). Photovoltaic module **200** of photovoltaic array **310** can be mounted on assembly framework **10** with mounting clip **210** or any suitable mounting means (e.g., a mounting bracket, adhesive, or braze joint). FIG. **11** illustrates photovoltaic array **320** supported by collapsible photovoltaic module mounting assembly framework **10**. Photovoltaic array **320** can include 15 photovoltaic modules, 3 modules high by 5 modules wide (3×5). FIG. **12** illustrates photovoltaic array **330** supported by collapsible photovoltaic module mounting assembly framework **10**. Photovoltaic array **330** can include 24 photovoltaic modules, 4 modules high by 6 modules wide (4×6). Photovoltaic module mounting assembly framework 10 can also support photovoltaic arrays with configurations of 1×4, 1×5, 1×6, 2×3, 2×4, 2×5, 2×6, 3×2, 3×4, 3×5, 3×6, 4×2, 4×3, 4×4, 4×5, 5×2, 5×3, 5×4, 5×5, 5×6, 6×2, 6×3, 6×4, 6×5, or 6×6 photovoltaic modules. The length and width of the photovoltaic array supported by collapsible photovoltaic module mounting assembly framework **10** can range from about 1 foot to about 35 feet.

[0049] Referring to FIG. **13**, a top view of supporting beam **400** of the collapsible photovoltaic module mounting assembly framework is depicted. Rail **400** includes rectangular top plate **410** having first end **413**, second end **414**, first side edge **411**, second side edge **412**. Supporting beam **400** can also include openings **430** which can be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to connect beam **400** to tilt brackets (**5** in FIG. **15** or **6** in FIG. **16**) or module rail. Openings **430** can also be used to attach module rail (**1** in FIG. **5** or **600** in FIG. **15**) to supporting beam **400**. Referring to FIG. **13**A, an end view of beam **400** is shown. First J-shaped side wall **420** extends downward, perpendicular from first side edge **411** of top plate **410**. Second J-shaped side wall **440** extends downward, perpendicular from second side edge **412** of top plate **410**. The resulting cross-section can be top hat-shaped. Supporting beam **400** can be formed from any suitable material, including metal such as aluminum or galvanized steel.

[0050] Referring to FIG. **14**, a top view of module rail **600** is depicted. Module rail **600** includes rectangular top plate **610** having first end **613**, second end **614**, first side edge **611**, second side edge **612**, first mounting structure **620**, second mounting structure **670**, first base plate **650**, and second base plate **680**. Module rail **600** can also include openings **630** which can be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to connect rail **600** to a supporting beam (**2** in FIG. **5** or **400** in FIG. **18**). Openings **630** can also be provided to attach photovoltaic module (**200** in FIG. **18**) to rail **600**. Referring to FIG. **14**A an end view of rail **600** is shown. First mounting structure **620** can be a bump-like structure to contact or secure photovoltaic modules. First mounting structure **620** can be adjacent to first side edge **611** of top plate **610**. First side wall **640** extends downward, perpendicular from first mounting structure **620** adjacent to top plate **610**, ending at first terminal edge **641**. First base plate **650** can extend from first terminal edge **641** of first side wall **640**. Second mounting structure **670** can be a bump-like structure to contact or secure photovoltaic modules. Second mounting structure **670** can be adjacent to second side edge **612** of top plate **610**. Second side wall **660** extends downward, perpendicular from second mounting structure **670** adjacent to top plate **610**, ending at second terminal edge **661**. Second base plate **680** can extend from second terminal edge **661** of second side wall **660**. The resulting cross-section can be top hat-shaped. Rail **600** can be formed from any suitable material, including metal such as aluminum or galvanized steel.

[0051] Referring to FIG. **15**, a view of tilt bracket **5** of the collapsible photovoltaic module mounting assembly framework is depicted. FIG. **15**A is a plate layout view of tilt bracket **5** in FIG. **15**. Tilt bracket **5** can include lower supporting portion **51** and tilted upper mounting portion **52**. Lower supporting portion **51** can have an opening **513** which can be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to attach to the upper end of supporting column (**4** in FIG. **5** and FIG. **18**). Tilt bracket **5** can have an opening **511** adjacent to lower end **521** of tilted upper mounting portion **52** which can be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to attach to one of two supporting beams (**2** in FIG. **3** or **400** in FIG. **13**) of collapsible photovoltaic module mounting assembly framework. Tilt bracket **5** can also include an opening **512** adjacent to upper end **522** of tilted upper mounting portion **52** which can be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to attach to one of two supporting beams (**2** in FIG. **3** or **400** in FIG. **13**) of collapsible photovoltaic module mounting assembly framework. Tilt bracket **5** can have rail connector **53** extending upward, perpendicular from lower end **521** of tilted upper mounting portion **52**. Rail connector **53** can include an opening **531** which can be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to attach to one of two module rails (**1** in FIG. **4** or **600** in FIG. **14**) of collapsible photovoltaic module mounting assembly framework. Opening **531** can also be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to secure one of two supporting beams (**2** in FIG. **3** or **400** in FIG. **13**). Tilt bracket **5** can also include rail connector **54** extending upward, perpendicular from upper end **522** of tilted upper mounting portion **52**. Rail connector **54** can include an opening **541** which can be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to attach to one of two module rails (**1** in FIG. **4** or **600** in FIG. **14**) of collapsible photovoltaic module mounting assembly framework. Opening **541** can also be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to secure one of two supporting beams (**2** in FIG. **3** or **400** in FIG. **13**).

[0052] Referring to FIG. **16**, a view of tilt bracket **6** of the collapsible photovoltaic module mounting assembly framework is depicted. FIG. **16**A is a plate layout view of tilt bracket **6** in FIG. **16**. Tilt bracket **6** can include lower supporting portion **61** and tilted upper mounting portion **62**. Lower supporting portion **61** can have an opening **613** which can be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to attach to the upper end of supporting column (**4** in FIG. **5** and FIG. **18**). Tilt bracket **6** can have an opening **611** adjacent to first end **621** of tilted upper mounting portion **62** which can be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to attach to one of two supporting beams (**2** in FIG. **3** or **400** in FIG. **13**)

of collapsible photovoltaic module mounting assembly framework. Tilt bracket **6** can also include an opening **612** adjacent to second end **622** of tilted upper mounting portion **62** which can be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to attach to one of two supporting beams (**2** in FIG. **3** or **400** in FIG. **13**) of collapsible photovoltaic module mounting assembly framework. Tilt bracket **6** can have rail stopper **63** extending upward, perpendicular from second end **622** of tilted upper mounting portion **62**. Rail stopper **63** can include an opening **631** which can be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to attach to one of two module rails (**1** in FIG. **4** or **600** in FIG. **14**) of collapsible photovoltaic module mounting assembly framework. Opening **631** can also be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to secure one of two supporting beams (**2** in FIG. **3** or **400** in FIG. **13**). Tilt bracket **5** and **6** can include any suitable material. For example, tilt bracket **5** and **6** can include metal, such as steel or aluminum, or any other suitable metal. Tilt bracket **5** and **6** can be manufactured by any suitable technique including any suitable metalworking technique such as casting, forging, or roll forming.

[0053] Referring to FIG. **17**, a top view of supporting beam connector **700** of the collapsible photovoltaic module mounting assembly framework is depicted. FIG. **17**A is a side view of supporting beam connector **700**. Beam connector **700** includes rectangular top plate **710** having first end **713**, second end **714**, first side edge **711**, second side edge **712**.

[0054] Referring to FIG. **17**B, an end view of beam connector **700** is shown. First side wall **720** extends downward, perpendicular from first side edge **711** of top plate **710**. Second side wall **740** extends downward, perpendicular from second side edge **712** of top plate **710**. The resulting cross-section can be top hat-shaped. Beam connector **700** can also include openings **730** on side wall **720** and **740** which can be configured to accommodate a hardware connector (e.g., a screw, nail, rivet, weld, adhesive, or braze joint) used to attach beam connector **700** to beam (**400** in FIG. **13**). Beam connector **700** can be formed from any suitable material, including metal such as aluminum or galvanized steel.

[0055] Based on the design showed in FIG. **13**, FIG. **14**, FIG. **15**, FIG. **16**, and FIG. **17**, the photovoltaic module mounting assembly framework including supporting beam **400** and module rail **600** can be used with different configurations to mount different size photovoltaic modules, such as 2 feet×4 feet cadmium telluride solar module. Photovoltaic module mounting assembly framework can also be customized to support different size photovoltaic modules. Photovoltaic module mounting assembly framework **10** can also support photovoltaic modules with dimensions of 1 ft×2 ft, 1 ft×1 ft, 2 ft×2 ft, 2 ft×3 ft, 3 ft×3 ft, 3 ft×4 ft, 4 ft×4 ft, or any other available photovoltaic module dimensions. Referring to FIG. **18** and FIG. **19**, photovoltaic module mounting assembly framework **800** can support **15** photovoltaic modules, 3 modules high by 5 modules wide (3×5). Photovoltaic module **200** can be mounted on module rail **600** with mounting clip **210** or any suitable mounting means (e.g., a mounting bracket, adhesive, or braze joint). Photovoltaic module mounting assembly framework **800** may include supporting columns **4** and tilt brackets **5**. Supporting column **4** can be configured to be installed adjacent to a surface such as the ground or a rooftop or any other suitable surface. Photovoltaic module mounting assembly framework **800** can also support photovoltaic arrays with configurations of 1×2, 1×3, 1×4, 1×5, 1×6, 2×2, 2×3, 2×4, 2×5, 2×6, 3×2, 3×4, 3×6, 4×2, 4×3, 4×4, 4×5, 4×6, 5×2, 5×3, 5×4, 5×5, 5×6, 6×2, 6×3, 6×4, 6×5, or 6×6 photovoltaic modules. The length and width of the photovoltaic array supported by collapsible photovoltaic module mounting assembly framework **800** can range from about 1 foot to about 35 feet.

[0056] A number of embodiments of the invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. It should also be understood that the appended drawings are not necessarily to scale, presenting a somewhat simplified representation of various preferred features illustrative of the basic principles of the invention.

1. A collapsible photovoltaic module mounting assembly framework for mounting a plurality of photovoltaic modules thereon, comprising:

a plurality of module support rails each configured to be attached to a portion of a photovoltaic module; and

a plurality of supporting beams;

wherein a first of the supporting beams is positioned under, and pivotally connected to, a first portion of the rails and a second of the supporting beams is positioned under, and pivotally connected to, a second portion of the rails;

wherein the supporting beams can be moved to a relative position adjacent to each other by moving the rails from a first orientation substantially perpendicular to the supporting beams to a second orientation substantially oblique to the supporting beams; and

wherein each supporting beam has a plurality of openings through which a hardware connector can be passed to connect the supporting beam to a support structure.

2. The collapsible photovoltaic module mounting assembly framework of claim **1**, further comprising a lock that locks the rails in an orientation substantially perpendicular to the supporting beams.

3. The collapsible photovoltaic module mounting assembly framework of claim **2**, wherein the lock can unlock to allow the rails to be moved to an orientation substantially oblique to the supporting beams.

4. The collapsible photovoltaic module mounting assembly framework of claim **1**, wherein the rails are hollow.

5. The collapsible photovoltaic module mounting assembly framework of claim **1**, wherein the supporting beams are hollow.

6. The collapsible photovoltaic module mounting assembly framework of claim **1**, wherein the rails and supporting beams are constructed from steel.

7. The collapsible photovoltaic module mounting assembly framework of claim **1**, wherein the rails and supporting beams are constructed from aluminum

8. The collapsible photovoltaic module mounting assembly framework of claim **1**, further comprising the support structure, the support structure comprising a supporting column and tilt bracket.

9. A photovoltaic module ground mounting system for mounting a plurality of photovoltaic modules in a plurality of rows and columns thereon, comprising:

a support structure comprising an upper end, wherein the support structure can be installed perpendicular to a surface;

a support surface installed on the upper end of the support structure;

a collapsible photovoltaic module mounting assembly framework configured to be mounted to the support surface, the framework comprising:

a plurality of module support rails each configured to be attached to a portion of a photovoltaic module; and

a plurality of supporting beams;

wherein a first of the supporting beams is positioned under, and pivotally connected to, a first portion of the rails and a second of the supporting beams is positioned under, and pivotally connected to, a second portion of the rails;

wherein the supporting beams can be moved to a relative position adjacent to each other by moving the rails from a first orientation substantially perpendicular to the supporting beams to a second orientation substantially oblique to the supporting beams; and

wherein each supporting beam has a plurality of openings through which a hardware connector can be passed to connect the supporting beam to the support surface.

10. The photovoltaic module ground mounting system of claim **9**, further comprising a lock that locks the rails in an orientation substantially perpendicular to the supporting beams.

11. The photovoltaic module ground mounting system of claim **10**, wherein the lock can unlock to allow the rails to be moved to an orientation substantially oblique to the supporting beams.

12. The photovoltaic module ground mounting system of claim **9**, wherein the rails and supporting beams are a rectangular shape and hollow.

13. The photovoltaic module ground mounting system of claim **9**, wherein the supporting beams are pivotally connected to the rails at pivot points near either side of a center of the module support rails.

14. The photovoltaic module ground mounting system of claim **9**, wherein the supporting beams are pivotally connected to the rails at pivot points provided near ends of the module support rails.

15. The photovoltaic module ground mounting system of claim **9**, wherein the rails and supporting beams are constructed from steel or aluminum

16. The photovoltaic module ground mounting system of claim **9**, wherein the support structure comprises a supporting column and the support surface comprises a tilt bracket.

17. A method of installing a plurality of photovoltaic modules in a plurality of rows and columns thereon, comprising the steps of:

positioning a support structure comprising a support surface installed on an upper end of the support structure;

attaching a photovoltaic module mounting assembly framework to the support surface, wherein the photovoltaic module mounting assembly framework comprises:

a plurality of module mounting rails each configured to be attached to a portion of a photovoltaic module;

a plurality of supporting beams;

wherein a first of the supporting beams is positioned under, and is pivotally connected to, a first portion of the rails and a second of the supporting beams is positioned under, and is pivotally connected to, a second portion of the rails;

wherein the supporting beams can be moved to a relative position adjacent to each other by moving the rails from a first orientation substantially perpendicular to the supporting beams to a second orientation substantially oblique to the supporting beams; and

wherein a top surface of each supporting beam has a plurality of openings through which a hardware connector can be passed to connect the supporting beam to the support surface, said photovoltaic mounting assembly being attached to the support surface with the rails being substantially perpendicular to the supporting beams; and

mounting photovoltaic modules to the photovoltaic module mounting framework assembly.

18. The method of claim **17**, wherein the support structure is a supporting column and the support surface is a tilt bracket.

19. The method of claim **17**, wherein attaching a collapsible photovoltaic module mounting assembly framework to the support surface comprises bolting each supporting beam to the support surface through the openings in the supporting beams.

20. The method of claim **17**, wherein the rails and supporting beams are a rectangular shape, hollow, and constructed of aluminum.

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