Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2723419 C 2014/11/04

(11)(21) 2 723 419

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 2009/05/01
(87) Date publication PCT/PCT Publication Date: 2009/11/12
(45) Date de délivrance/Issue Date: 2014/11/04
(85) Entrée phase nationale/National Entry: 2010/11/03
(86) N° demande PCT/PCT Application No.: US 2009/042522
(87) N° publication PCT/PCT Publication No.: 2009/137352
(30) Priorités/Priorities: 2008/05/05 (US61/050,341); 2008/09/22 (US61/098,941); 2009/02/03 (US61/149,451)

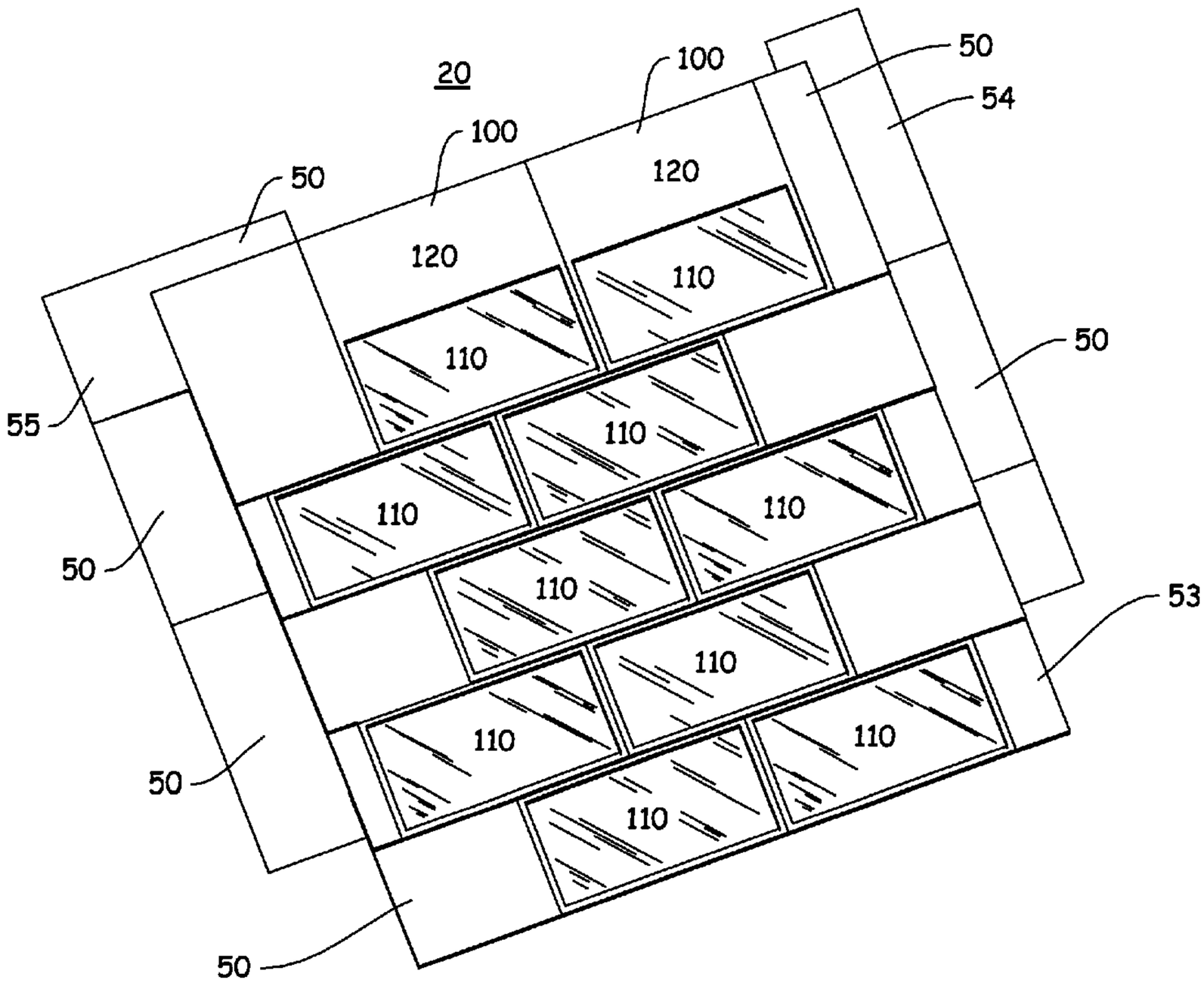
(51) Cl.Int./Int.Cl. *H02S 20/10* (2014.01), *E04D 13/18* (2014.01), *H02S 40/34* (2014.01), *H02S 40/36* (2014.01)

(72) Inventeurs/Inventors:
GASTON, RYAN, US;
KEENIHAN, JAMES R., US;
GRAHAM, ANDREW T., US;
LANGMAID, JOE A., US

(73) Propriétaire/Owner:
DOW GLOBAL TECHNOLOGIES LLC, US

(74) Agent: SMART & BIGGAR

(54) Titre : SYSTEME D'INSTALLATION DE DISPOSITIFS PHOTOVOLTAIQUES SUR UNE STRUCTURE
(54) Title: SYSTEM FOR INSTALLATION OF PHOTOVOLTAIC DEVICES ON A STRUCTURE



(57) Abrégé/Abstract:
The present invention is premised upon a connector device and method that can more easily electrically connect a plurality of PV devices and/or locate these devices upon a building or structure in two rows/columns with opposing current flows. It also can optionally provide some additional components (e.g. a bypass diode and/or an indicator means) and can enhance the service-ability of the device.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 November 2009 (12.11.2009)

PCT

(10) International Publication Number
WO 2009/137352 A3

(51) International Patent Classification:
H01L 31/042 (2006.01) *E04D 13/18* (2006.01)
H01L 31/05 (2006.01)

(21) International Application Number:
PCT/US2009/042522

(22) International Filing Date:
1 May 2009 (01.05.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

61/050,341	5 May 2008 (05.05.2008)	US
61/098,941	22 September 2008 (22.09.2008)	US
61/149,451	3 February 2009 (03.02.2009)	US

(71) Applicant *(for all designated States except US)*: **DOW GLOBAL TECHNOLOGIES INC.** [US/US]; Washington Street, 1790 Building, Midland, MI 48674 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **GASTON, Ryan** [US/US]; 3919 E. Pine Hollow Drive, Midland, MI 48642 (US). **KEENIHAN, James, R.** [US/US]; 600 N. Shadyside, Midland, MI 48640 (US). **GRAHAM, Andrew, T.** [US/US]; 2214 E. Wyllys Ct., Midland, MI 48642 (US). **LANGMAID, Joe, A.** [US/US]; 1726 Gun Club Rd., Caro, MI 48723 (US).

(74) Agent: **KURTYCZ, Eric**; Dobrusin & Thennisch PC, 29 W. Lawrence Street, Suite 210, Pontiac, MI 48342 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,

[Continued on next page]

(54) Title: SYSTEM FOR INSTALLATION OF PHOTOVOLTAIC DEVICES ON A STRUCTURE

(57) Abstract: The present invention is premised upon a connector device and method that can more easily electrically connect a plurality of PV devices and/or locate these devices upon a building or structure in two rows/columns with opposing current flows. It also can optionally provide some additional components (e.g. a bypass diode and/or an indicator means) and can enhance the serviceability of the device.

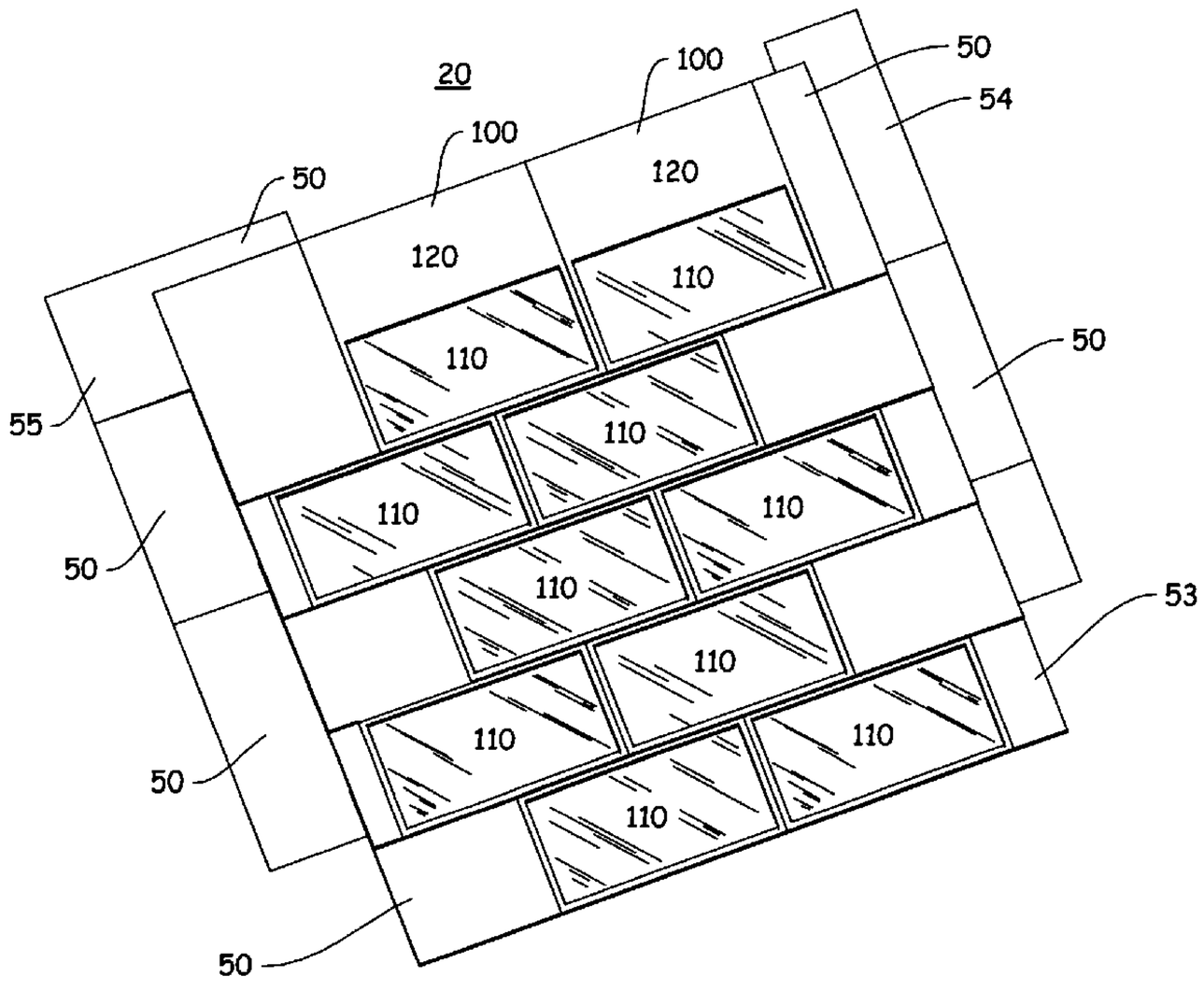


FIG 1

WO 2009/137352 A3

WO 2009/137352 A3

ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) Date of publication of the international search report:
18 March 2010

53191-15

System for Installation of Photovoltaic Devices on a Structure

This invention was made with U.S. Government support under contract DE-FC36-07G017054 awarded by the Department of Energy. The U.S. Government has certain rights in this invention.

FIELD OF THE INVENTION

[001] The present invention relates to an improved photovoltaic device assembly and method of making same, more particularly to an improved photovoltaic device assembly (kit) with opposing current flows in adjoining rows or columns and method of making same for providing solar power.

BACKGROUND

[002] Efforts to improve photovoltaic devices or "PV devices", particularly to improve the connection, installation, and service of multiple devices are subject to continuing development within the PV industry. Of special interest are those PV devices that are integrated into building structures or fascia (e.g. roofing shingles, exterior wall surfaces, canopies, awnings), or stand alone PV systems (e.g. solar farms). To aid in their commercial and functional viability, they should satisfy a number of criteria. The individual devices and the overall assembly (sometimes known as a kit) should be robust, that is they should be able to remain functional in a myriad of environmental

conditions (e.g. heat, cold, wind, rain, snow, etc.). In the case of building structures, they should also not subject the building structure to overly adverse modifications due to their presence, such as multiple roof penetrations made to electrically connect and/or locate the plurality of devices, resulting in the roof which could have to be subsequently sealed against leaks. The roof penetrations and/or extensive electrical wiring/connections can make installation time consuming and expensive. In either a building structure or stand alone PV system, the relative ease of installation provided by the present invention can be advantageous. Furthermore, when a device component (e.g. a single panel and/or a sub-component such as a bypass diode) does become damaged or needs to be replaced, it can be valuable to have a system that allows easy replacement of the device component or sub-component.

[003] Among the literature that can pertain to this technology include the following patent documents: US20080190047(A1); US4321416; US5575861; US5437735; US5990414; US6840799; EP1744372; US6875914; US5590495; US5986203; US2008/0115822; EP1923920; US7365266; US20070295393 A1; US20070295392 A1; WO 2008/139102, US2011/0100436, US2011/0183540, WO2009/137,348, WO2009/137,347, WO2009/137,352, and WO2009/137353.

SUMMARY OF THE INVENTION

[004] The present invention is directed to a solution to at least one or more of the issues described above. Particularly, the present invention seeks to provide a robust photovoltaic device assembly and method that can more easily electrically connect a plurality of PV devices (while minimizing the total number of electrical connections in the kit) and/or locate these devices upon a structure (e.g. a building wall, building roof, or platform). It also can optionally provide some additional components (e.g. a spacer piece/device and/or connector pieces) and can enhance the serviceability of the device.

[005] Accordingly, pursuant to a first embodiment of the present invention, there is contemplated a photovoltaic device kit including: a. at least a plurality of photovoltaic devices in at least a first and a second row or column as applied to a structure, the photovoltaic device including: i. a photovoltaic cell assembly including at least one peripheral edge, at least one photovoltaic cell inboard of the at least one peripheral edge, which the photovoltaic cell includes a photoactive portion, wherein the at least one photovoltaic cell includes a surface that allows transmission of light energy to the photoactive portion for conversion into electrical energy; ii. at least one positive buss terminal and at least one negative buss terminal for transferring current to or from the photovoltaic cell assembly via at least one integral photovoltaic connector assembly located within the at least one peripheral edge; and iii. a body portion including a lower surface portion that contacts the structure, and an upper surface portion that receives a fastener that attaches the photovoltaic device to the structure, wherein the body portion is at least partially joined to at least one edge portion of the photovoltaic cell assembly along at least a portion of a bottom segment of the body portion while leaving the surface of the at least one photovoltaic cell exposed; b. at least one edge piece disposed at the end or within the at least upper and adjoining lower row of photovoltaic devices, the at least one edge piece including at least one edge connector assembly for connecting each respective row of photovoltaic devices; wherein, when in use, a current flows across the first row or column in one direction and across the second row or column in the opposite direction.

[006] Accordingly, pursuant to a second embodiment of the present invention, there is contemplated a photovoltaic device assembly including: a. a plurality of first photovoltaic devices individually interconnected via a plurality of photovoltaic device connector assemblies in a first row, wherein a current flow is created in a first direction; b. a plurality of discrete second photovoltaic devices individually interconnected via the plurality of photovoltaic device connector assemblies in a second row, wherein the current flow is created in an opposing direction from the current flow of the first photovoltaic devices; and c. a first edge piece spanning between and connecting the first and second rows at one end.

[007] The invention of both the first and/or second embodiments can be further characterized by one or any combination of the features described herein, such as

including at least one spacer device connected between two photovoltaic devices, one photovoltaic device and one edge piece, or both; the at least one edge piece includes a building connector assembly or electrical lead assembly; the at least one integral photovoltaic connector assembly, the at least one edge connector assembly, or both include a strain relief feature; the at least one integral photovoltaic connector assembly, the at least one edge connector assembly, or both, further includes an integral connector housing adapted to receive a connector element; the connector element comprises: a. a base portion including a first end portion, a second end portion, an intermediate portion and an outer surface; b. a locator portion located on the outer surface of the intermediate portion, the locator portion including a bearing wall that is shaped to generally complement the integral connector housing; and c. at least one electrically conductive member that is substantially surrounded by the base portion and that spans between the first and second end portions and includes connective terminals at opposing ends that are shaped to interlock with an opposing terminal in the integral connector housing, so that the bearing wall partially contacts an opposing surface in the integral connector housing; the at least one edge piece includes at least one edge connector assembly for connecting to a second edge piece; the at least one edge piece includes an indicator device to communicate a circuit status; the structure is a building.

[008] Looking more towards the second embodiment, it can be further characterized by one or any combination of the features described herein, such as including a second edge piece spanning between and connecting the first and second rows at an opposing end, wherein at least the first edge piece includes a first electrical circuit that includes at least a pass-though electrical connector or electrical lead assembly and wherein at least the second edge piece includes a second electrical circuit that includes at least an electrical return circuit interconnect; the plurality of discrete first photovoltaic devices and the plurality of discrete second photovoltaic devices comprise: a. a photovoltaic cell assembly including at least one peripheral edge, at least one photovoltaic cell inboard of the at least one peripheral edge, which the photovoltaic cell includes a photoactive portion, wherein the at least one photovoltaic cell includes a surface that allows transmission of light energy to the photoactive portion for conversion into electrical energy; b. at least one positive buss terminal and at least one negative buss terminal for transferring current to or from the photovoltaic cell assembly via at

least one integral photovoltaic connector assembly located within the at least one peripheral edge; and c. a body portion including lower surface portion that contacts a structure, and an upper surface portion that receives a fastener that attaches the photovoltaic device to the structure, wherein the body portion is at least partially joined to at least one edge portion of the photovoltaic cell assembly along at least a portion of a bottom segment of the body portion while leaving the surface of the at least one photovoltaic cell exposed; the body portion and at least one peripheral edge at least include a unitary polymeric portion; the first edge piece and the second edge piece comprise a polymeric body that substantially envelops at least a portion of the first and second electrical circuits respectfully; the integral photovoltaic connector assembly includes a locator feature for locating one of the plurality of discrete first photovoltaic devices and the plurality of discrete second photovoltaic devices to another or to the first or second end piece within the respective row; the first row, second row, or both, include at least one spacer device; the structure is a building.

[009] Accordingly, pursuant to a third embodiment of the present invention, there is contemplated a method of constructing a photovoltaic device assembly on a surface of a structure, including the steps of: a. providing a plurality of individual photovoltaic devices, wherein the individual photovoltaic devices include: i. a photovoltaic cell assembly including at least one peripheral edge, at least one photovoltaic cell inboard of the at least one peripheral edge, which the photovoltaic cell includes a photoactive portion, wherein the at least one photovoltaic cell includes a surface that allows transmission of light energy to the photoactive portion for conversion into electrical energy; ii. at least one positive buss terminal and at least one negative buss terminal for transferring current to or from the photovoltaic cell assembly via at least one integral photovoltaic connector assembly located within the at least one peripheral edge; and iii. a body portion including a lower surface portion that contacts the structure, and an upper surface portion that receives a fastener that attaches the photovoltaic device to the structure, wherein the body portion is at least partially joined to at least one edge portion of the photovoltaic cell assembly along at least a portion of a bottom segment of the body portion while leaving the surface of the at least one photovoltaic cell exposed; b. providing a plurality of edge pieces; c. attaching a first individual photovoltaic device to the surface; d. attaching a second individual photovoltaic device to the first individual

photovoltaic device via a connector element; e. attaching the second individual photovoltaic device to the surface; f. repeat steps c-e until a first row is attached to the surface, wherein a current flow can flow in a first flow direction; g. begin attaching a second row of individual photovoltaic devices adjacent to the first row, using the same steps as the first row except that the current flow is in a second flow direction; and h. attaching at least one edge piece via a connector element to at least one end of the first and second row.

[0010] The invention of the third embodiment can be further characterized by one or any combination of the features described herein, such as including the step of providing a spacer device; the first row, second row, or both, include at least one spacer device in place of at least one of the individual photovoltaic devices; the steps c-h are repeated to create the photovoltaic device assembly with a plurality of rows; a separate connector element is provided which includes: i. a base portion including a first end portion, a second end portion, an intermediate portion and an outer surface; ii. a locator portion located on the outer surface of the intermediate portion, the locator portion including a bearing wall that is shaped to generally complement the integral connector housing; and iii. at least one electrically conductive member that is substantially surrounded by the base portion and that spans between the first and second end portions and includes connective terminals at opposing ends that are shaped to interlock with an opposing terminal in the integral connector housing, so that the bearing wall partially contacts an opposing surface in the integral connector housing; some or all of the plurality of connector elements have the first end portion integral to the edge piece, the photovoltaic device, or both; the structure is a building.

[0011] It is also should be appreciated that the present invention contemplates a photovoltaic device assembly and method comprising a plurality of PV devices of any of the embodiments described above or subsequently in this application.

[0012] It should be appreciated that the above referenced embodiments and examples are non-limiting, as others exist within the present invention, as shown and described herein.

DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is an exemplary illustration of a perspective view of an assembled kit (row) according to an embodiment of the present invention.

[0014] FIG. 1A is an exemplary illustration of a schematic of the one possible assembled kit derivation shown in FIG. 1, according to an embodiment of the present invention.

[0015] FIG. 2 is another exemplary illustration of a schematic of the one possible assembled kit derivation shown in FIG. 1, according to an embodiment of the present invention.

[0016] FIG. 3 is a partial exploded view of the bottom two rows (left side) of the kit of Figure 2.

[0017] FIG. 4 is one exemplary illustration of an exploded view of a PV device piece according to an embodiment of the present invention.

[0018] FIG. 5 is an exemplary illustration of a perspective view of a connector piece according to an embodiment of the present invention.

[0019] FIG. 6 is an exemplary illustration of an exploded perspective view of two PV devices and the connector of FIG. 5.

[0020] FIG. 7 is an exemplary illustration of a perspective view of a partially integrated connector.

[0021] FIG. 8 is an exemplary illustration of a perspective view (top) of one possible edge piece according to an embodiment of the present invention.

[0022] FIG. 9 is an exemplary illustration of a perspective view (bottom) of one possible edge piece according to an embodiment of the present invention.

[0023] FIG. 10 is another exemplary illustration of a perspective view (bottom) of an edge piece with ribs and integrated wiring according to an embodiment of the present invention.

[0024] FIG. 11 is another exemplary illustration of a perspective view (bottom) of an edge piece with ribs and a wiring channel according to an embodiment of the present invention.

[0025] FIG. 12 is a perspective view of ribs and wiring channel of FIG. 11.

[0026] FIG. 13 is an exemplary illustration of a schematic of one possible kit derivation according to an embodiment of the present invention.

[0027] FIG. 14 is an exemplary illustration of a row of PV devices with a spacer device.

[0028] FIG. 15 is an exemplary illustration of a perspective view of an assembled kit (column) according to an embodiment of the present invention.

[0029] FIG. 16 is an exemplary illustration of a schematic of one possible kit (column) derivation according to an embodiment of the present invention.

[0030] FIG. 17 is an exemplary illustration of two perspective view (top and bottom) of a PV device (column kit) according to an embodiment of the present invention.

[0031] FIG. 18 is an exemplary illustration of two perspective views (top and bottom) of an edge piece (column kit-top) according to an embodiment of the present invention.

[0032] FIG. 19 is an exemplary illustration of a perspective view of a structure pass-through electrical connector assembly.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0033] The present invention is a photovoltaic device assembly (or kit) and method of making same. This assembly can include a plurality of photovoltaic devices ("PV devices" or "PVD") that are placed in rows or columns (e.g. two or more); wherein the devices can be both physically and electrically connected by connectors, edge pieces, spacer pieces, or any combination thereof. The assembly is configured to aid in providing quick and easy installation and to reduce the number of potential structure, (façade or roof – in the case of the preferred structure of a building roof application) penetrations needed. Preferably, the photovoltaic device assembly utilizes PV devices and connectors that are the same or similar (functionally and/or structurally) to those described in US patent applications publication Nos. 2011/0100436 and 2011/0183540 (and in related WO2009/137,348 and WO2009/137,347, respectively), and in WO2009/137,352 and WO2009/137,353.

[0034] Generally, the present invention contemplates a photovoltaic device assembly or kit 20 (for example as a row configuration as shown in Figs. 1, 1a, and 2 fully assembled and for example as a column configuration fully assembled as shown in Fig. 15 and Fig. 16) that can include at least a plurality of PV devices 100 in at least two rows or columns as applied to a building (or other structure). As shown in Fig. 2, the wiring at the bottom of the kit 20 may be routed up and across (e.g. via channels 65)

assembled kit 20 so that the electrical wires are at or near the top of the kit. The first row/column configured to produce a current flow 21 (shown with an arrow) in one direction and the second row configured to have an opposite current flow. The kit 20, can include at least one edge piece 50 located at the end or within the at least two rows/columns of PV devices 100. The PV devices 100 can be further described as at least including a photovoltaic cell assembly 110 and a body portion 120.

[0035] The edge piece 50 may include two or more edge connector assemblies 52 for connecting each respective row or column of photovoltaic devices. The edge piece can include electrical element or elements 51 incorporated between edge connector assemblies 52 such that the rows are electrically connected together or have a single electrical output 500 from the kit 20 at or near an outer edge of the kit. In certain cases, the edge piece may have no electrical connector assemblies 52 and function solely as a filler piece 54 or a starter piece 53. Preferably, the edge connector assemblies and the photovoltaic device connector assemblies 58 are the same or similar (e.g. functionally and/or structurally). A description for one is intended to apply to the other unless specifically stated otherwise. The edge piece connector assembly can be, as in the first embodiment, integral to the edge piece (i.e. located within at least one peripheral edge of an edge piece as is shown in Fig. 3) or it can be a separate element that is used in the assembly between one peripheral edge of an edge piece and one peripheral edge of a PV device or between peripheral edges of adjacent edge pieces and mating to the connector housing or connector elements in those pieces, depending on the kit design.

[0036] The edge piece connector assembly 52 can include a housing 56 integral to the edge piece (e.g. a female housing), as shown in the PV device in Fig 6, adapted to receive a separate connector piece 58 (i.e., shaped to generally complement an opposing connector housing), a connector integrated housing 59 with a connector piece at least partially integrated therein (Fig 7), or any combination thereof and at least one electrically conductive member that spans between the first and second end portions and includes connective terminals at opposing ends that are shaped to interlock with an opposing terminal in the opposing connector housing. .

[0037] The assembly can also include any number of spacer pieces 400 (e.g. as shown in Fig. 14) that may or may not contain any photovoltaic devices (e.g. power generating means) or other components. It is contemplated that spacer pieces can

provide additional functionality to the kit. In one example, a spacer piece 400 can provide a through hole for roof vents. In another example, a spacer piece 400 or pieces can provide an aesthetic function, such as staggering the rows or columns.

[0038] It is also contemplated that the assembly or kit can be configured to provide a targeted power output (e.g. 0.1 to 8 KWp or more (KWp defined as kilowatt-peak) and to fit standard building designs (e.g. mass produced homes) that share roof and/or fascia layouts, or can be custom configured for one-off designs. For example, the kit can be configured to fit (e.g. number of PV devices, number of rows, number and location of spacers/edge pieces) one particular roof design that is utilized in a particular model home offered by a builder (e.g. the Beaumont™ model offered by Pulte Homes ™).

[0039] The individual components that make up the kit are described in further detail and illustrative examples of some of the possible kit configurations are provided below.

PV DEVICE

[0040] In an illustrative example, the PV device 100 can be described generally as a three dimensional article that includes an energy producing device (e.g. solar cells), electrical circuitry to transfer the energy produced, and a body which holds the energy producing device and allows it to be effectively mounted onto a structure. It is contemplated that a PV device 100 of the present invention is preferably a discrete part /component that is used in the overall kit. It is also contemplated that the PV devices used in one row/column are configured to have a current flow 21 in one direction and the PV devices used in an adjoining or second row/column are configured to have a current flow 21 in an opposing direction. It may also be described that the PV devices of one row/column have one polarity while the PV devices of the second row/column have an opposite polarity.

[0041] For example, as shown in Fig. 3, the PV device 100 can be further described as including a photovoltaic cell assembly 110 and a body portion 120 (which can also be referred to as a body support portion where it provides structural support). The body portion 120 having an upper surface portion 122, a lower surface portion 124 and side wall portion 126 spanning therebetween. The body portion 120 can be further described as including a main body portion 222, a side body portion 224, and an optional bottom body portion 226 and locator (not shown). The PV device 100 can also be described as

having an active portion 130 and an inactive portion 135. The active portion 130 can include at least the photovoltaic cell assembly 110, a portion of the side body portion 224 and the optional bottom body portion 226. The inactive portion 135 can include at least the main body portion 222, a portion of the side body portion 224, and some or all of the electrical circuitry of the PV device 100.

[0042] For example as shown in an exploded view of a PV device 100 in Fig. 4, the photovoltaic cell assembly 110 can be further described as including a photovoltaic cell 111, protective layers 113, and at least some of the electrical circuitry 114 of the PV device. The PV devices 100 can also be described in an alternative fashion. The PV devices 100 can include components such as the photovoltaic cell assembly 110, at least one positive buss terminal 140 and at least one negative buss terminal 141(not shown), and a body portion 120.

[0043] The PV devices 100 can include at least one peripheral edge 112, at least one photovoltaic cell 111 inboard of the at least one peripheral edge 112.

[0044] The positive and negative buss terminals 140, 141, which can function to transfer current to or from the photovoltaic cell assembly 110 via at least one integral photovoltaic connector assembly 57 located within the at least one peripheral edge 112. Preferably, the positive and negative buss terminals 140, 141 are located on opposing edges of the PV device and each transfer current via an integral connector assembly 57 disposed in opposing peripheral edges. For example, the PV device used in the first row have the positive buss terminal 140 on the right side of the PV device and the negative buss terminal 141 on the left side, in the second row this is reversed. In the case of a column, the positive buss terminal 140 is on top and the negative on the bottom for the first column and reversed on the adjoining column.

[0045] The body portion 120 lower surface portion 124 can contact the structure (e.g. building substrate and/or structure). Also having an upper surface portion 122 that receive a fastener (not shown, e.g. nail, screw, staple, rivet, etc.) that attaches the photovoltaic device 100 to the structure. Furthermore, the body portion 120 can be at least partially joined to at least one edge portion of the photovoltaic cell assembly 110 along at least a portion of a bottom segment 156 of the body portion 120 while leaving at least a portion of the at least one photovoltaic cell 111 exposed to receive radiation.

[0046] It is contemplated that the PV device 100 can be constructed at least partially of flexible materials (e.g. thin films or deformable materials, with significant plastic or elastic elongation such as plastics, synthetic and natural rubbers, films, elastomers, or the like) to allow at least some flexibility for conforming to an irregular contour in a building structure. It is also contemplated that it can be desirable to at least keep the photovoltaic cell relatively rigid, generally to prevent any cracking of the cell. Thus, some parts of the PV device can be constructed with a more rigid material (e.g. glass plate, mineral filled composites, or polymeric sheets). Although, the photovoltaic cell can be partially or substantially rigid, it is possible for the PV device to be generally flexible. For this invention, flexible means that the PV device is more flexible or less rigid than the substrate (e.g. structure) to which it is attached. Preferably, in the case of a flexible substrate the PV device can bend about a 1 meter diameter cylinder without a decrease in performance or critical damage. Preferably, in the case of a rigid substrate the PV device can bend about 20 meter diameter cylinder without a decrease in performance or critical damage. For example, in the case of a PV device shingle, shingles generally are less rigid than the roof deck; the roof deck provides structural rigidity. In some other examples the roofing product itself provides the necessary rigidity and the roof deck is absent, or minimized.

The photovoltaic cell 110, contemplated in the present invention may be constructed of any number of known photovoltaic cells commercially available or may be selected from some future developed photovoltaic cells. These cells function to translate light energy into electricity. The photoactive portion of the photovoltaic cell is the material which converts light energy to electrical energy. Any material known to provide that function may be used including crystalline silicon, or amorphous silicon. However, the photoactive layer is preferably a layer of IB-IIIA-chalcogenide, such as IB-IIIA-selenides, IB-IIIA-sulfides, or IB-IIIA-selenide sulfides. More specific examples include copper indium selenides, copper indium gallium selenides, copper gallium selenides, copper indium sulfides, copper indium gallium sulfides, copper gallium selenides, copper indium sulfide selenides, copper gallium sulfide selenides, and copper indium gallium sulfide selenides (all of which are referred to herein as CIGSS). These can also be represented by the formula CuIn(1-x)GaxSe(2-y)Sy where x is 0 to 1 and y is 0 to 2. The copper indium selenides and copper indium gallium selenides are preferred. Additional

electroactive layers such as one or more of emitter (buffer) layers, conductive layers (e.g. transparent conductive layers) and the like as is known in the art to be useful in CIGSS based cells are also contemplated herein. These cells may be flexible or rigid and come in a variety of shapes and sizes, but generally are fragile and subject to environmental degradation. In a preferred embodiment, the photovoltaic cell assembly 110 is a cell that can bend without substantial cracking and/or without significant loss of functionality. Exemplary photovoltaic cells are taught and described in a number of US patents and publications, including US3767471, US4465575, US20050011550 A1, EP841706 A2, US20070256734 a1, EP1032051A2, JP2216874, JP2143468, and JP10189924a.

CONNECTOR

[0047] It is contemplated that the kit 20 may use a plurality of connectors 58, for example such as those described in US provisional application 61/098,941. These connectors can be separate components (e.g. as shown in Figs. 5-6) or partially integrated into the PV device 100, the edge piece 50, or both (e.g. as shown in Fig. 7). In an illustrative example shown in Fig. 5, the connector 58 can be described generally as including a base portion 210 including a first end portion 212, a second end portion 214 and an outer surface 216. It also can include a locator portion 218 located on the outer surface. In one particular embodiment, the locator portion can be described as including a bearing wall that can be shaped to generally complement an opposing female connector housing 56 that can be located in a PV device 100 or edge piece 50. Furthermore, upon installation, the bearing wall can at least partially contact an opposing surface in the female connector housing. Moreover, the connector assembly can include at least one electrically conductive member that is substantially surrounded by the base portion and that spans between the first and second end portions and includes connective terminals at opposing ends. These terminals can be shaped to interlock with an opposing terminal in the opposing female connector housing.

[0048] It is also contemplated that the opposing female connector housing can be integral to an outer wall section (e.g. portions such as top, bottom, or sides of the PV device or edge piece) of the PV device 100 or edge piece 50. The housing can be connected to the PV device or edge piece via a fastener scheme (e.g. mechanical

fasteners, adhesives, or a combination thereof) or can be integrated into the PV device or edge piece via the structure of the device/piece (e.g. over-molded into the device or part of the framework of the PV device or edge piece for example as shown in Fig 10). In either case, it is contemplated that female connector housing integral to or connected to a PV device or edge piece and/or the connector assembly includes a strain relief feature (or combination of one or more features) to allow movement of the assembly while maintaining an electrical contact between the respective terminals.

[0049] The edge piece connector assembly may be further characterized by one or any combination of the features described herein, such as the opposing female connector housing is integral to an outer wall section of the edge piece or the photovoltaic device; the connector assembly includes a bypass diode electrically connected to the at least one electrically conductive member; the connector assembly includes an indicator device to communicate a circuit status; the connector assembly includes a locking device that locks the male connector element to the opposing female connector housing upon installation; the connector assembly includes a second electrically conductive member, the first end portion of which is integral to the outer wall section of the photovoltaic device or edge piece, the connector element (male or female) is integral to the first connector housing (male or female), an outwardly projecting portion in the locator portion that projects upward towards a top surface that is generally coplanar with a top surface of the photovoltaic device or edge piece.

[0050] It should be appreciated that the above referenced aspects and examples are non-limiting, as others exist within the present invention, as shown and described herein.

EDGE PIECE

[0051] The edge piece 50, for example as shown in Figs.8-11 and 18, generally function to physically and/or electrically connect at least two rows or columns of PV devices 100. It can also function to connect one edge piece to another edge piece. The edge piece 50 can be disposed at a single end, opposing ends, within a row/column, or any combination thereof of a row/column of PV devices 100. It is contemplated that an edge piece 50 can include a through roof (or building structure) connector feature (e.g. a structure pass-through electrical connector assembly 510) or electrical leads or insulated wires (e.g. electrical lead assembly) that allow for the electrical output of the PV device

or devices to be electrically connected to the complimentary electrical devices located within the structure. It is also contemplated that a filler piece 54 may be used to fill any possible gaps in the edge pieces when assembled. The edge piece can be attached to the structure in the same manner as the PV device 100, for example with a fastener such as a nail or screw being driven through a portion of the body. The fastener preferably being placed in an area that does not contain any additional components (e.g. wires, connectors and the like). It is contemplated that a fastening zone (not shown) can be marked on the edge piece to aid in installation (e.g. physical markings on the PV device, edge piece, or both such as "nail here" or "fastener" or some other graphical demarcation). The edge piece 50 can also include additional components such as electrical transmission lines (e.g. wires), electrical switches, fuses, by-pass diodes, solar cells, circuit status indicators, or any combination thereof.

[0052] As shown in Figs. 8-13, it is contemplated that the main body portion 60 can have an outer surface portion 62, an inner surface portion 64 (e.g. portion that contacts the building or structure surface) and side surface portions 66 that connect the outer and inner surface portions 62, 64. Optionally, the inner surface portion 64 can be solid (e.g. a unitary block) or have geometric features (e.g. ribs 61 for example as shown in Fig 10). The main body portion 60 can be any number of shapes or sizes, but preferably is shaped to complement the shape of the PV device 100 that it connects thereto. In this example, the main body portion 60 is "stepped" vertically to allow for a complementary fit to two rows of PV devices that are stacked and layered (e.g. akin to roofing shingles). The main body portion 60 can also be "staggered" horizontally to allow for a complimentary fit to the two rows of PV devices, if the devices are installed with an offset (again, akin to roofing shingles). It also can include a flashing portion 68 that can be adapted to interface with and/or sit under other building materials (e.g. abutting standard roofing shingles, trim materials, building siding, or the like).

[0053] In one illustrative example, shown in Fig. 9, a bottom view of an edge piece 50 can be described generally as including a main body portion 60 and two edge connector assembly 52 (one example of which may be "the partially integrated connector assembly" as described above) and an electrical element or elements 51 (e.g. wires, electrically conductive foil or polymers) spanning between the two edge connector assemblies 52, one of which is hidden behind the body portion 60 of the edge piece.

[0054] In another illustrative example shown in Fig. 10, (an alternative bottom view of an edge piece) the electrical element 51 can be integrally connected to the edge piece 50 (e.g. molded within the piece). Preferably, the element is wire or foil pieces that are molded into the edge piece 50 (partially or fully encapsulated by the edge piece) along with at least a portion of the connector assembly 52.

[0055] In yet another illustrative example, shown in Figs 11-12 (also bottom views of the edge piece), the electrical element 51 can be removably attached via any number of attachment features (e.g. adhesive, mechanical fasteners, press-fit into channels 65, for example, cut into ribs 61, shown in Fig 12, or any combination thereof). It is contemplated that the PV devices 100 may also include ribs 61 with channels 65 for any required wire routing.

[0056] The main body portion 60 can be constructed of any number of materials (e.g. polymers, metals and/or ceramics), so long as it resists environmental degradation as it is exposed to the outdoor over the years of service (e.g. 10, 20 or 30 years or more). Preferred materials or combinations of materials include a filled or unfilled moldable plastic (e.g. polyolefins, acrylonitrile butadiene styrene, hydrogenated styrene butadiene rubbers, polyester amides, polysulfone, acetel, acrylic, polyvinyl chloride, nylon, polyethylene terephthalate, polycarbonate, thermoplastic and thermoset polyurethanes, synthetic and natural rubbers, epoxies, styrene-acrylonitrile ("SAN"), polymethyl methacrylate, polystyrene, or any combination thereof). Fillers can include one or more of the following: colorants, fire retardant ("FR") or ignition resistant ("IR") materials, reinforcing materials, such as glass or mineral fibers, surface modifiers. Plastic can also include anti-oxidants, release agents, blowing agents, and other common plastic additives.

ILLUSTRATIVE EXAMPLES

[0057] The various examples discussed below and shown in the figures generally attempt to take PV devices, edge pieces, connectors and optionally other components (e.g. spacers 400 as shown in Fig. 14) to create a photovoltaic device kit 20 that when assembled can be configured to provide a targeted power output and preferably require two or less electrical connections to the inverter or the underlying building electrical system. It is contemplated that the geometry of these kits can be varied and the

following examples should not be considered as limiting. Thus, for the sake of clarity, the following examples are provided to illustrate the invention but are not intended to limit the scope thereof. The rows of PV devices can be staggered (e.g. as traditional roofing shingles) or lined up in columns. The rows and/or columns can be vertical, horizontal or anywhere in-between. In all the illustrative examples discussed below, it is assumed that the PV devices can be physically and electrically connected to one another within the row via connector assemblies as described previously. The lines 600 shown represent the electrical transmission line or circuits within the PV devices 100 and/or the edge pieces 50 and the dots represent connectors.

[0058] Referring to Fig. 13, a first illustrative example of the present invention is shown (schematical view). In example, a photovoltaic device kit 20 can include at least a plurality of PV devices 100 in multiple rows and multiple edge pieces 50 (one set on each row end). At both ends of a row of PV devices 100, the PV devices can be physically and electrically connected to an edge piece 50 via and edge piece connector assembly 52. The edge piece can include electrical element or elements 51 that electrically connect the rows together and have two electrical outputs 500 from the kit 20 at or near an inner edge of the kit.

[0059] It is contemplated that the electrical output 500 may be accomplished via a pass-through electrical connector assembly 510 (for example as shown in Fig. 19 as a part of a connector assembly) or electrical lead assembly (for example a set of wires attached to an edge piece or a connector assembly – not shown)

[0060] Referring to Fig. 14, a single row of PV devices 100 including an exemplary spacer piece 400 is shown.

[0061] According to another embodiment, tile style installations (e.g. columns) are preferably arranged as shown in Figs. 15 and 16. Referring to Figs. 15 - 18, a second illustrative example of the present invention is shown. In this example, one possible vertical configuration of PV devices 100 is shown (e.g. 2 rows x 3 columns). In this example 3 columns of PV devices 100 include a flow channel 1100 on one side that can aid in water flow control and/or provide an interlocking function. Also, edge pieces 50 are provided with geometry appropriate to fit in this vertical configuration and with different geometries between edge pieces at the top of the column versus the bottom of the column (e.g. as seen in Fig. 18). The fully assembled kit 20 is shown in Figs. 15 and

16. Also shown in this example are ribs 61 that are formed on the back side of the PV devices and edge pieces. These ribs 61 can help reduce the mass of the components and aid in providing the desired rigidity for the components. Rib designs can be incorporated into both the vertical (column) and horizontal (row) examples or embodiments.

[0062] In Fig. 16, a schematic of one possible electrical circuit is shown with connectors 52 and electrical element 51 (wiring preferably integral to the PV devices and edge pieces. In the vertical configuration of the kit 20, the physical and electrical connections to the PV devices 100 occur at or near the top and bottom of the devices (versus at the sides as in the row configurations described in the earlier examples).

[0063] Unless stated otherwise, dimensions and geometries of the various structures depicted herein are not intended to be restrictive of the invention, and other dimensions or geometries are possible. Plural structural components can be provided by a single integrated structure. Alternatively, a single integrated structure might be divided into separate plural components. In addition, while a feature of the present invention can have been described in the context of only one of the illustrated embodiments, such feature can be combined with one or more other features of other embodiments, for any given application. It will also be appreciated from the above that the fabrication of the unique structures herein and the operation thereof also constitute methods in accordance with the present invention.

[0064] The preferred embodiment of the present invention has been disclosed. A person of ordinary skill in the art would realize however, that certain modifications would come within the teachings of this invention. Therefore, the following claims should be studied to determine the true scope and content of the invention.

[0065] Any numerical values recited in the above application include all values from the lower value to the upper value in increments of one unit provided that there is a separation of at least 2 units between any lower value and any higher value. As an example, if it is stated that the amount of a component or a value of a process variable such as, for example, temperature, pressure, time and the like is, for example, from 1 to 90, preferably from 20 to 80, more preferably from 30 to 70, it is intended that values such as 15 to 85, 22 to 68, 43 to 51, 30 to 32 etc. are expressly enumerated in this specification. For values which are less than one, one unit is considered to be 0.0001,

0.001, 0.01 or 0.1 as appropriate. These are only examples of what is specifically intended and all possible combinations of numerical values between the lowest value and the highest value enumerated are to be considered to be expressly stated in this application in a similar manner.

[0066] Unless otherwise stated, all ranges include both endpoints and all numbers between the endpoints. The use of "about" or "approximately" in connection with a range applies to both ends of the range. Thus, "about 20 to 30" is intended to cover "about 20 to about 30", inclusive of at least the specified endpoints.

[0068] The term "consisting essentially of" to describe a combination shall include the elements, ingredients, components or steps identified, and such other elements ingredients, components or steps that do not materially affect the basic and novel characteristics of the combination.

[0069] The use of the terms "comprising" or "including" to describe combinations of elements, ingredients, components or steps herein also contemplates embodiments that consist essentially of the elements, ingredients, components or steps.

[0070] Plural elements, ingredients, components or steps can be provided by a single integrated element, ingredient, component or step. Alternatively, a single integrated element, ingredient, component or step might be divided into separate plural elements, ingredients, components or steps. The disclosure of "a" or "one" to describe an element, ingredient, component or step is not intended to foreclose additional elements, ingredients, components or steps.

ELEMENT NUMBER TABLE

photovoltaic device assembly or kit 20
current flow 21
edge piece 50
electrical element of the edge piece 51
edge connector assemblies 52
starter piece 53
filler piece 54
end piece 55
female connector housing 56
separate connector piece 58
integral photovoltaic connector assembly 57

male connector housing 59
main body portion 60
ribs 61
outer surface portion 62
inner surface portion 64
channels 65
side surface portions 66
flashing portion 68
photovoltaic device(s) 100
photovoltaic cell assembly 110
a photovoltaic cell 111
peripheral edge 112
protective layers 113
electrical circuitry 114
body portion 120
upper surface portion 122
lower surface portion 124
side wall portion 126
active portion 130
inactive portion 135
positive buss terminal 140
negative buss terminal 141
bottom segment 156
base portion 210
first end portion 212
second end portion 214
outer surface 216
locator portion 218
main body portion 222
side body portion 224
body portion 226
spacer piece 400
electrical output 500
pass-through electrical connector assembly 510
electrical transmission lines in PV device 600
flow channel 1100

53191-15

CLAIMS:

1. A photovoltaic device kit comprising:

a. at least a plurality of photovoltaic devices in at least a first and a second row or column as applied to a structure, the photovoltaic device including:

i. a photovoltaic cell assembly including at least one peripheral edge, at least one photovoltaic cell inboard of the at least one peripheral edge, which the photovoltaic cell includes a photoactive portion, wherein the at least one photovoltaic cell includes a surface that allows transmission of light energy to the photoactive portion for conversion into electrical energy;

ii. at least one positive buss terminal and at least one negative buss terminal for transferring current to or from the photovoltaic cell assembly via at least one integral photovoltaic connector assembly located within the at least one peripheral edge; and

iii. a body portion including a lower surface portion that contacts the structure, and an upper surface portion that receives a fastener that attaches the photovoltaic device to the structure, wherein the body portion is at least partially joined to at least one edge portion of the photovoltaic cell assembly along at least a portion of a bottom segment of the body portion while leaving the surface of the at least one photovoltaic cell exposed;

b. at least one edge piece disposed at the end or within the at least upper and adjoining lower row of photovoltaic devices, the at least one edge piece including at least one edge connector assembly for connecting each respective row of photovoltaic devices;

wherein, when in use, a current flows across the first row or column in one direction and across the second row or column in the opposite direction.

2. The photovoltaic device kit according to claim 1, further including at least one spacer device connected between two photovoltaic devices, one photovoltaic device and one edge piece, or both.

3. The photovoltaic device kit according to claims 1 or 2, wherein the at least one edge piece includes a building connector assembly or electrical lead assembly.

4. The photovoltaic device kit according to any one of claims 1 to 3, wherein the at least one integral photovoltaic connector assembly, the at least one edge connector assembly, or both include a strain relief feature.

5. The photovoltaic device kit according to any one of claims 1 to 4, wherein the at least one integral photovoltaic connector assembly, the at least one edge connector assembly, or both, further includes an integral connector housing adapted to receive a connector element.

6. The photovoltaic device kit according to claim 5, wherein the connector element comprises:

a. a base portion including a first end portion, a second end portion, an intermediate portion and an outer surface;

b. a locator portion located on the outer surface of the intermediate portion, the locator portion including a bearing wall that is shaped to generally complement the integral connector housing; and

c. at least one electrically conductive member that is substantially surrounded by the base portion and that spans between the first and second end portions and includes connective terminals at opposing ends that are shaped to interlock with an opposing terminal in the integral connector housing, so that the bearing wall partially contacts an opposing surface in the integral connector housing.

53191-15

7. The photovoltaic device kit according to any one of claims 1 to 6, wherein the at least one edge piece includes at least one edge connector assembly for connecting to a second edge piece.

8. The photovoltaic device kit according to any one of claims 1 to 7, wherein the at least one edge piece includes an indicator device to communicate a circuit status.

9. The kit according to any one of claims 1 to 8 wherein the structure is a building.

10. A photovoltaic device assembly comprising:

a. a plurality of first photovoltaic devices individually interconnected via a plurality of photovoltaic device connector assemblies in a first row on a structure, wherein a current flow is created in a first direction;

b. a plurality of discrete second photovoltaic devices individually interconnected via the plurality of photovoltaic device connector assemblies in a second row on the structure, wherein the current flow is created in an opposing direction from the current flow of the first photovoltaic devices; and

c. a first edge piece spanning between and connecting the first and second rows at one end.

11. The photovoltaic device assembly according to claim 10, including a second edge piece spanning between and connecting the first and second rows at an opposing end, wherein at least the first edge piece includes a first electrical circuit that includes at least a pass-through electrical connector or electrical lead assembly and wherein at least the second edge piece includes a second electrical circuit that includes at least an electrical return circuit interconnect.

12. The photovoltaic device assembly according to claim 10, wherein the plurality of discrete first photovoltaic devices and the plurality of discrete second photovoltaic devices comprise:

a. a photovoltaic cell assembly including at least one peripheral edge, at least one photovoltaic cell inboard of the at least one peripheral edge, which the photovoltaic cell includes a photoactive portion, wherein the at least one photovoltaic cell includes a surface that allows transmission of light energy to the photoactive portion for conversion into electrical energy;

b. at least one positive buss terminal and at least one negative buss terminal for transferring current to or from the photovoltaic cell assembly via at least one integral photovoltaic connector assembly located within the at least one peripheral edge; and

c. a body portion including lower surface portion that contacts [[a]]the structure, and an upper surface portion that receives a fastener that attaches the photovoltaic device to the structure, wherein the body portion is at least partially joined to at least one edge portion of the photovoltaic cell assembly along at least a portion of a bottom segment of the body portion while leaving the surface of the at least one photovoltaic cell exposed.

13. The photovoltaic device assembly according to claim 12, wherein the body portion and at least one peripheral edge at least include a unitary polymeric portion.

14. The photovoltaic device assembly according to any one of claims 10 to 13 wherein the first edge piece and the second edge piece comprise a polymeric body that substantially envelops at least a portion of the first and second electrical circuits respectfully.

15. The photovoltaic device assembly according to any one of claims 10 to 14 wherein the integral photovoltaic connector assembly includes a

locator feature for locating one of the plurality of discrete first photovoltaic devices and the plurality of discrete second photovoltaic devices to another or to the first or second end piece within the respective row.

16. The photovoltaic device assembly according to any one of claims 10 to 14 wherein the first row, second row, or both, include at least one spacer device.

17. The device assembly according any one of claims 10 to 16 wherein the structure is a building.

18. A method of constructing a photovoltaic device assembly on a surface of a structure, comprising the steps of:

a. providing a plurality of individual photovoltaic devices, wherein the individual photovoltaic devices include:

i. a photovoltaic cell assembly including at least one peripheral edge, at least one photovoltaic cell inboard of the at least one peripheral edge, which the photovoltaic cell includes a photoactive portion, wherein the at least one photovoltaic cell includes a surface that allows transmission of light energy to the photoactive portion for conversion into electrical energy;

ii. at least one positive buss terminal and at least one negative buss terminal for transferring current to or from the photovoltaic cell assembly via at least one integral photovoltaic connector assembly located within the at least one peripheral edge; and

iii. a body portion including a lower surface portion that contacts the structure, and an upper surface portion that receives a fastener that attaches the photovoltaic device to the structure, wherein the body portion is at least partially joined to at least one edge portion of the photovoltaic cell assembly along at least a portion of a bottom segment of the body portion while leaving the surface of the at least one photovoltaic cell exposed;

b. providing a plurality of edge pieces;

c. attaching a first individual photovoltaic device to the surface;

d. attaching a second individual photovoltaic device to the first individual photovoltaic device via a connector element;

e. attaching the second individual photovoltaic device to the surface;

f. repeat steps c-e until a first row is attached to the surface, wherein a current flow can flow in a first flow direction;

g. begin attaching a second row of individual photovoltaic devices adjacent to the first row, using the same steps as the first row except that the current flow is in a second flow direction; and

h. attaching at least one edge piece via a connector element to at least one end of the first and second row.

19. The method of constructing a photovoltaic device assembly on a surface of a structure according to claim 18, including the step of providing a spacer device.

20. The method of constructing a photovoltaic device assembly on a surface of a structure according to claim 19, wherein the first row, second row, or both, include at least one spacer device in place of at least one of the individual photovoltaic devices.

21. The method of constructing a photovoltaic device assembly on a surface of a structure according to any one of claims 18 to 20 wherein the steps c-h are repeated to create the photovoltaic device assembly with a plurality of rows.

22. The method of constructing a photovoltaic device assembly on a surface of a structure according to any one of claims 18 to 21 wherein a separate connector element is provided which includes: i. a base portion including a first end

portion, a second end portion, an intermediate portion and an outer surface; ii. a locator portion located on the outer surface of the intermediate portion, the locator portion including a bearing wall that is shaped to generally complement the integral connector housing; and iii. at least one electrically conductive member that is substantially surrounded by the base portion and that spans between the first and second end portions and includes connective terminals at opposing ends that are shaped to interlock with an opposing terminal in the integral connector housing, so that the bearing wall partially contacts an opposing surface in the integral connector housing.

23. The method of constructing a photovoltaic device assembly on a surface of a structure according to any one of claims 18 to 20 wherein some or all of the plurality of connector elements have the first end portion integral to the edge piece, the photovoltaic device, or both.

24. The method of any one of claims 18 to 23 wherein the structure is a building.

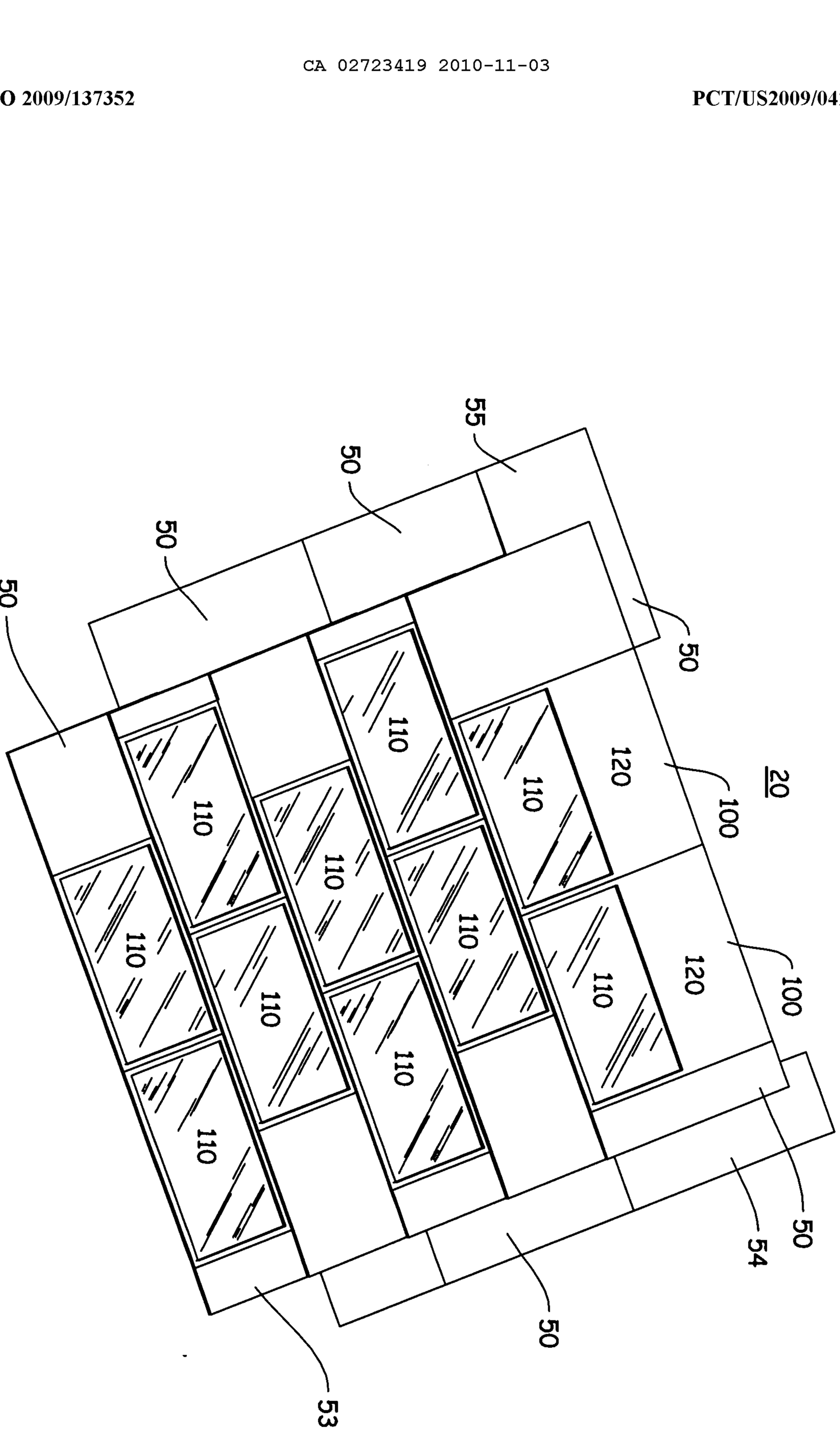

55
50
50
50
20
100
110
120
110
110
110
110
110
110
110
110
110
110
110
110
110
120
100
50
54
50
53

FIG 1

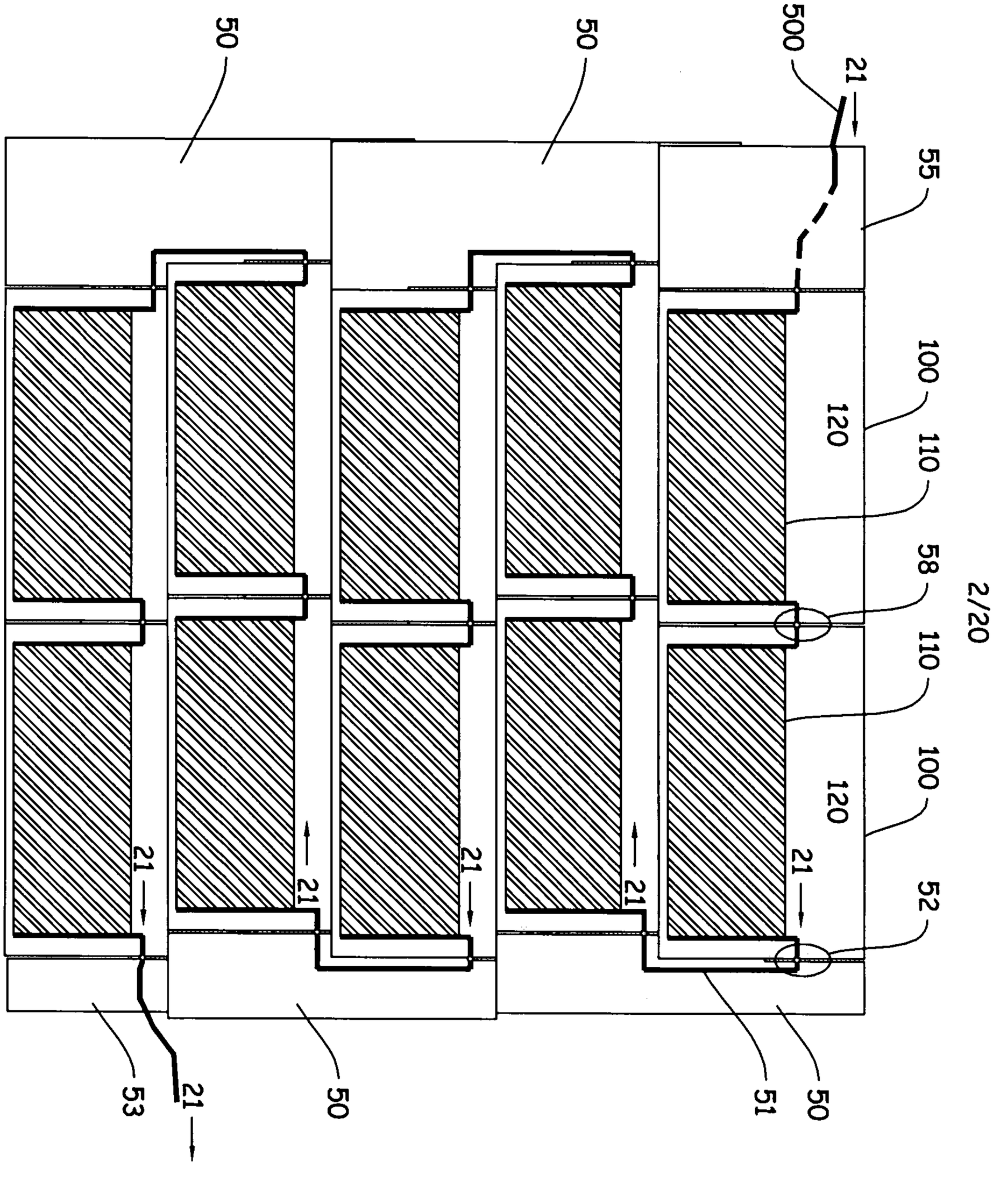

50
50
500
21
55
100
120
110
58
2/20
110
100
120
52
21
21
21
21
21
53
21
50
51
50

FIG 1A

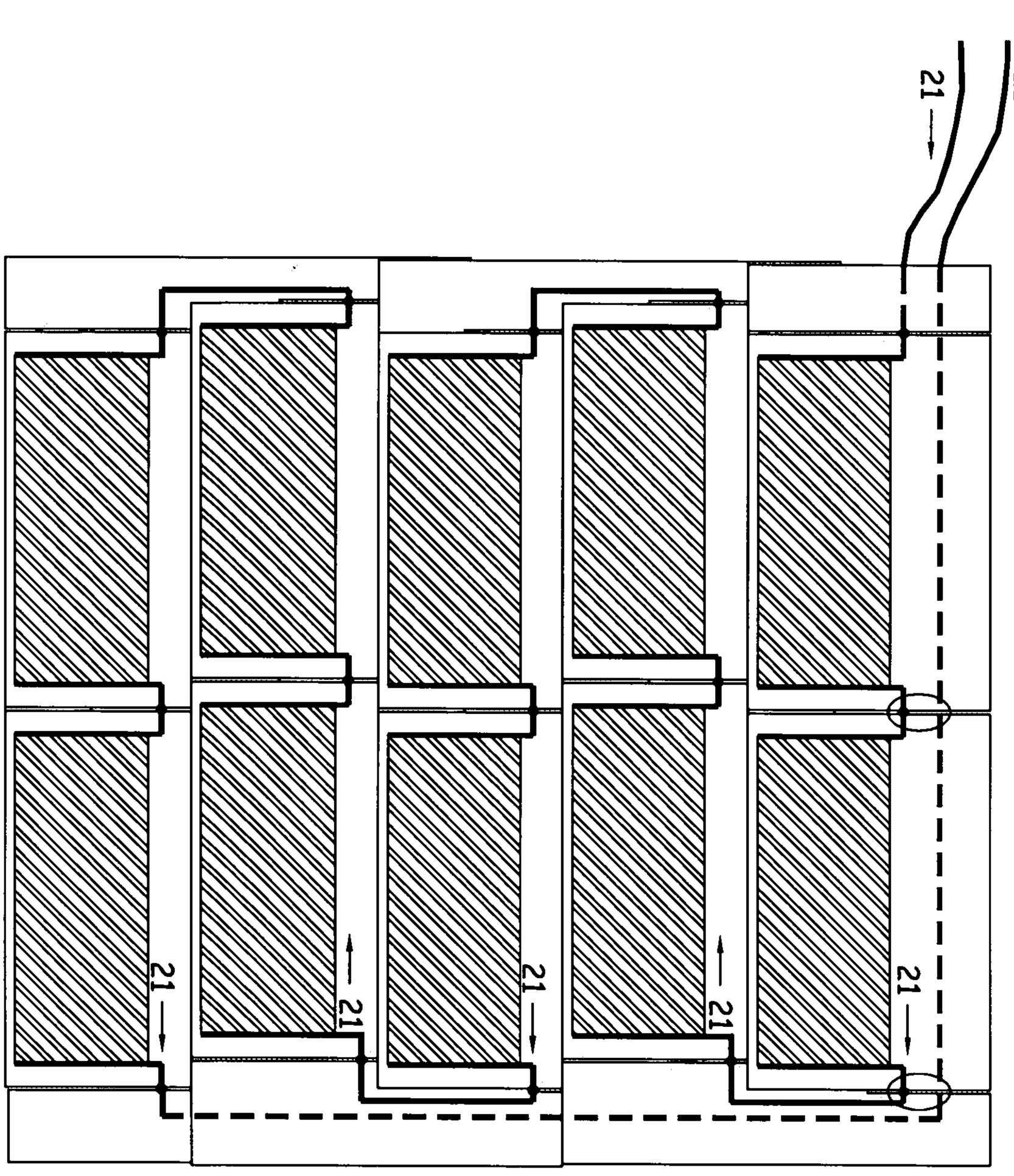


FIG 2

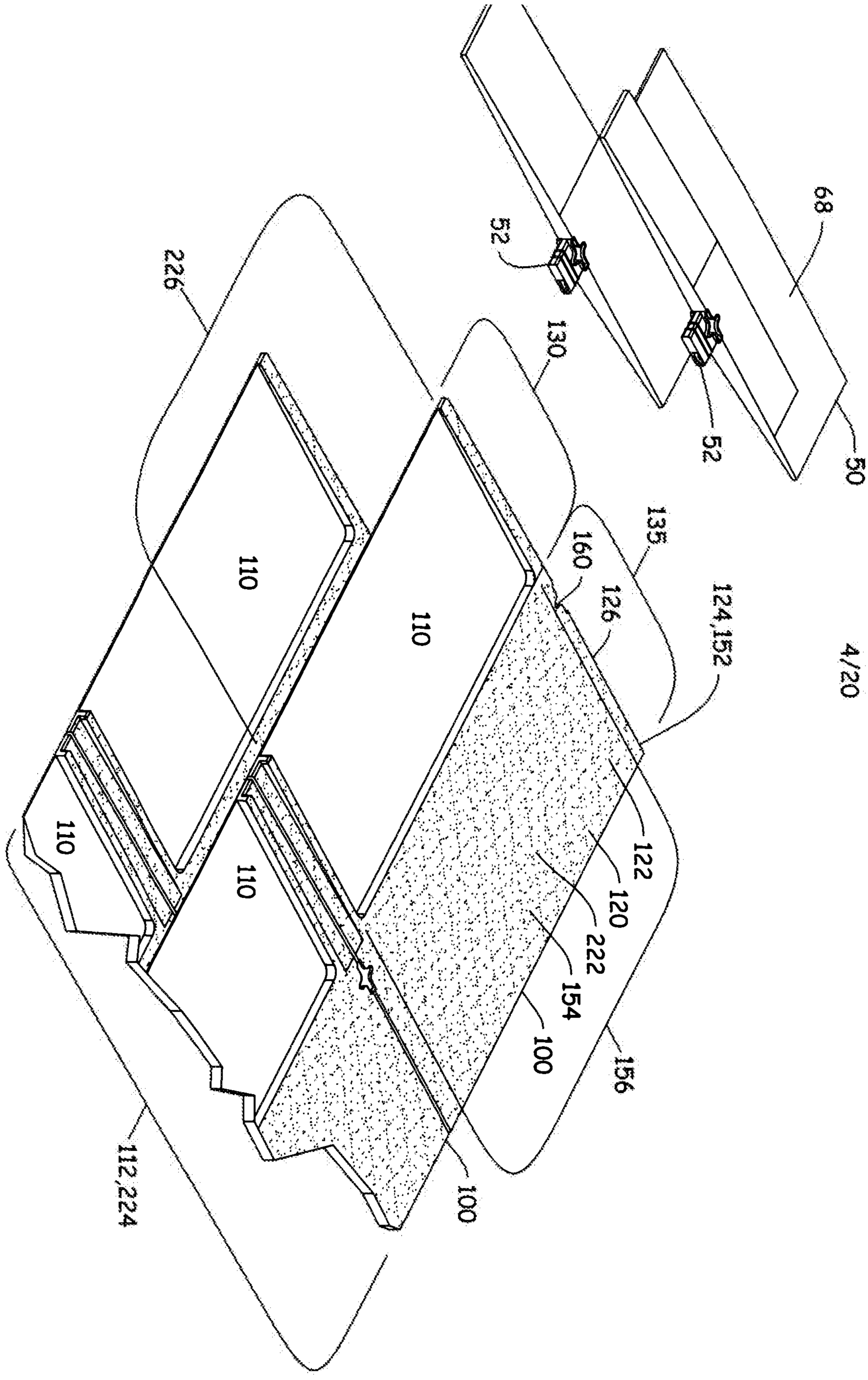

68
52
130
52
50
135
160
126
124, 152
226
110
110
110
122
120
222
154
100
156
112, 224
100

FIG 3

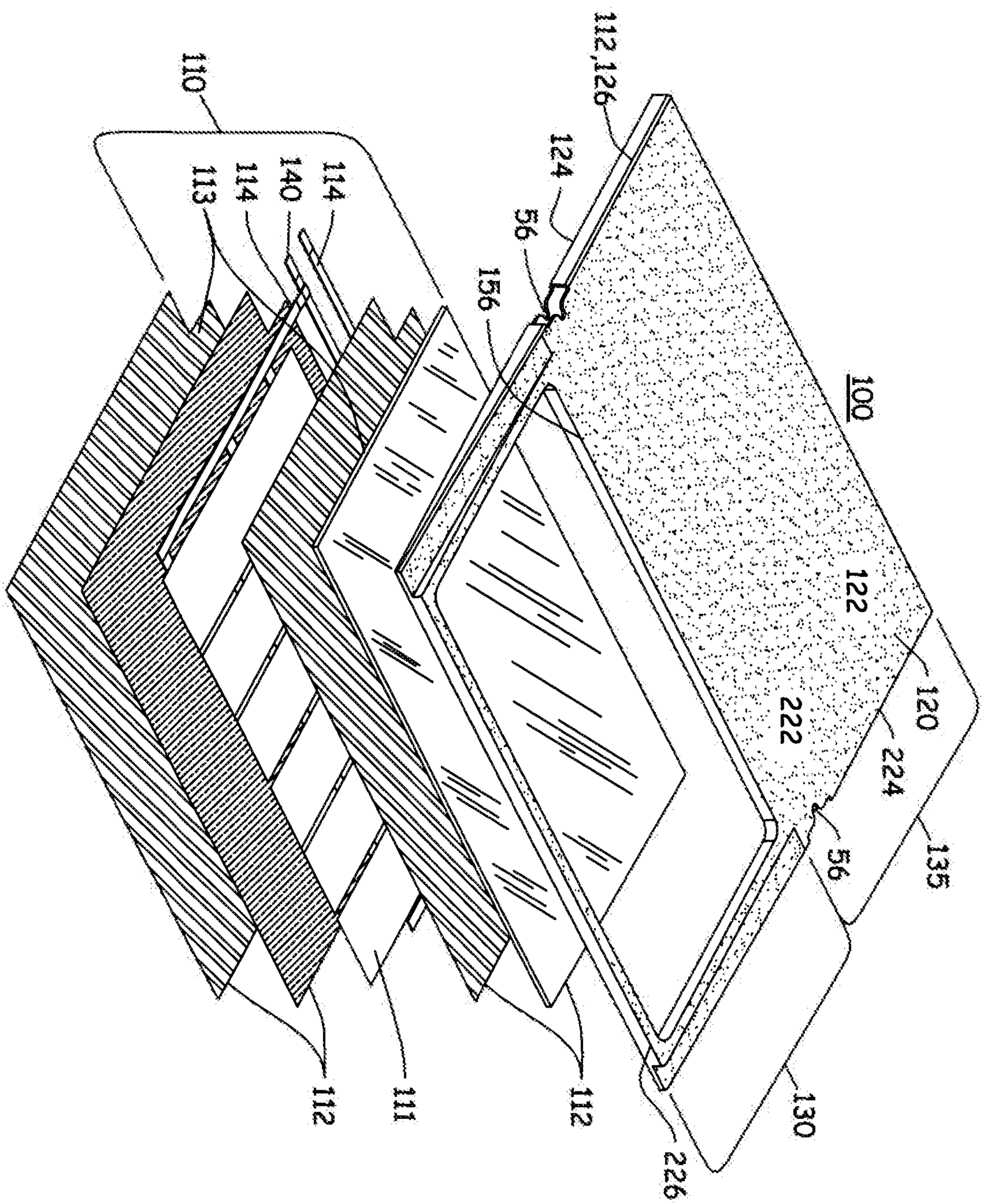

112
110
114
140
114
113
126
124
56
156
100
122
120
222
224
56
135
130
112
111
112

FIG 4

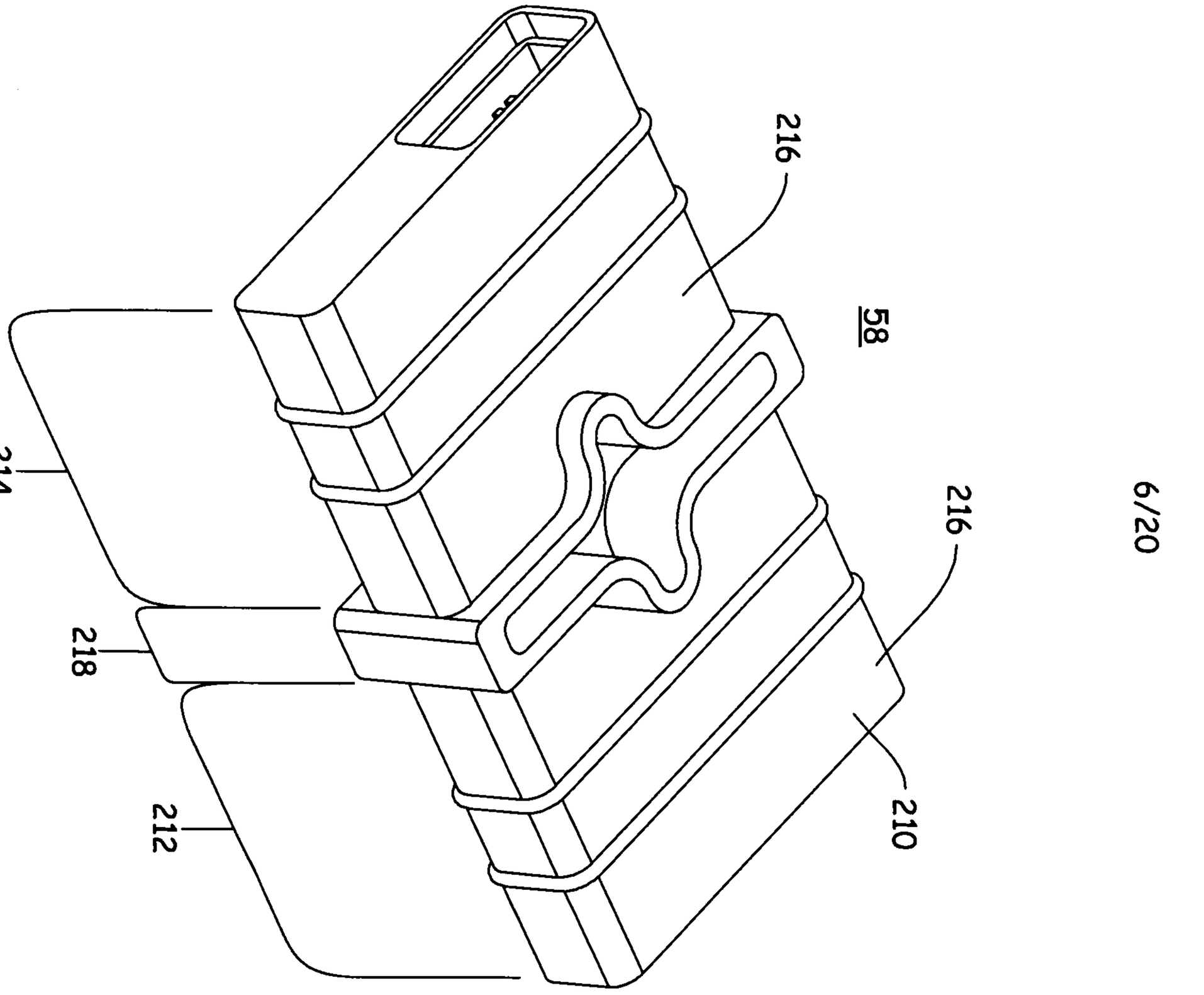


FIG 5

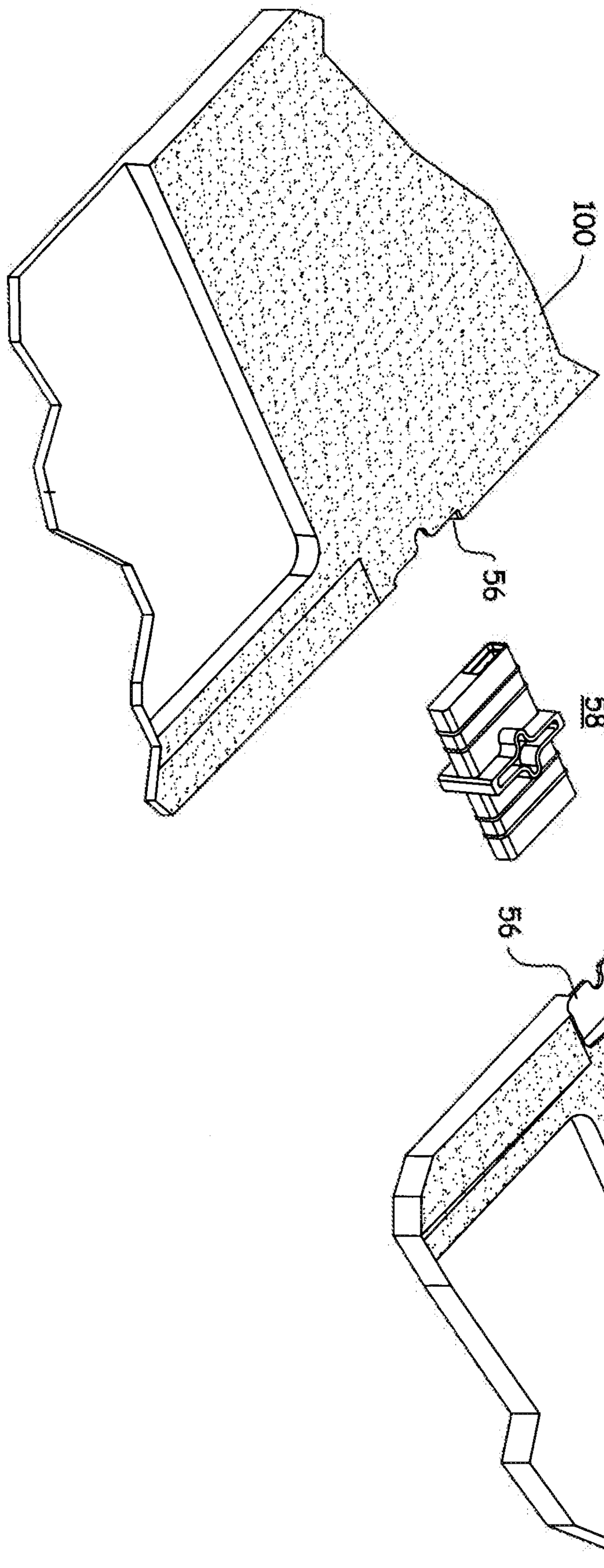


FIG 6

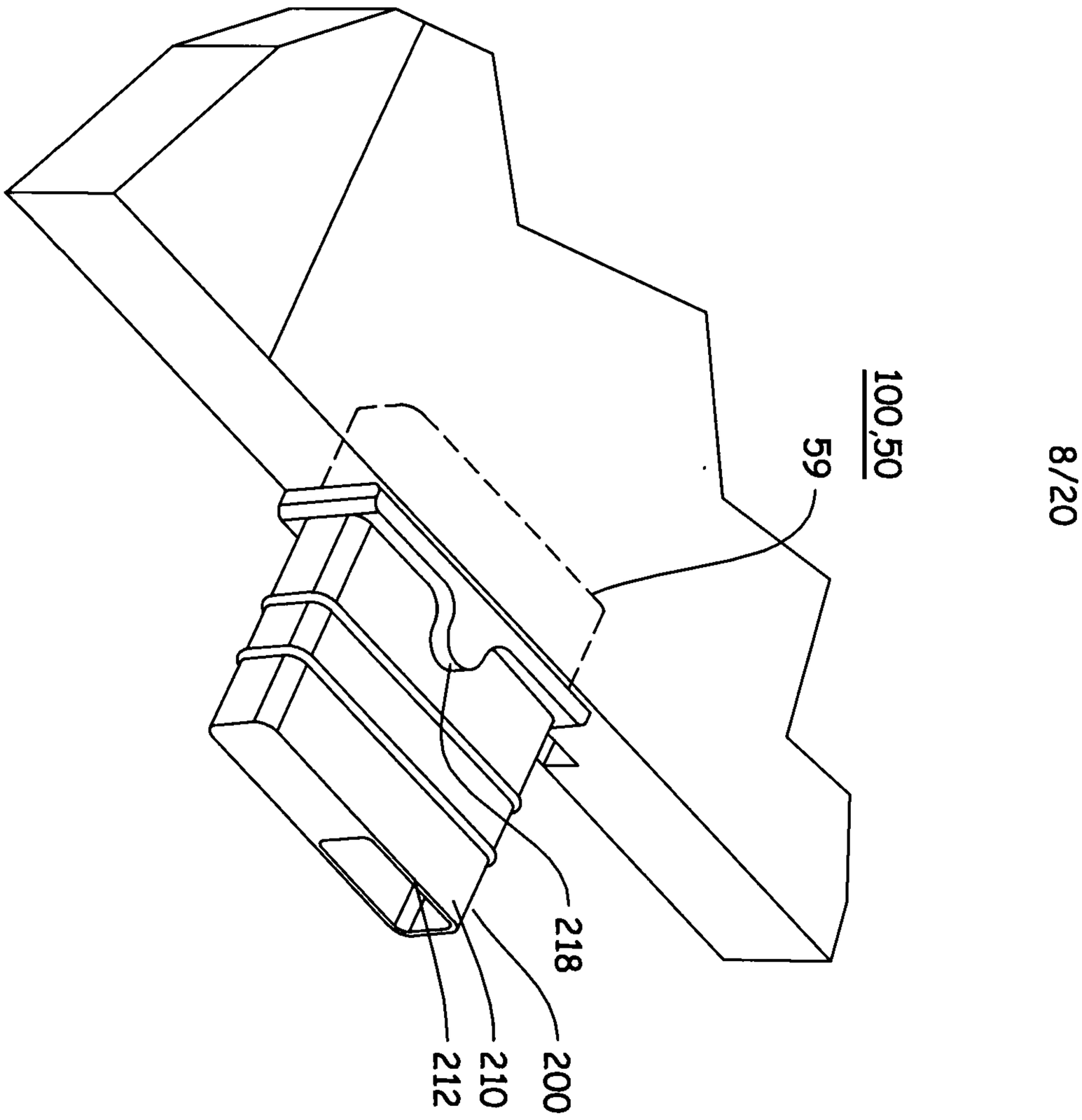


FIG 7

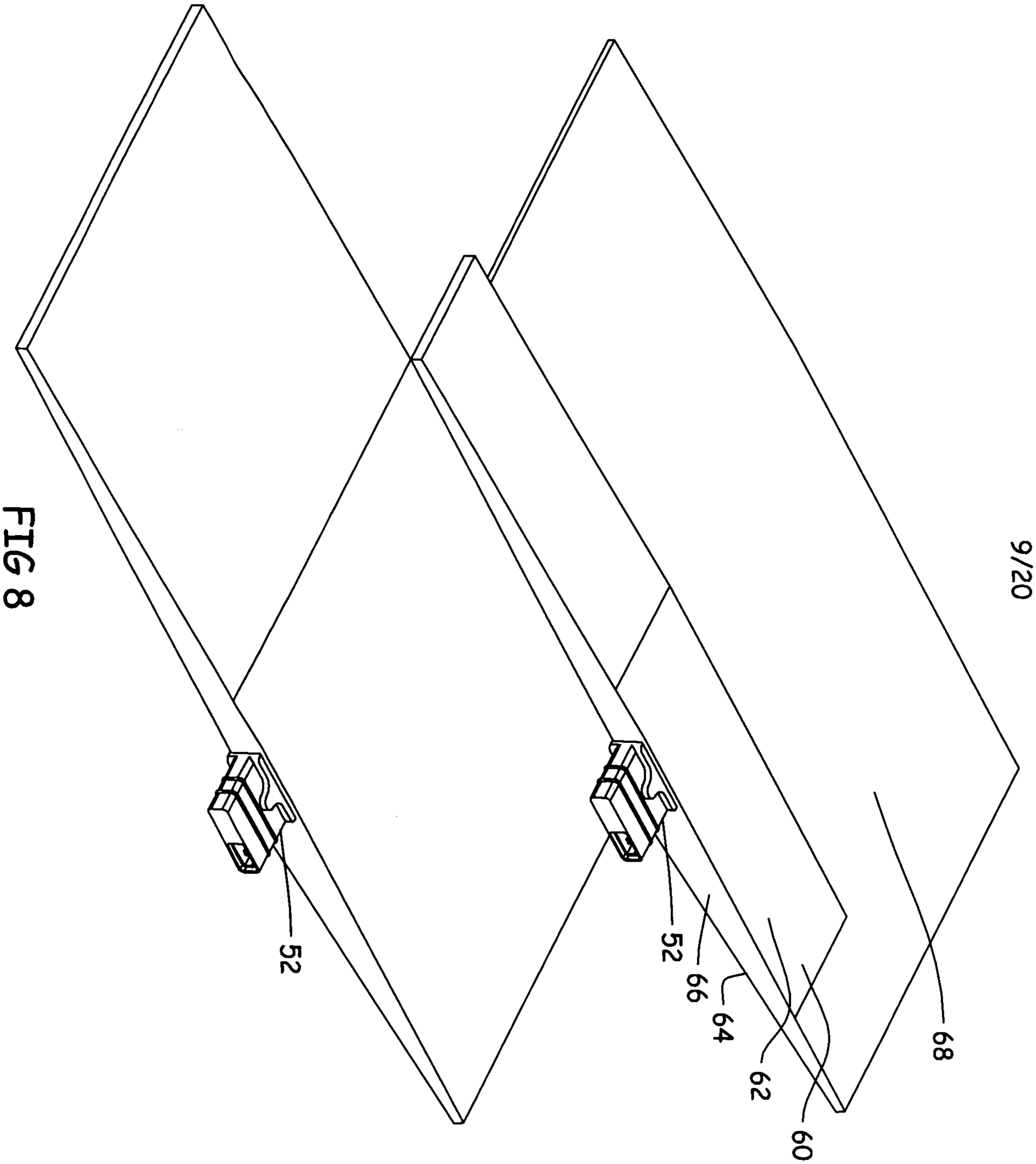


FIG 8

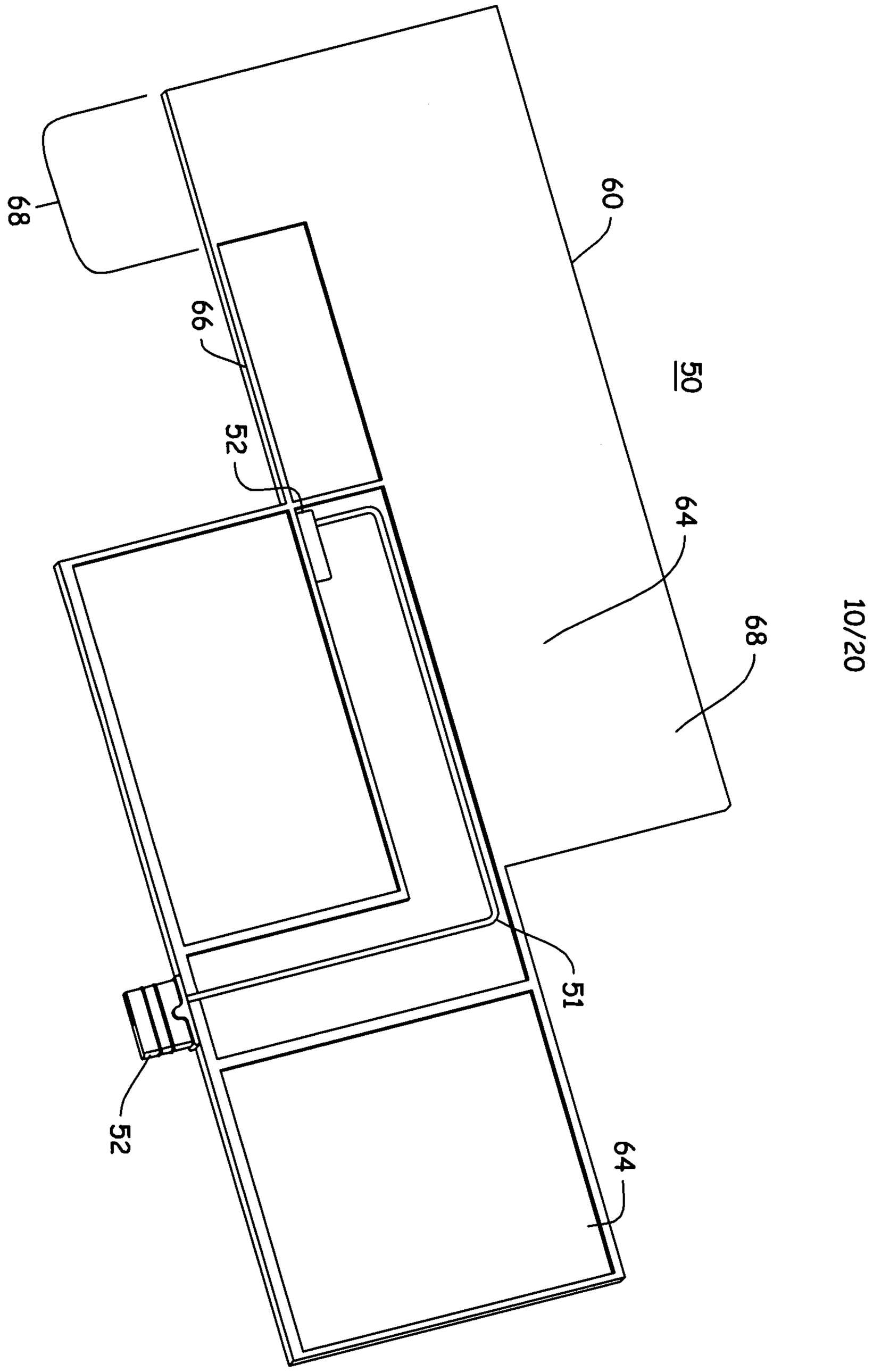


FIG 9

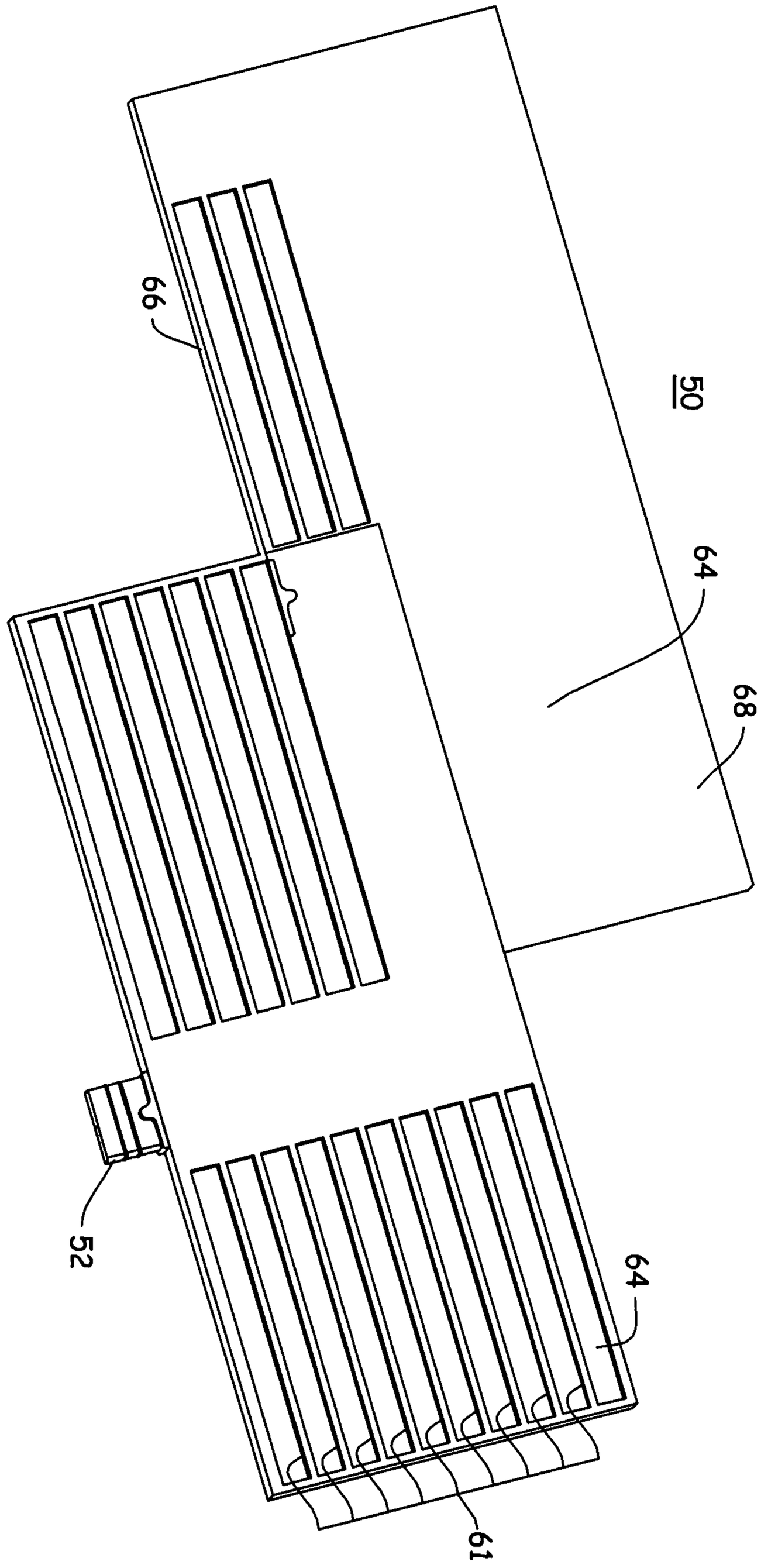


FIG 10

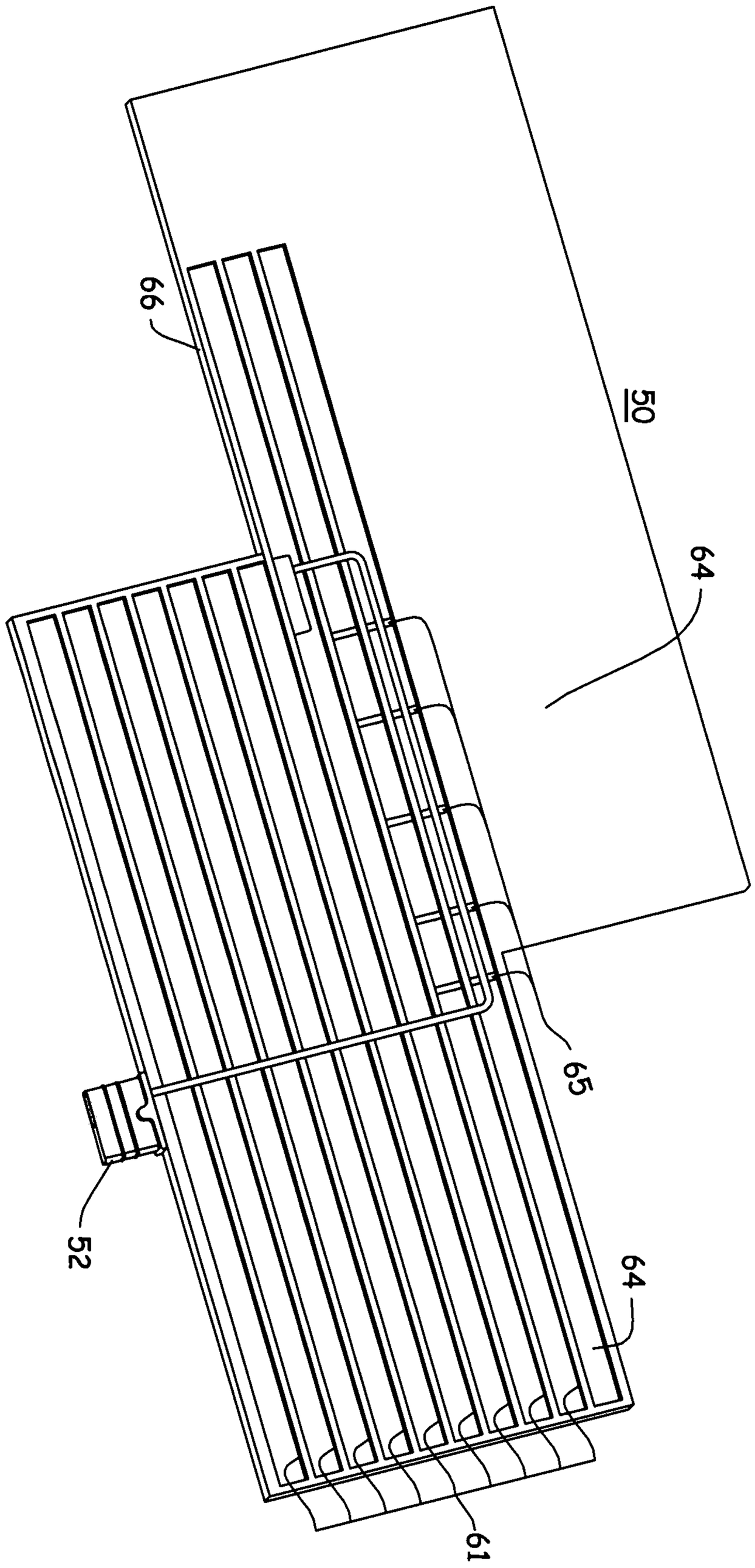


FIG 11

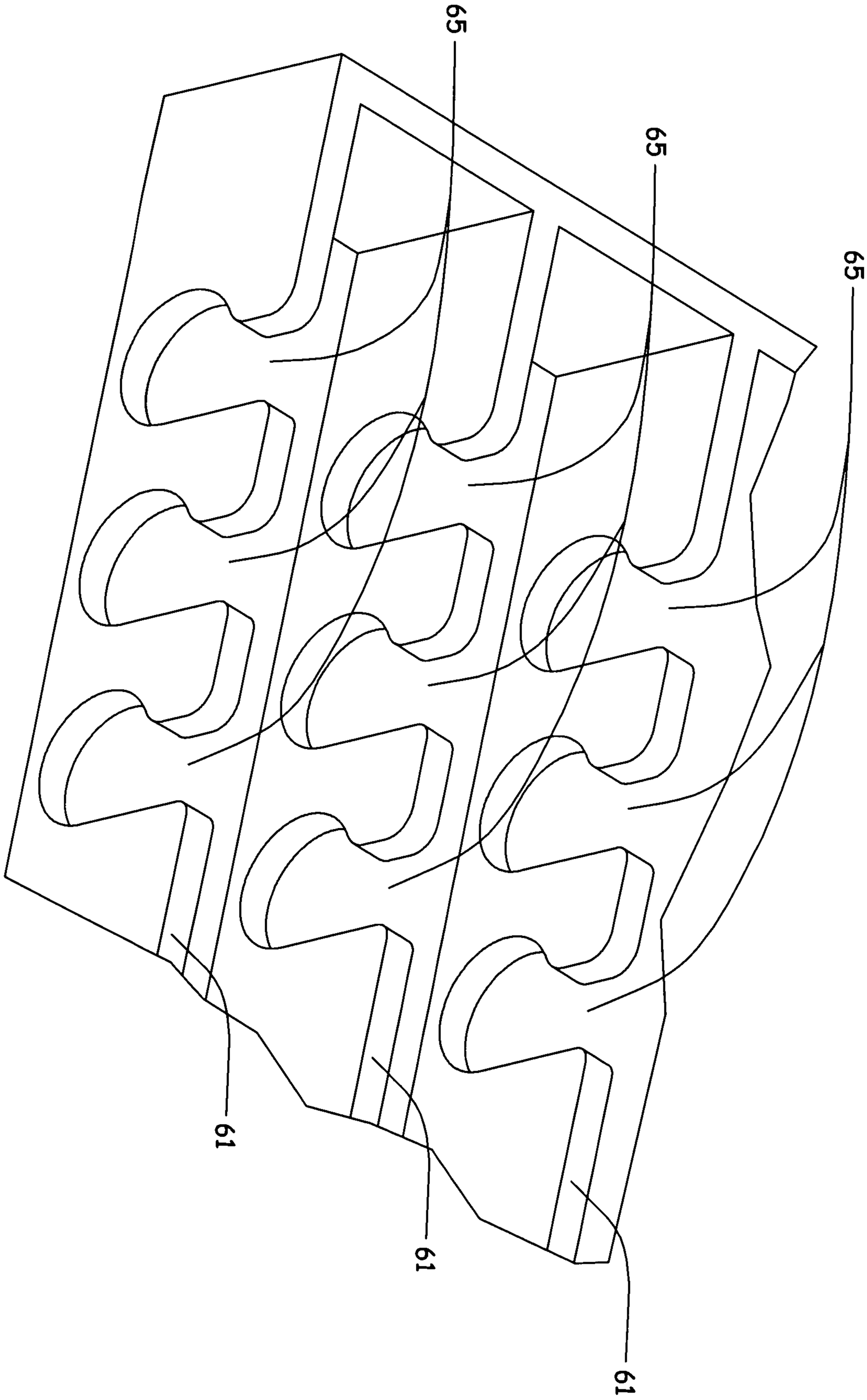


FIG 12

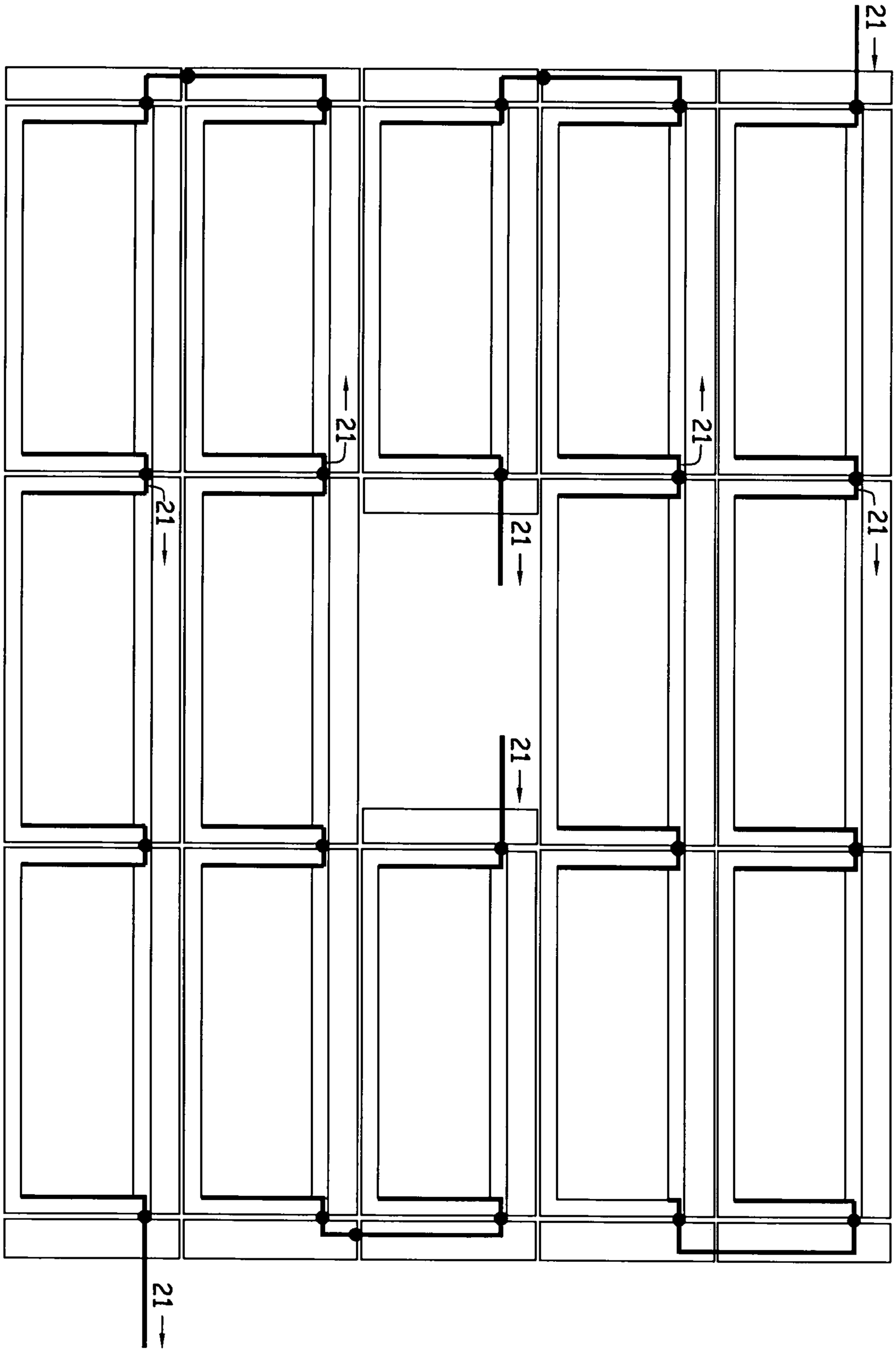


FIG 13

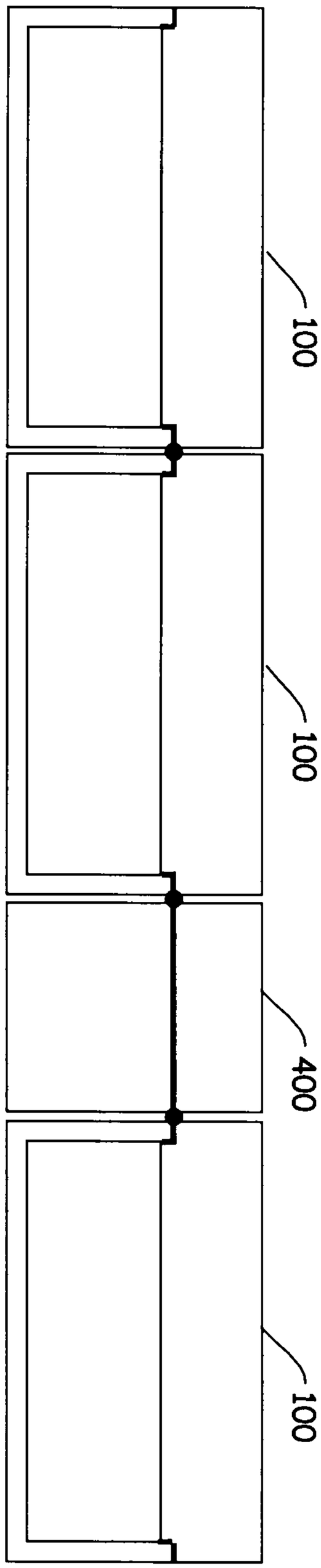


FIG 14

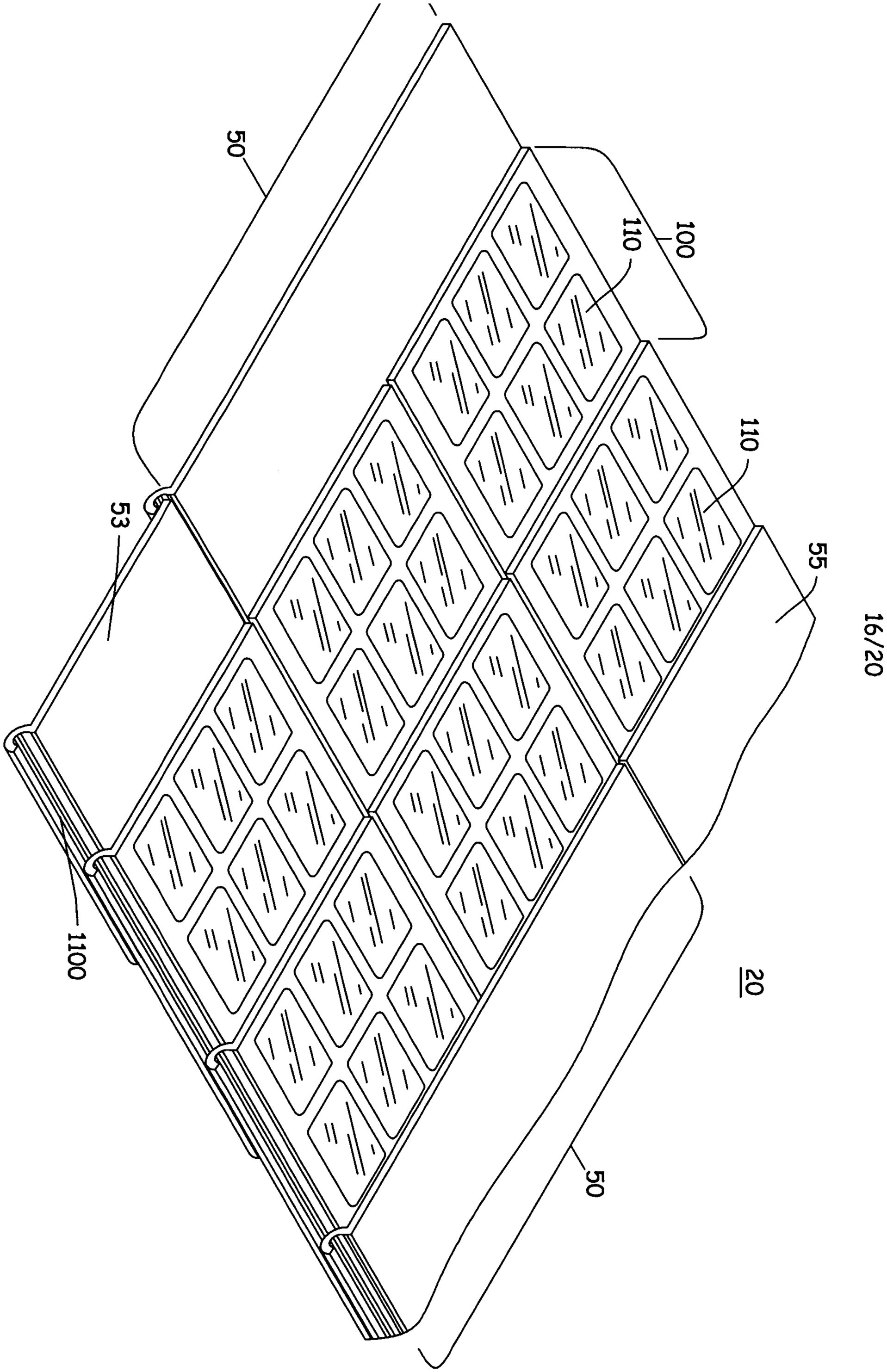


FIG 15

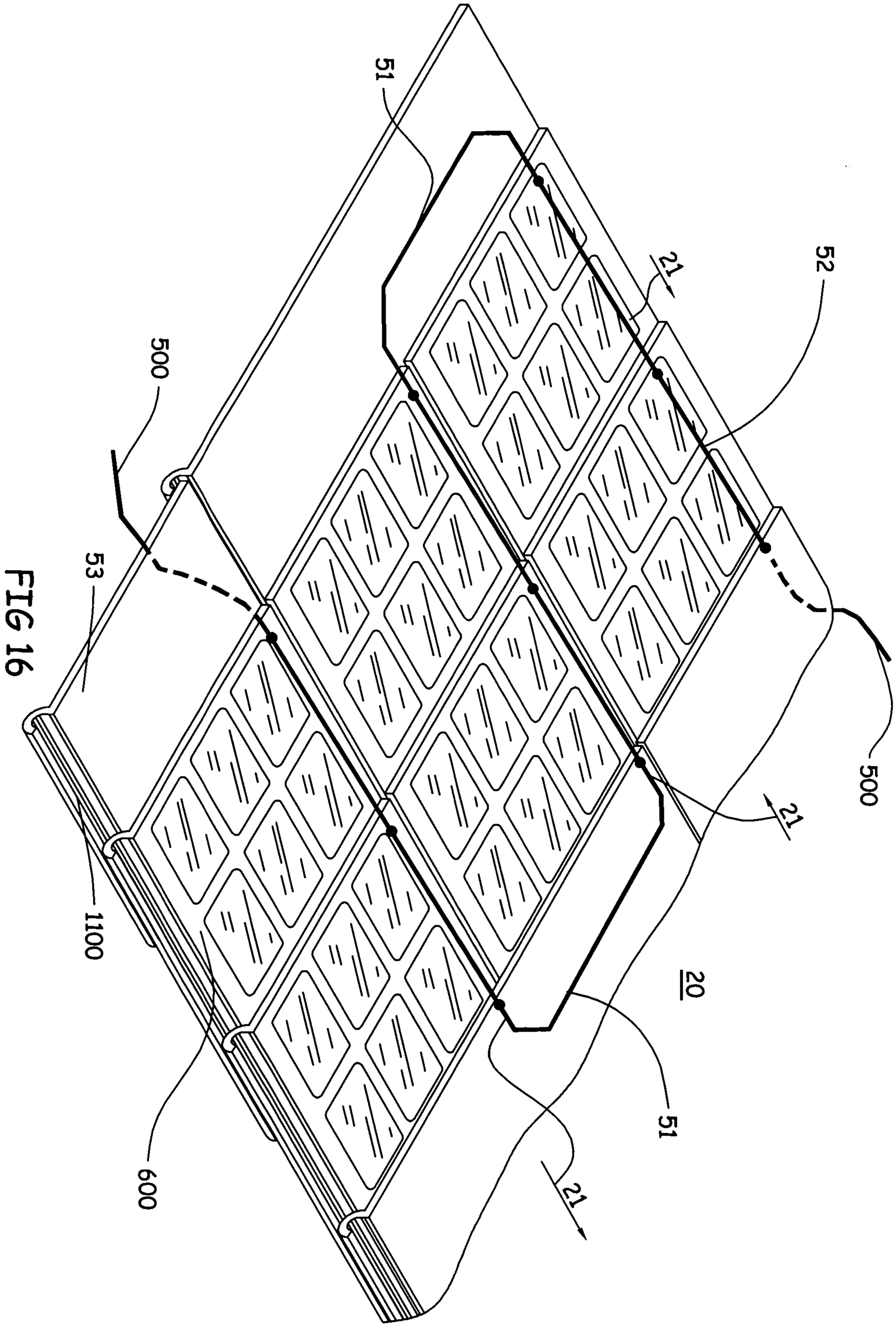


FIG 16

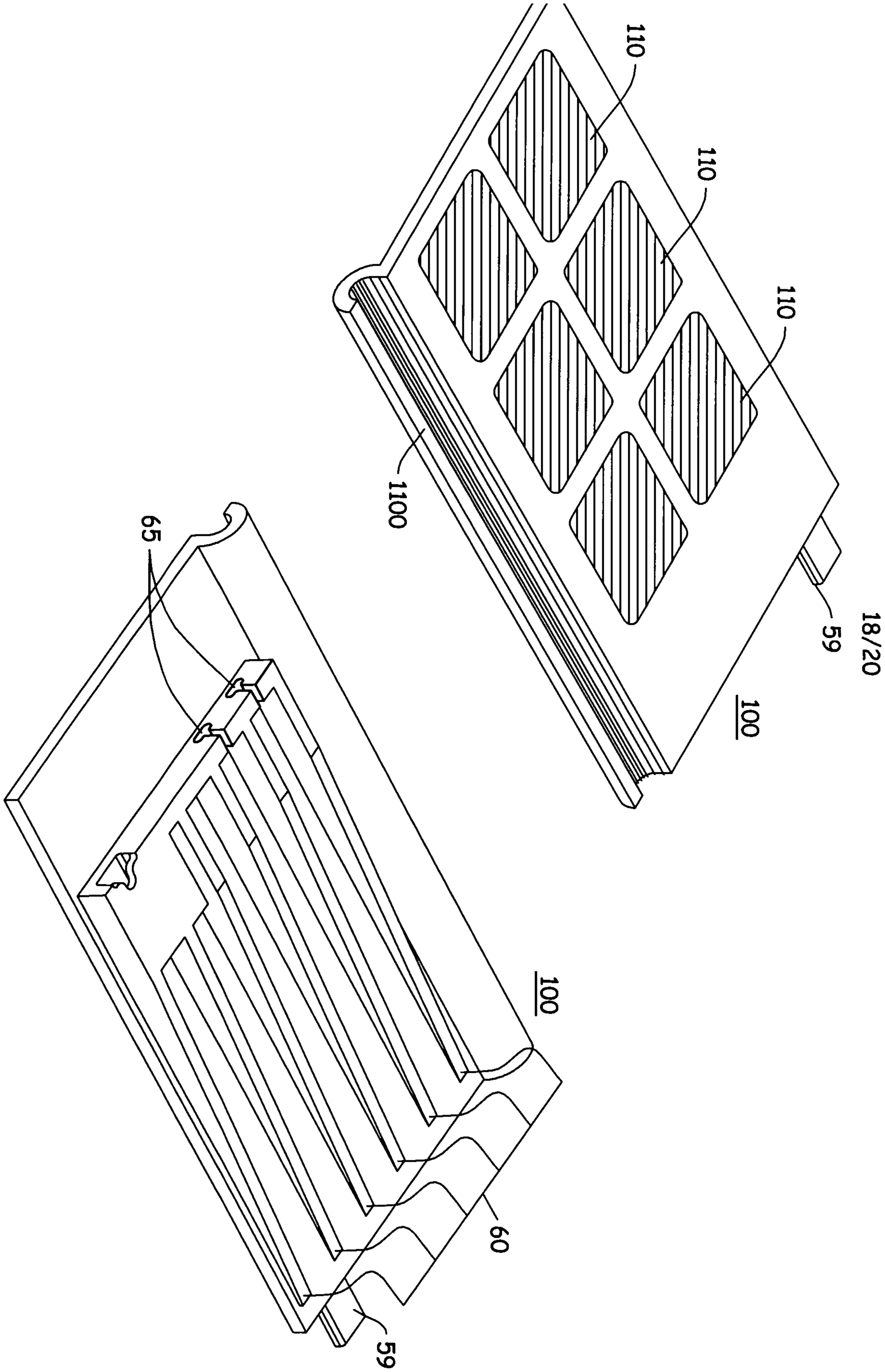


FIG 17

PCT/US2009/042522
WO 2009/137352
CA 02723419 2010-11-03

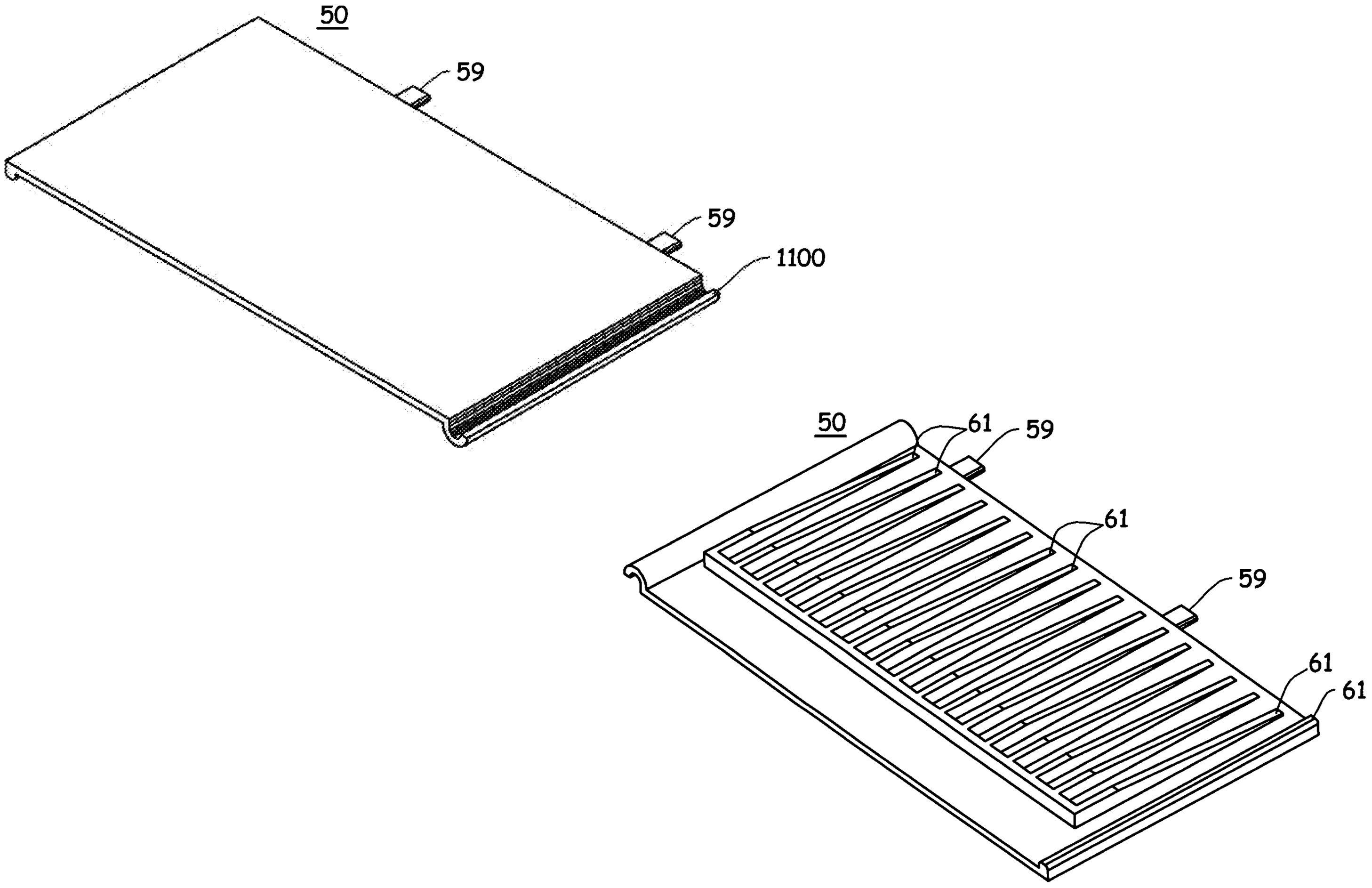


FIG 18

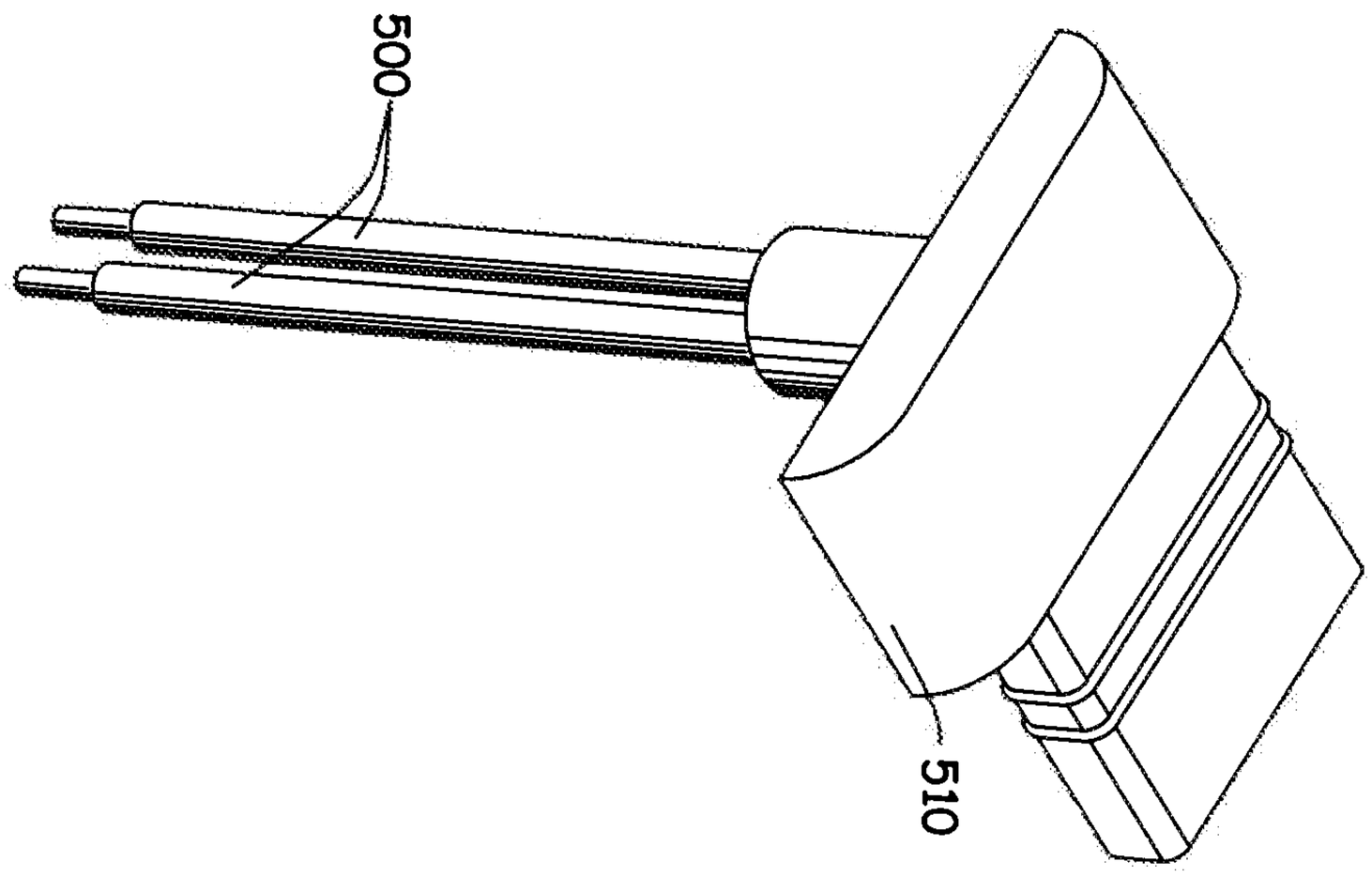
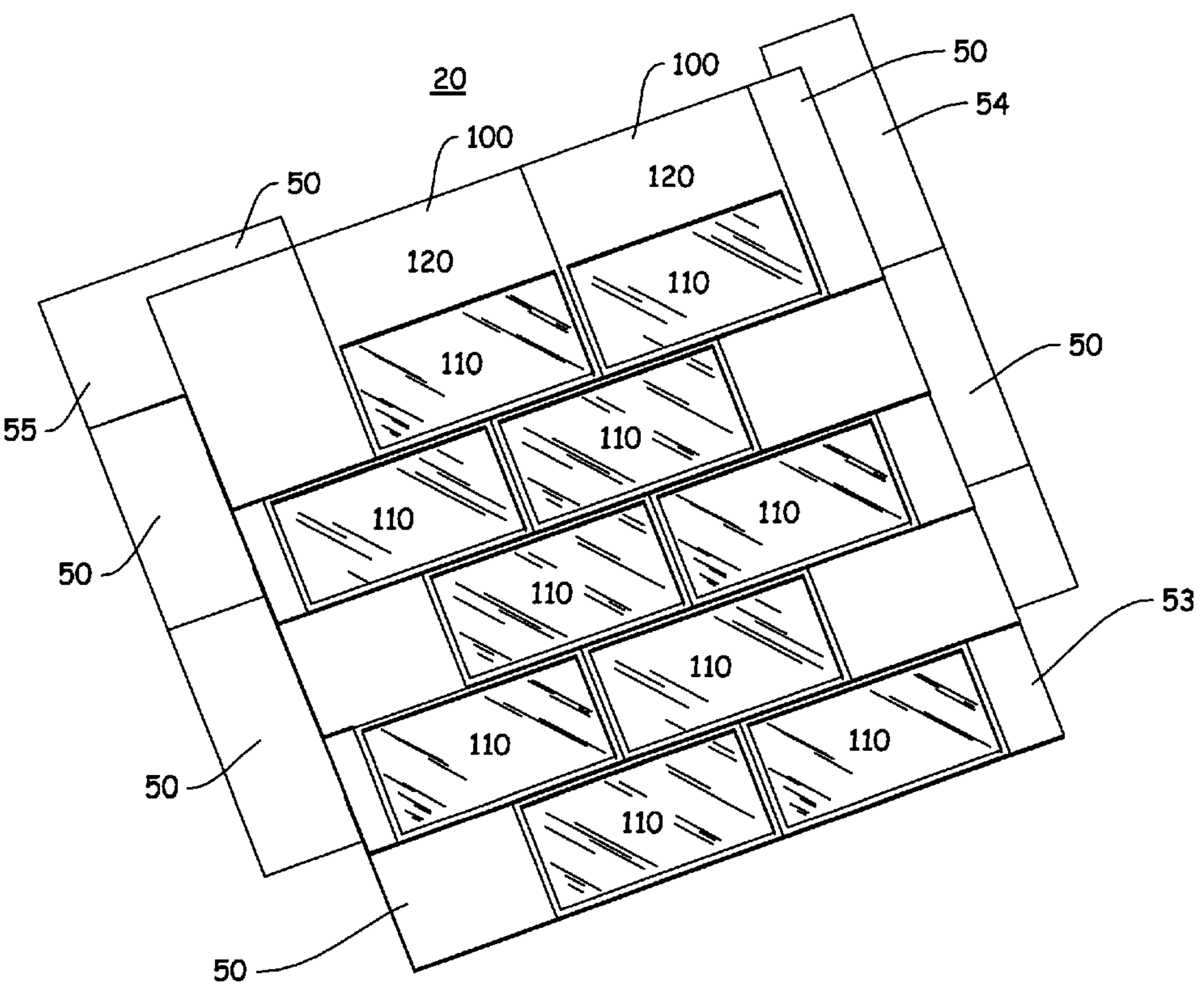


FIG. 19


20
100
100
50
50
54
120
120
110
110
50
55
110
110
110
110
50
53
110
110
110
50