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(54) Title: PV CELL DESIGN FOR PV MODULES WITH SHINGLED CELLS

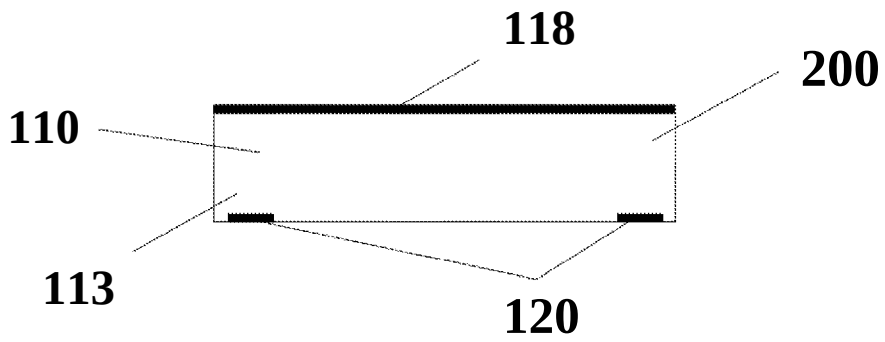

Fig. 2

(57) Abstract: The present invention is a PV cell design which introduces one or multiple additional electrical contacts on a PV cell. For PV modules that are constructed with shingled PV cells this invention makes it convenient to: 1) connect metal ribbons to shingled PV strings only from the rear side of the PV cells; 2) incorporate by-pass diodes; and 3) establish inter-string connection. The present invention also improves the aesthetics, reliability, and durability of PV modules that are constructed with shingled PV cells.

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[Continued on next page]

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PV Cell Design for PV Modules with Shingled Cells

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SPECIFICATION

BACKGROUND OF THE INVENTION

[0001] The present invention is in the technical field of photovoltaics (PV). More particularly, the present invention is in the technical field of PV modules.

[0002] Some known PV modules are constructed by shingling PV cells to form a PV string. The PV cells are full size or segmented PV cells. A full PV cell is cut, by a laser or mechanical means, and then separated to form segmented PV cells. For the remaining of this document the term "PV cell(s)" refers to either full size or segmented PV cell(s). "Shingling" refers to connecting multiple PV cells in series by partially overlapping them, with the front cell electrode of one PV cell couples with the rear cell electrode of an adjacent PV cell. Sometimes electrically conductive adhesive (ECA) or solder is applied at the overlapped interface to improve mechanical strength and electrical connection.

[0003] In conventional PV modules the electrical connections between the PV cells within a PV string is via metal ribbons. In PV modules that are constructed with shingled PV cell there is no metal ribbons between the PV cells within a PV string. Electrical access to the segmented PV cells within a PV string is therefore very limited.

SUMMARY OF THE INVENTION

[0004] The present invention is a PV cell design that enables and enhances electrical access to PV cells in a PV module constructed by shingled PV cells.

[0005] The present invention introduces additional electrical contacts on PV cells. The size and position of these metal contacts are designed to provide reliable electrical connection and minimize the negative impact on PV cell efficiency.

[0006] The present invention provides means for PV cells of a PV string constructed by shingled PV cells to be connected to other PV cells in different PV strings, and to external circuitries. Which makes it possible to protect a PV module by means of by-pass diodes in the event of shading or compromised PV cells during operation. It also makes it possible to design PV modules without by-pass diodes by providing multiple inter-string connections in a PV module consist of PV strings constructed by shingled PV cells.

[0007] The present invention enhances reliability and aesthetic appearance of PV modules by avoiding directly coupling metal ribbons to the front surface of the PV cells within PV strings constructed by shingled PV cells.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Fig. 1 is a top plan view of an example PV cell of present invention.

[0009] Fig. 2 is a bottom plan view of an example PV cell of the invention.

[0010] Fig. 3 is a cross-section view of two shingled PV cells of the invention from the side.

[0011] Fig. 4 is a top plan view of an example PV string constructed with PV cells of the invention.

[0012] Fig. 5 is a bottom plan view of an example PV string constructed with PV cells of the invention.

[0013] Fig. 6 is a schematic diagram from the top of an example PV module (with by-pass diodes) constructed with PV cells of the invention.

[0014] Fig. 7 is a schematic diagram from the bottom of an example PV module (with by-pass diodes) constructed with PV cells of the invention.

[0015] Fig. 8 is a schematic diagram from the top of an example PV module (with inter-string metal ribbons) constructed with PV cells of the invention.

[0016] Fig. 9 is a schematic diagram from the bottom of an example PV module (with inter-string metal ribbons) constructed with PV cells of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Certain terminology may be used in the following description for the purpose of reference only, and thus are not intended to be limiting. For example, terms such as "front" and "rear" refer to internally consistent directions in the drawings to which reference is made. Terms such as "top", "bottom", and "side" may describe the orientation and/or location of portions of

the component within a consistent but arbitrary frame of reference which is made clear by reference to the text and the associated drawings describing the component under discussion. Such terminology may include the words specifically mentioned above, derivatives thereof, and words of similar import.

[0018] Referring now to the invention in more detail, in Fig. 1 there is shown a top plan view of an example PV cell 200. The PV cell 200 includes a front cell electrode 116, along with fingers 114 disposed on the top surface of a silicon substrate 110. There is an anti-reflection layer 112 disposed on the top surface of a silicon substrate 110.

[0019] Fig. 2 shows the bottom plan view of the same example PV cell 200 of the invention as shown in Fig. 1. It is shown a rear cell electrode 118, along with additional electrical contacts 120 disposed on the surface of a silicon substrate 110. There is a metal conductive layer 113 disposed on the top surface of a silicon substrate 110.

[0020] The present invention introduces additional electrical contacts 120 in Fig. 2. The additional electrical contact 120 is electrically coupled to the rear cell electrode 118. The size, shape, and position of the additional electrical contact 120 can vary and consideration is taken to ensure adequate contact area for reliable bounding but no excessive loss of cell efficiency due to reduced back side field (BSF). In the example PV cell 200 in Fig. 2 the additional electrical contact 120 is located along the narrow region along one of the edges, where the PV cell 200 will be overlapping with another PV cell 200 when forming a PV string. Such arrangement of the additional electrical contact 120 minimizes the impact on the efficiency of PV modules that are constructed with shingled PV cell of the invention.

[0021] The additional electrical contact 120 in Fig. 2 is fabricated by similar process during the PV cell fabrication as the rear cell electrode 118.

[0022] Fig. 3 shows the cross-section view of two shingled PV cells of the invention from the side. These two PV cells 200 and 201 are jointed together in series by coupling the rear cell electrode 118 of PV cell 200 to the front cell electrode 116 of PV cell 201. Electrically conductive adhesive (ECA) or solder 117 is sometime applied between the rear cell electrode 118 of PV cell 200 and the front cell electrode 116 of PV cell 201 to mechanically and/or electrically connect the PV cells to each other. The additional electrical contact 120 of PV cells 200 and 201 are exposed and accessible.

[0023] Fig. 4 shows the top plan view of an example PV string 300 constructed with PV cells 200, 201, 202, and 203 of the invention. These PV cells are jointed together in series by coupling the rear cell electrode 118 of one PV cell to the front cell electrode 116 of the adjacent PV cell. Electrically conductive adhesive (ECA) or solder 117 is sometime applied between the rear cell electrode 118 and the front cell electrode 116 to mechanically and/or electrically connect the PV cells to each other. Once the PV string 300 is completed with desired number of PV cells (in the case shown in Fig. 4 there are four PV cells 200, 201, 202, 203), only one PV cell 203 has its front cell electrode 116 exposed.

[0024] Fig. 5 shows the bottom plan view of the same example PV string 300 as shown in Fig. 4 constructed with PV cells 200, 201, 202, and 203 of present invention. These PV cells are jointed together in series by coupling the rear cell electrode 118 of one PV cell to the front cell electrode 116 of the adjacent PV cell. Electrically conductive adhesive (ECA) or solder 117 is sometime applied between the rear cell electrode 118 and the front cell electrode 116 to mechanically and/or electrically connect the PV cells to each other. Once the PV string 300 is completed with desired number of PV cells (in the case shown in Fig. 4 there are four PV cells 200, 201, 202, 203), only one PV cell 200 has its rear cell electrode 118 exposed, and all PV cell 200, 201, 202, and 203 have their additional electrical contacts 120 exposed.

[0025] Fig. 6 is a schematic diagram from the top of an example PV module. Fig. 6 only shows the key components that are directly related to the invention. Other necessary components for a PV module such as glass, EVA, backsheet, frame, and junction box are left out. The PV module 500 is consisted of PV strings 400, module metal ribbons 510, by-pass diodes 520, and module electrodes 530 and 540.

[0026] In more details Fig. 6 shows that each PV string 400 is constructed with multiple PV cells 201, 202, 203... 217. As described in Fig. 4 and Fig. 5. PV cells 201, 202, 203... 217 are connected in series. Note in this arrangement PV cells 201, 202, 203…216 are active PV cells and contribute generating PV electricity when the PV module 500 is in normal operating condition, while PV cell 217 functions solely as electrical contact between PV cell 216 and module metal ribbon 510.

[0027] In Fig. 6 multiple PV strings 400 are connected in parallel by module metal ribbons 510. At one end of the strings, module metal ribbons 510 are connect to the rear cell electrode 118 of PV cell 201 by using ECA or soldered 117. At the other end of the PV string 400, module metal

ribbons 510 are connected to the additional electrical contacts 120 of PV cell 217 by using ECA or soldered 117.

[0028] As the positive electrode and negative electrode are on opposite surfaces of a PV cell, it is a common practice to solder metal ribbon to the front and the rear side of PV cells to extract electricity. However, this method causes severe reliability issue as the soldering process leaves micro-cracks on PV cell and later causes PV cell breakage and loss of power in the field. Soldering metal ribbons to, particularly the front side of, the PV cells of shingled PV module causes even higher rate of PV cell breakage as the soldering happens very close to the PV cell edge. In addition, the metal ribbons attached to the front side of the PV modules are clearly visible, causing the PV modules to have unpleasing appearance.

[0029] The inclusion of the PV cell 217 in Fig. 6 solves the abovementioned problems. The PV cell 217 has its rear cell electrode 118 electrically coupled to PV cell 216, and its additional electrical contact 120 electrically coupled to module metal ribbon 510. Although PV cell 217 doesn't contribute to direct electricity generation it allows electricity being conducted from the PV cell 216 to module metal ribbon 510 in Fig. 6. In addition, the module metal ribbon 510 is hidden behind the PV cell 217, making PV module 500 aesthetically pleasing. Attaching module metal ribbon 510 to the additional electrical contact 120 in the rear side of PV cell 217 by using ECA or soldered 117 has proven to be much more reliable than attaching metal ribbon 510 to the front cell electrode 116 of Fig. 1 by using ECA or soldered 117.

[0030] In PV module design, by-pass diodes are commonly used to protect a PV module in the event of shading or compromised PV cell(s). It is convenient to connect by-pass diodes in parallel with portion of the PV string in conventional PV module as there are metal ribbon between the PV cells in conventional PV modules. However, it is not straightforward to include by-pass diodes in PV modules that are constructed with shingled PV cells, as the PV cells are connected directly by shingling neighboring cells together.

[0031] Current invention introduces additional electrical contacts 120 at the rear side of the PV cells in Fig. 2. The additional electrical contacts 120 are along the edges of the PV cell. In a completed PV string 400 in Fig. 6, the additional electrical contacts 120 are directly behind the area overlapped and shaded by the neighboring PV cells. Therefore, the detrimental effect of the additional electrical contacts 120 on the backside field (BSF) of the PV cells, or on the PV module efficiency is minimized.

[0032] The additional electrical contacts 120 make it convenient to incorporate by-pass diodes in PV module design. Fig. 6 shows module metal ribbon 510 are connected to the additional electrical contacts 120 of the PV cell 205 and 211 in the middle of PV string 400 by using ECA or soldered 117. Depend on the PV cell reverse break-down characteristics, module metal ribbon 510 can be configured in such way that the by-pass diodes are connected in parallel with desired number of PV cells.

[0033] In Fig. 6 multiple by-pass diodes 520 are connected in series by module metal ribbons 510. Each by-pass diode 520 are connected in parallel with a portion of the PV strings 400 by module metal ribbon 510.

[0034] Fig. 6 also shows module electrode of positive polarity 530 and module electrode of negative polarity 540 are connected to module metal ribbons 510.

[0035] Fig. 7 is a schematic diagram from the bottom of an example PV module 500 as shown in Fig. 6. Fig. 7 only shows the key components that are directly related to the invention. Other necessary components for a PV module such as glass, EVA, backsheet, frame, and junction box are left out. The PV module 500 is consisted of PV strings 400, module metal ribbons 510, by-pass diodes 520, and module electrodes 530 and 540.

[0036] In more details Fig. 7 shows that each PV string 400 is constructed with multiple PV cells 201, 202, 203... 217. As described in Fig. 4 and Fig. 5. PV cells 201, 202, 203... 217 are connected in series. Note in this arrangement PV cells 201, 202, 203…216 are active PV cells and contribute generating PV electricity when the PV module 500 is in normal operating condition, while PV cell 217 functions solely as electrical contact between PV cell 216 and module metal ribbon 510.

[0037] In Fig. 7 multiple PV strings 400 are connected in parallel by module metal ribbons 510. At one end of the strings, module metal ribbons 510 are connect to the rear cell electrode 118 of PV cell 201 by using ECA or soldered 117. At the other end of the PV string 400, module metal ribbons 510 are connected to the additional electrical contacts 120 of PV cell 217 by using ECA or soldered 117.

[0038] Fig. 7 shows module metal ribbon 510 are connected to the additional electrical contacts 120 of the PV cell 205 and 211 in the middle of PV string 400 by using ECA or soldered 117.

[0039] In Fig. 7 multiple by-pass diodes 520 are connected in series by module metal ribbons 510. Each by-pass diode 520 are connected in parallel with a portion of the PV strings 400 by module metal ribbon 510.

[0040] Fig. 7 also shows module electrode of positive polarity 530 and module electrode of negative polarity 540 are connected to module metal ribbons 510.

[0041] In contrast to conventional PV modules, in which all PV cells are connect in series, the PV strings in shingled PV modules can be configured in a mix of serial and parallel connection to provide desired voltage and current output characteristics. Parallel connected PV strings provide additional operational tolerance for shading and/or component damage. In some module designs by-pass diodes is not necessary. Fig. 8 and Fig. 9 show an example of such designs.

[0042] Fig. 8 is a schematic diagram from the front of an example PV module 600. Fig. 8 only shows the key components that are directly related to the current invention. Other necessary components for a PV module such as glass, EVA, backsheet, frame, and junction box are left out. The PV module 600 is consisted of PV strings 400, module metal ribbons 510, inter-string metal ribbon 625, and module electrodes 530 and 540.

[0043] With additional metal contact 120 on every PV cell in Fig. 8, inter-string connections can be made between corresponding locations of neighboring PV strings. In the event of shading, cell breakage, and other damage that cause imbalance of current in one PV string, the inter-string connections allow electrical current to be redistributed to the neighboring PV strings and beyond for better PV module performance.

[0044] In more details Fig. 8 shows that each PV string 400 is constructed with multiple PV cells 201. As described in Fig. 4 and Fig. 5. PV cells 201, 202, 203... 217 are connected in series. Note in this arrangement PV cells 201, 202, 203…216 are active PV cells and contribute generating PV electricity when the shingled PV module 600 is in normal operating condition, while PV cell 217 functions solely as electrical contact between PV cell 216 and module metal ribbon 510.

[0045] In Fig. 8 multiple PV strings 400 are connected in parallel by module metal ribbons 510. At one end of the strings, module metal ribbons 510 are connect to the rear cell electrode 118 of PV cell 201 by using ECA or soldered 117. At the other end of the PV string 400, module metal ribbons 510 are connected to the additional electrical contacts 120 of PV cell 217 by using ECA or soldered 117.

[0046] Fig. 8 shows multiple inter-string metal ribbon 625 connecting correspondent additional electrical contacts 120 of neighboring PV strings 400 by using ECA or soldered 117. In some cases, inter-connecting a fraction of all the corresponding additional electrical contacts 120 is adequate to provide protection.

[0047] Fig. 8 also shows module electrode of positive polarity 530 and module electrode of negative polarity 540 are connected to module metal ribbons 510.

[0048] Fig. 9 is a schematic diagram front the bottom of the same example PV module 600 as shown in Fig. 8. Fig. 9 only shows the key components that are directly related to the current invention. Other necessary components for a PV module such as glass, EVA, backsheet, frame, and junction box are left out. The PV module 600 is consisted of PV strings 400, module metal ribbons 510, inter-string metal ribbon 625, and module electrodes 530 and 540.

[0049] In more details Fig. 9 shows that each PV string 400 is constructed with multiple PV cells 201. As described in Fig. 4 and Fig. 5. PV cells 201, 202, 203... 217 are connected in series. Note in this arrangement PV cells 201, 202, 203…216 are active PV cells and contribute generating PV electricity when the shingled PV module 600 is in normal operating condition, while PV cell 217 functions solely as electrical contact between PV cell 216 and module metal ribbon 510.

[0050] In Fig. 9 multiple PV strings 400 are connected in parallel by module metal ribbons 510. At one end of the strings, module metal ribbons 510 are connect to the rear cell electrode 118 of PV cell 201 by using ECA or soldered 117. At the other end of the PV string 400, module metal ribbons 510 are connected to the additional electrical contacts 120 of PV cell 217 by using ECA or soldered 117.

[0051] Fig. 9 shows multiple inter-string metal ribbon 625 connecting correspondent additional electrical contacts 120 of neighboring PV strings 400 by using ECA or soldered 117. In some cases, inter-connecting a fraction of all the corresponding additional electrical contacts 120 is adequate to provide protection.

[0052] Fig. 9 also shows module electrode of positive polarity 530 and module electrode of negative polarity 540 are connected to module metal ribbons 510.

[0053] While the foregoing written description of the invention enables one of ordinary skill to make and use what is considered presently to be the best mode thereof, those of ordinary skill will understand and appreciate the existence of variations, combinations, and equivalents of the specific embodiment, method, and examples herein. The invention should therefore not be

limited by the above described embodiment, method, and examples, but by all embodiments and methods within the scope and spirit of the invention.

WHAT IS CLAIMED IS:

1. A photovoltaic (PV) module comprising:

a first PV string comprising:

a plurality of shingled PV cell, each PV cell comprising a front cell electrode, a rear cell electrode, and one or multiple additional electrical contacts, wherein the front cell electrode of the PV cell is aligned and coupled with the rear cell electrode of an adjacent PV cell of the plurality of PV cell to electrically couple the plurality of PV cell in series; and

a first PV cell comprising a front cell electrode, a rear cell electrode, and one or multiple additional electrical contacts electrically coupled to the rear cell electrode, the rear cell electrode electrically coupled to the PV cell of the plurality of shingled PV cell, wherein the additional electrical contact is configured to be coupled to metal ribbons to transfer a power output of the plurality of PV cell.

2. The PV module of claim 1, wherein the front cell electrode and the rear cell electrode are positioned on opposite surfaces of the PV cell.

3. The PV module of claim 1, wherein the rear cell electrode and the additional electrical contact are positioned on the same surface of the PV cell.

4. The PV module of claim 2, wherein the rear cell electrode of the first PV cell is electrically coupled to a second PV cell of the plurality of PV cell segments.

5. The PV module of claim 4, wherein the rear cell electrode and the additional electrical contact are positioned on a rear surface of the first PV cell, the first PV cell is located at an end of the first PV string with its rear cell electrode coupled to an adjacent PV cell, and the additional electrical contact of the first PV cell is coupled to a metal ribbon on the rear side of the PV module.

6. The PV module of claim 1 further comprising one or multiple middle PV cell coupled to the plurality of PV cells, the middle PV cell including a front cell electrode, a rear cell electrode, and an additional electrical contact.

7. The PV module of claim 6, wherein the first PV cell is coupled to the second PV cell at an end of the first PV string, the middle PV cell is coupled between two adjacent PV cell in a middle portion of the first PV string.

8. The PV module of claim 1 further comprising a last PV cell electrically coupled to the plurality of PV cell, the last PV cell including a front cell electrode, a rear cell electrode, and an additional electrical contact, and the additional electrical contact of the last PV cell is coupled to a metal ribbon on the rear side of the PV module.

9. The PV module of claim 8, wherein the first PV cell is coupled to the second PV cell at an end of the first PV string, the last PV cell electrically coupled to the plurality of PV cell at an opposite end of the first PV string from the first PV cell.

10. The PV module of claim 1 further comprising:

a second PV string spaced apart from the first PV string, the second PV string comprising:

a plurality of shingled PV cell; and

the first PV cell including a front cell electrode, a rear cell electrode and, an additional electrical contact electrically coupled to the rear cell electrode, the rear cell electrode electrically coupled to an adjacent PV cell of the plurality of shingled PV cell; and

a metal ribbon coupled to the additional electrical contact of the first PV cells of the first PV string and the second PV string, the metal ribbon extending across a gap between the first PV string and the second PV string; and

the middle PV cells including a front cell electrode, a rear cell electrode, and an additional electrical contact electrically coupled to the rear cell

electrode, the front cell electrode and the rear cell electrode electrically coupled to adjacent PV cells of the plurality of shingled PV cell; and

a metal ribbon coupled to the additional electrical contact of the middle PV cells, the metal ribbon extending across a gap between the first PV string and the second PV string; and

the last PV cell including a front cell electrode, a rear cell electrode, and an additional electrical contact, the front cell electrode electrically coupled to an adjacent PV cell of the plurality of shingled PV cell; and

a metal ribbon coupled to the rear cell electrode or the additional electrical contact of the last PV cells of the first PV string and the second PV string, the metal ribbon extending across a gap between the first PV string and the second PV string.

11. The PV module of claim 1, wherein the first PV cell of a PV string is not an active PV cell.

12. The PV module of claim 1, the additional electrical contact comprises one or multiple electrode terminal electrically coupled to the rear cell electrode.

13. A PV cell for coupling a shingled PV string comprising a plurality of PV cell to a metal ribbon, the PV cell comprising:

a rear cell electrode, the rear cell electrode configured to be electrically coupled to the plurality of PV cell; and

one or multiple additional electrical contacts electrically coupled to the rear cell electrode, the additional electrical contact configured to be coupled to a metal ribbon to transfer a power output of the plurality of PV cell.

14. The PV cell of claim 13, wherein the rear cell electrode and the additional electrical contact are positioned on the same surface of the PV cell.

15. The PV cell of claim 13, wherein the PV cell further comprises a front electrode.

16. The PV cell of claim 15, wherein the rear cell electrode and the front cell electrode are positioned on opposite surfaces of the PV cell.

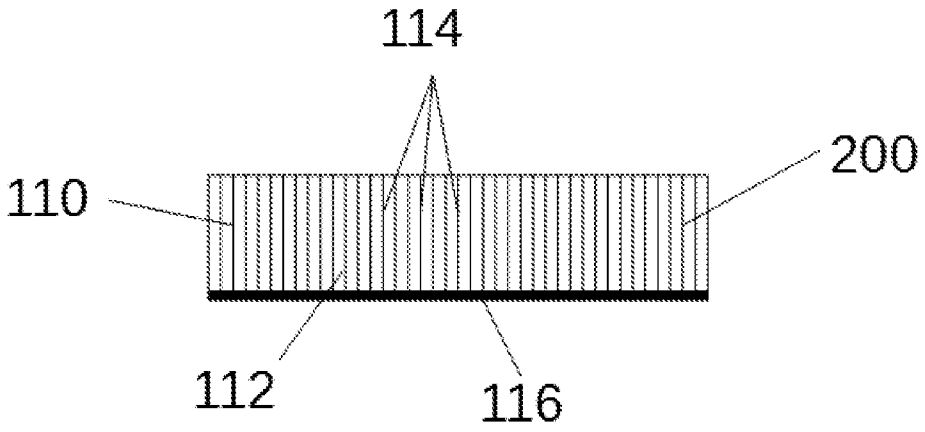

Fig. 1

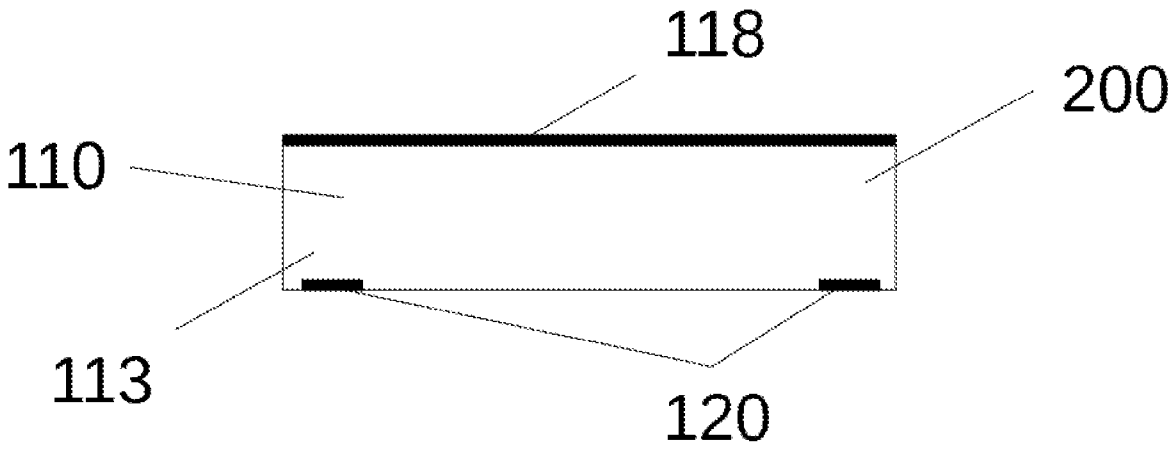

Fig. 2

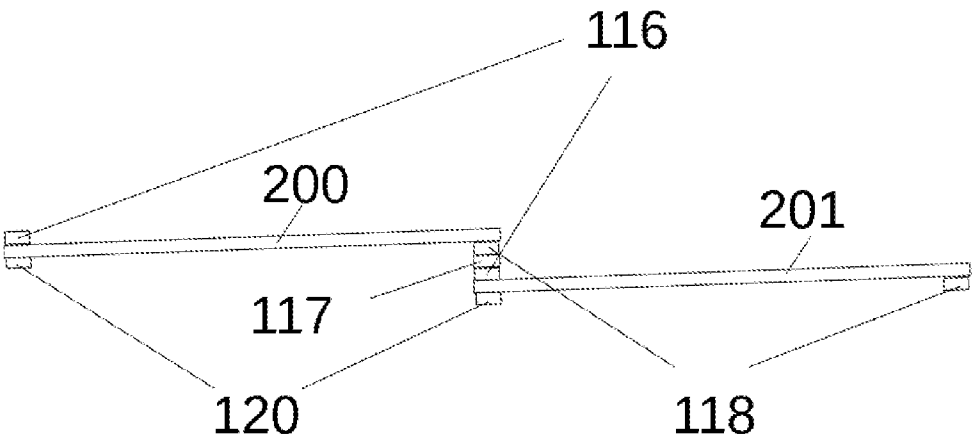

Fig. 3

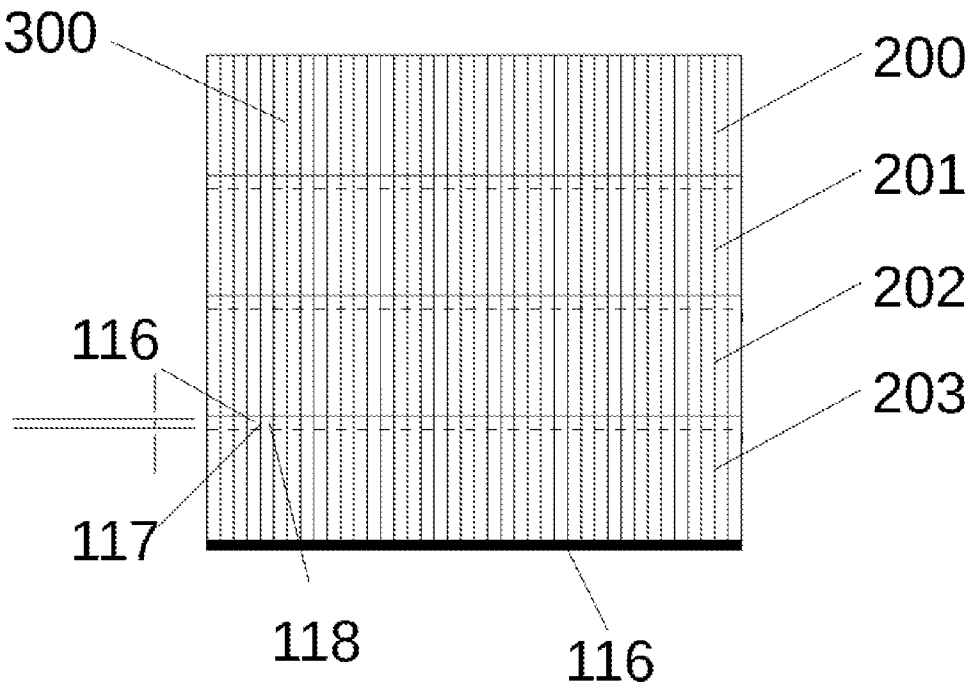

Fig. 4

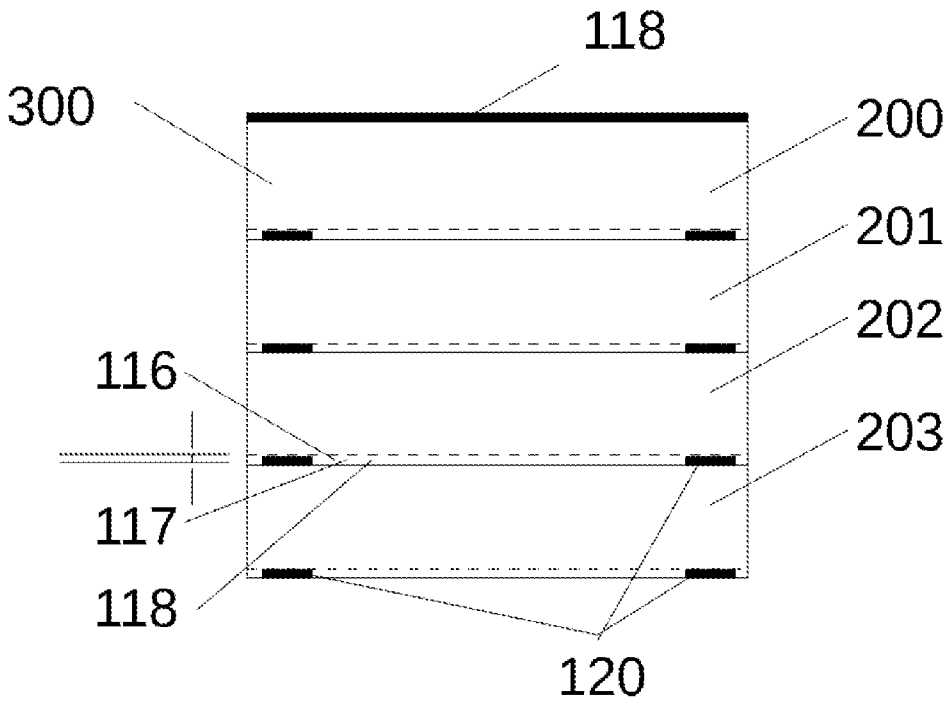

Fig. 5

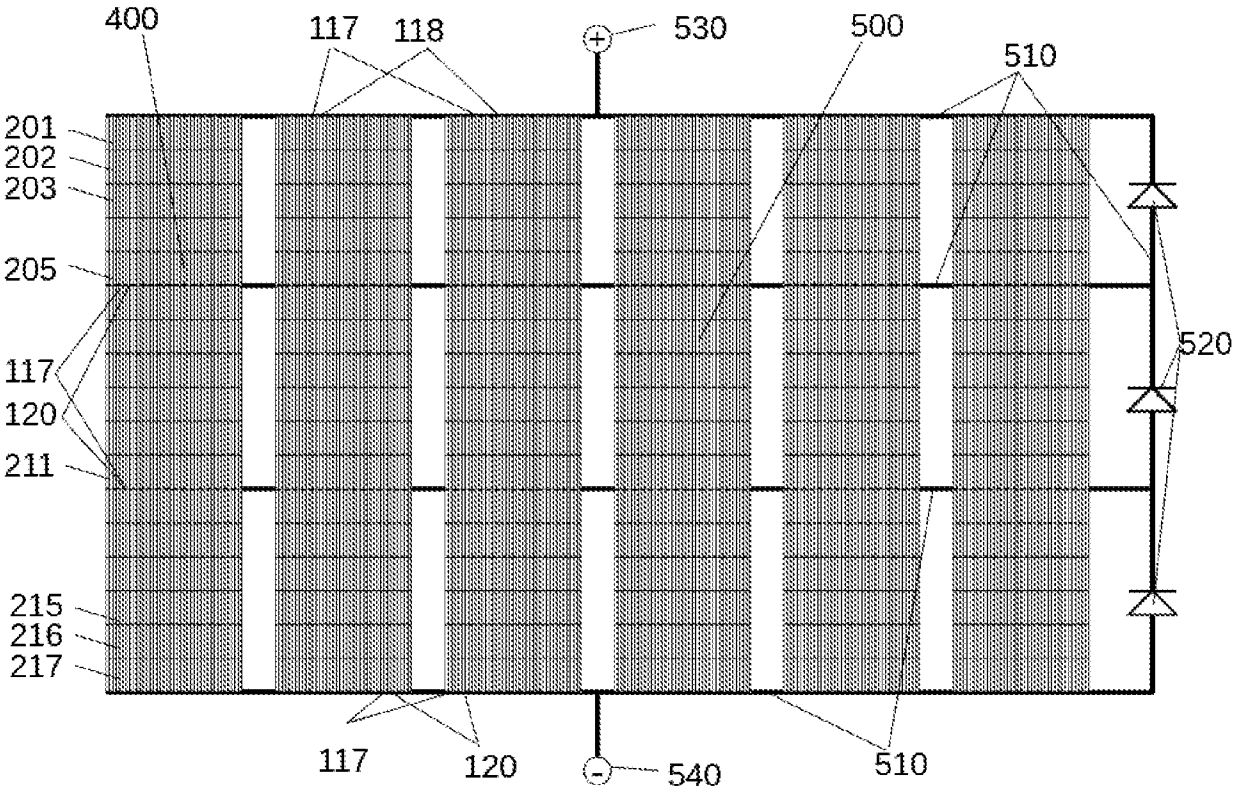
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Fig. 6

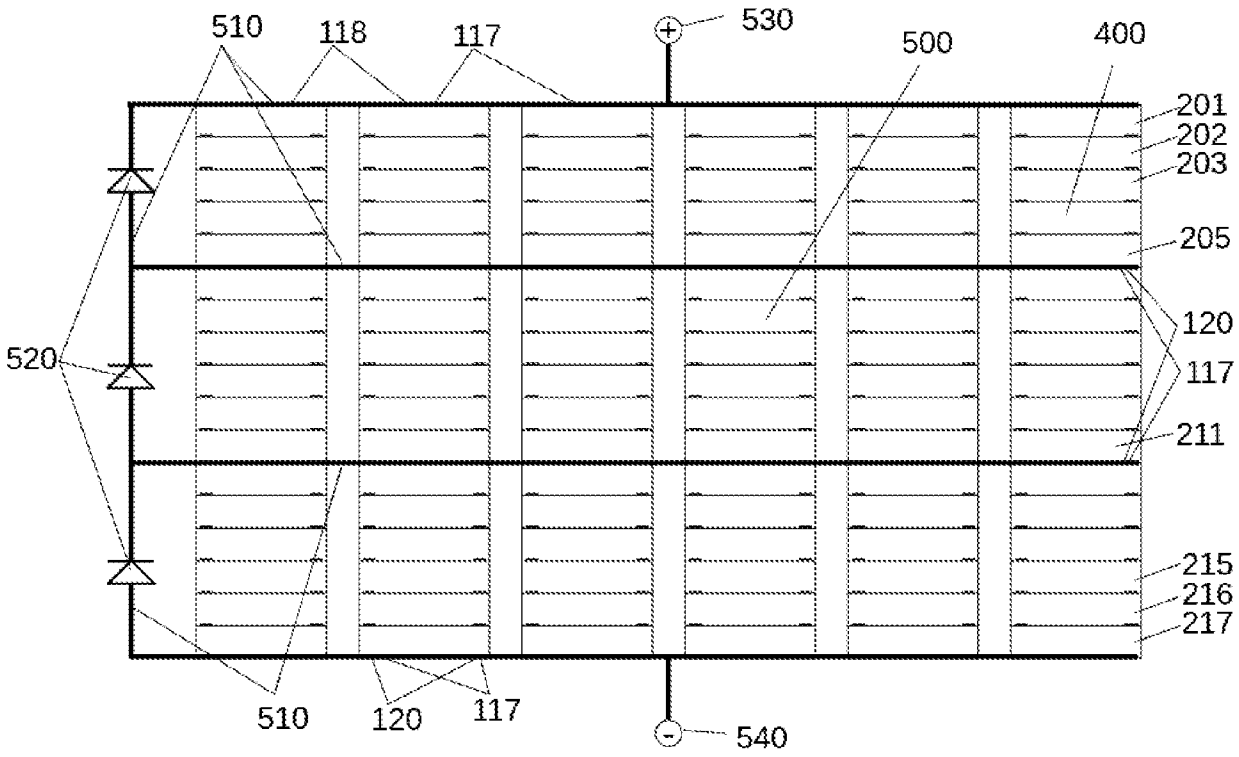
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Fig. 7

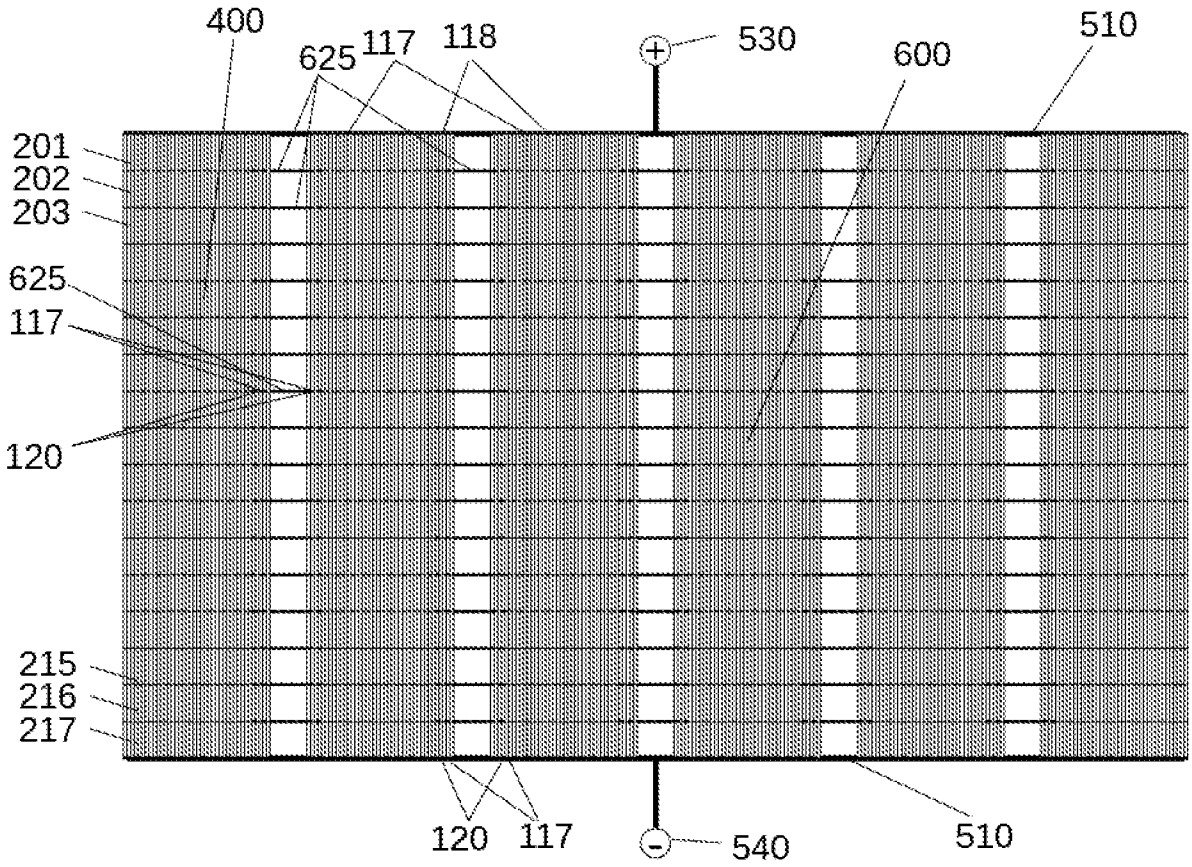
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Fig. 8

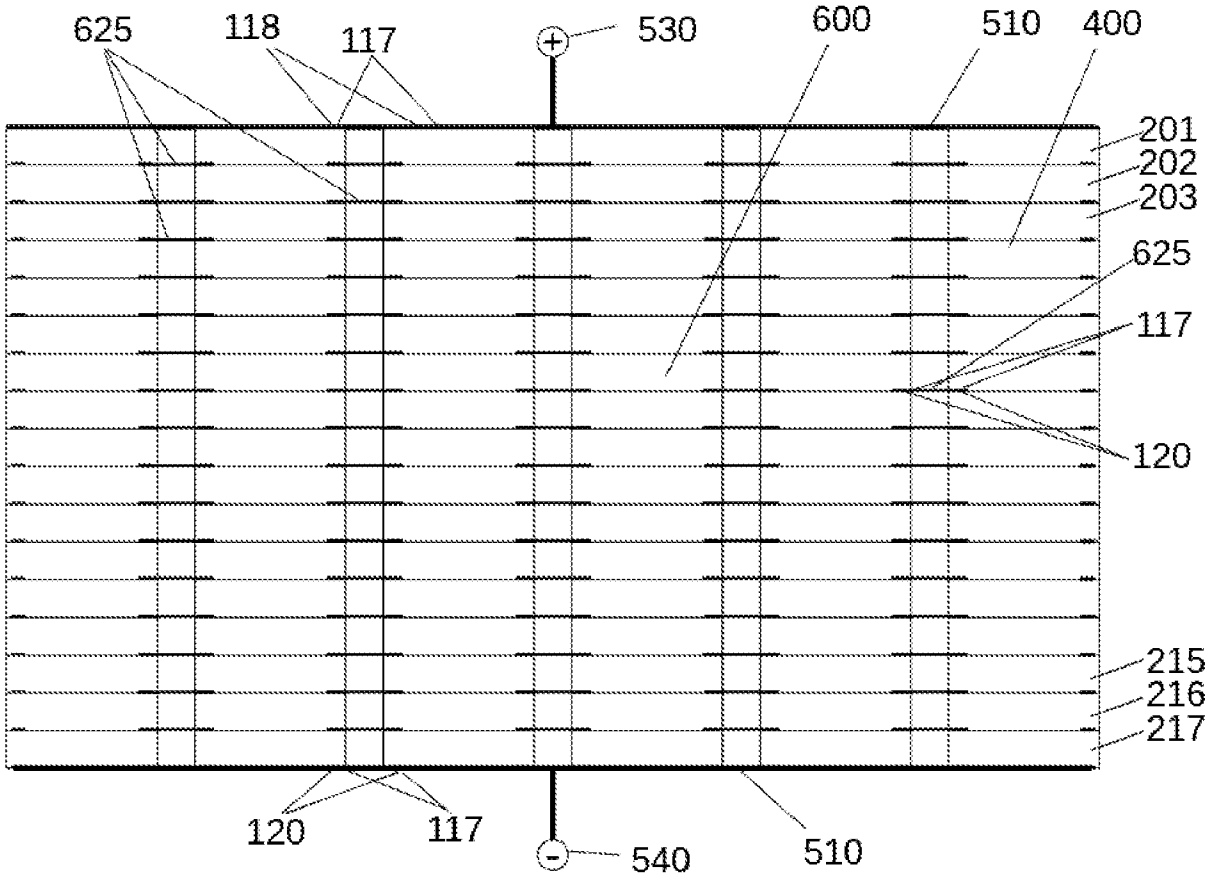
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Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 17/51289

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H01 L 31/0224; H02S 40/34, H02S 40/36 (201 8.01)
CPC - H01 L 31/0201 , H01 L 31/02245; H02S 40/34, H02S 40/3

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History Document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2015/0349145 A1 (COGENRA SOLAR, INC.) 03 December 2015 (03.12.2015), entire document especially Fig 8E; paras [0096], [0098], [0164]	1-16
Y	US 2014/0196768 A1 (HENG et al.) 17 July 2014 (17.07.2014), entire document especially Fig 2; para [0044]	1-16
Y	US 2014/0366464 A1 (BUILDING MATERIALS INVESTMENT CORPORATION) 18 December 2014 (18.12.2014), entire document especially para [0065]	11
A	US 2014/0124014 A1 (COGENRA SOLAR, INC.) 08 May 2014 (08.05.2014), entire document	1-16

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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

Date of the actual completion of the international search	Date of mailing of the international search report
13 January 2018	**09 FEB 2018**
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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