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(54) **Title:** CELL TRAY FOR A CELL STACK OR OTHER MULTIPLE CELL BATTERY MODULE

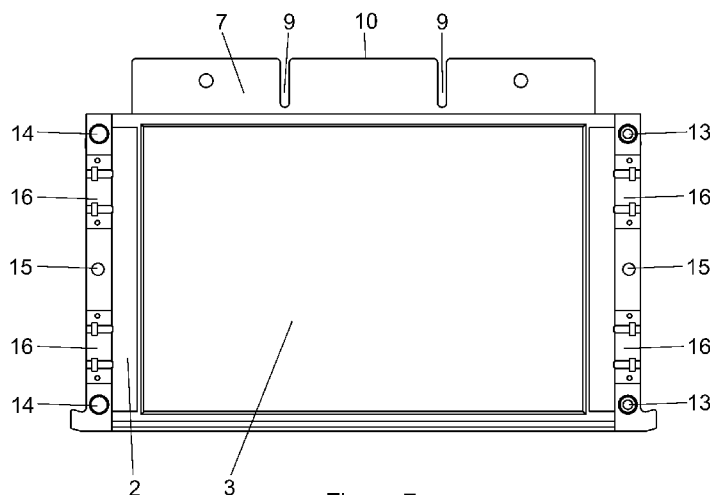


Figure 7

(57) **Abstract:** A cell tray is provided comprising an injection moulded plastic frame and a thermally conductive heat sink panel wherein the injection moulded plastic frame is moulded onto the heat sink panel in a manner permanently attaching the heat sink panel to the injection moulded plastic frame. The plastic frame preferably has a depth relative to the heat sink panel corresponding to a major part of the thickness of a cell to be received therein with the balance of the thickness of the cell corresponding to the thickness of plastic material that flows around the edges of the heat sink panel to locate such edges relative to the heat sink panel so that the space between two juxtaposed heat sink panels substantially equals the thickness of a cell. Preferably, the plastic frame surrounds three sides of a rectangular heat sink panel with the heat sink panel projecting beyond a fourth side of the rectangular frame to provide a heat dissipating fin arrangement projecting beyond the confines of an assembled cell stack that includes a plurality of cells and cell trays.



CELL TRAY FOR A CELL STACK OR OTHER MULTIPLE CELL BATTERY MODULE

5 FIELD OF THE INVENTION

This invention relates to a cell tray for a cell stack or other multiple cell battery module wherein the cell tray cooperates with the peripheral region of the individual cells and serves to locate the multiple cells relative to each
10 other. More particularly, the invention relates to a cell tray that has a heat sink associated with it.

BACKGROUND TO THE INVENTION

15 Cell stacks utilizing injection moulded plastic frames for locating the individual cells relative to each other in a cell stack or other multiple cell battery module are known, for example from international patent publication number WO/2006/113517 to ENERDEL INC. In that instance each of the individual cells is supported in a surrounding plastic frame composed of two parts that
20 fit together in order to support the cell in its operative position. No mention is made of any heat sink.

International patent publication number WO/2009/146196 describes an arrangement in which heat sinks are interposed between cells of a cell stack
25 and the whole arrangement is bolted together. This arrangement, whilst having the potential to operate effectively, involves considerable assembly with accompanying costs.

OBJECT OF THE INVENTION

It is an object of this invention to provide a cell tray for a cell stack or other multiple cell battery module in which a heat sink facility is provided with enhanced facility for assembly of the cells and heat sinks.

SUMMARY OF THE INVENTION

In accordance with this invention there is provided a cell tray comprising an injection moulded plastic frame and a thermally conductive heat sink panel, the cell tray being characterized in that the injection moulded plastic frame is moulded onto the heat sink panel in a manner permanently attaching the heat sink panel to the injection moulded plastic frame.

Further features of the invention provide for the plastic frame to have a depth relative to the heat sink panel corresponding to a major part of the thickness of a cell to be received therein with the balance of the thickness of the cell corresponding to the thickness of plastic material that flows around the edges of the heat sink panel to locate such edges relative to the heat sink panel in a manner such that, in use, the space between two juxtaposed heat sink panels substantially equals the thickness of a cell; for the plastic frame to surround three sides of a rectangular heat sink panel with the heat sink panel projecting beyond a fourth side of the rectangular frame to provide a heat dissipating fin arrangement projecting beyond the confines of an assembled cell stack that includes a plurality of cells and cell trays according to the invention; for the heat sink panel to have a row of perforations in line with said fourth side of the rectangular plastic frame so that molten plastic material can, during the moulding process, flow through the perforations and set to lock the panel to the plastic of the frame; for the plastic frame to include projections and cooperating sockets for aligning a plurality of cell trays in a stacked cooperating relationship; and for the plastic frame to have

moulded into it formations for receiving terminals of cells located in the cell trays, in use.

5 The heat dissipating fin may have gaps extending inwardly from the free edge of the heat sink panel with the gaps terminating short of the said fourth side of the rectangular frame so that the heat dissipating fin is effectively divided into a plurality of adjacent sections along its length to provide for enhanced contact with air that is to cool the heat sink panels, in use.

10 Alternatively, and preferably, the heat dissipating fin has a portion thereof nearer a leading end edge removed to render the surface area of the heat dissipating fin asymmetric about a position in between the leading end edge and a coolant air departure region of the heat dissipating fin. The leading
15 end edge of the heat dissipating fin is that end edge that was first contacted by coolant air that flows along the length of the heat dissipating fin, in use. Preferably, from a structural point of view, the portion of the fin that is removed is preferably defined by a rectangular aperture through the fin in the half thereof nearer the leading end edge of the fin.

20 The heat dissipating fin preferably extends along one of the longer sides of the rectangular plastic frame.

The heat sink panels can conveniently be made of sheet aluminium that is die-cut and punched to provide the required features of the heat sink panel.

25

The plastic frame can have the usual material saving and contraction accommodating recesses moulded into them.

Of course, the cell tray can be produced using known insert moulding
30 techniques.

In order that the invention may be more fully understood one embodiment thereof will now be described with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

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In the drawings:-

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Figure 1 is a perspective illustration of a battery module made up of multiple cell stacks;

Figure 2 is a schematic end view of one cell stack;

Figure 3 is an elevation of a die-cut and punched heat sink panel prior to moulding of the plastic frame thereon;

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Figure 4 is a schematic view of the top edge of a single cell tray;

Figure 5 is an enlarged sectional view showing the edge of the heat sink panel embedded in the plastic material of the frame;

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Figure 6 is an enlarged sectional view showing the plastic material of the frame passing through a perforation in the heat sink panel;

25

Figure 7 is an elevation of one embodiment of completed cell tray from one side thereof;

Figure 8 is an elevation of the same completed cell tray from the opposite side thereof;

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Figure 9 is a perspective view showing the cell trays of two cell stacks opened out in the manner of a book and showing one

face of one cell tray and the opposite face of the other cell tray;

Figure 10 is an elevation of a second embodiment of completed cell tray from one side thereof; and,

Figure 11 is an elevation of the second embodiment of completed cell tray from the other side thereof.

10 DETAILED DESCRIPTION WITH REFERENCE TO THE DRAWINGS

In the embodiment of the invention illustrated in the drawings, a cell tray (1) comprises a rectangular injection moulded plastic frame (2) and a thermally conductive aluminium heat sink panel (3) permanently attached to the plastic frame by virtue of the fact that the plastic frame is moulded onto the heat sink panel by an insert moulding technique. The heat sink panel is thus permanently attached to the injection moulded plastic frame in the first instance by virtue of a small amount of plastic material (4) that becomes moulded onto the opposite side of the three edges of the heat sink panel as shown in Figure 5. The heat sink panel is conveniently made of sheet aluminium that is die-cut and punched to provide the required features of the panel and cell tray that are further described below.

In this embodiment of the invention the cell tray is of basically rectangular shape with the longer dimension of the rectangle extending horizontally, in the operative position, as can be clearly seen in Figures 7 and 8.

The plastic frame is located predominantly on one side of the heat sink panel and has a depth relative to the heat sink panel corresponding to a major part of the thickness of a pouch cell (5) to be accommodated therein with the balance of the thickness of the cell corresponding to the thickness of plastic material (4) that flows around the edges of the heat sink panel to locate such

edges relative to the plastic frame. This arrangement is such that the space between two juxtaposed heat sink panels substantially equals the thickness of a cell. The plastic frame surrounds three sides of the rectangular heat sink panel with those three edges of the heat sink panel extending into the plastic material, as shown clearly in Figure 5.

The fourth side of the heat sink panel projects beyond the plastic frame and assumes the form of an extension that serves as a heat dissipating fin (7) in the assembled condition of a cell stack and thus of a battery module, as illustrated especially in Figures 1, 2 and 8. In one embodiment of heat dissipating fin, the fin may have gaps (9) extending inwardly from the free edge (10) of the heat sink panel with the gaps terminating short of the said fourth side of the rectangular frame so that the heat dissipating fin is effectively divided into a plurality, in this instance three, adjacent sections of substantially equal length along the length of the fin. This arrangement is intended to provide for enhanced turbulence of the air that is to cool the heat sink panels, in use, by way of the heat dissipating fins. As will be clear from the foregoing, the heat dissipating fins extend, in this embodiment, along the top of one of the longer sides of the rectangular plastic frame.

20

As shown especially in Figures 3 and 8, this embodiment of heat sink panel has a row of small perforations (12) in line with said fourth side of the plastic rectangular frame so that molten plastic material can, during the moulding process, become locked into the perforations as indicated by numeral (6) in Figure 6. In this manner the fourth side of the plastic rectangular frame becomes firmly attached to the heat sink panel.

25

The plastic frame has projections (13) at two adjacent corners thereof and two cooperating sockets (14) at the other two adjacent corners on the one face thereof and coaxially on the other face, complementary sockets and projections. The arrangement is such that when a stack of cell trays is located next to each other to form a cell stack, the projections and sockets

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inter-engage and serve the purpose of aligning the plurality of cell trays in a stacked cooperating relationship. The stack can be secured together using screw threaded fasteners (not shown) passing through holes (15) in the sides of the frames. Additionally, the projections and sockets may mechanically clip
5 together to reduce the risk of separation during the assembly stage

The plastic frame has moulded into it recesses (16) for receiving terminals (17) of cells (5) located in the cell trays.

10 As is common practice in the plastic injection moulding art, the plastic frame is provided, in the usual manner, with material saving and contraction compensating recesses moulded into them.

It is to be noted that the plastic material is chosen to be compatible with the
15 thermal expansion properties of the heat sink panel in order to prevent warping of the tray cell.

Referring now particularly to Figures 10 and 11, it has been found that a different embodiment of heat sink panel and heat dissipating fin may be
20 advantageous especially in instances in which a ceiling (21) is present over the battery modules and coolant air is to flow from one end of the heat dissipating fins to the other. In such instances, the one end edge of the heat dissipating fin forms a leading end edge (22) towards which coolant airflow flows in use in the general direction indicated by arrow "X". The opposite end
25 region (23) of the heat dissipating fin forms a coolant air departure region, in this instance in which coolant air leaves the heat dissipating fin after flowing from the leading end edge along the fin. The direction of the departure of the coolant air may be somewhat transverse to the length of the heat dissipating fin such as in the general direction indicated by arrows "Y" as a result of
30 changing direction upwards because of buoyancy effects.

In this second embodiment of the invention, the heat dissipating fin has a portion thereof nearer the leading end edge removed to form an aperture (24) and render the surface area of the heat dissipating fin asymmetric about a position in between the leading end edge and the coolant air departure region of the heat dissipating fin. In this instance the aperture (24) is of generally rectangular shape with a lower boundary of the rectangle approximately coincident with the outer periphery of the plastic frame. With this arrangement is possible to build the plastics material to the lower edge of the aperture to hold a continuous strip (25) of plastics material on the reverse side of the heat sink panel to form a fourth side to the plastic frame on the reverse side in addition to the front side of the panel as will be seen from a reference to Figure 10.

The rectangular aperture has a length that is just short of one half of the length of the heat dissipating fin, and a height of about one half of the height of the heat dissipating fin. The aperture is preferably located a short distance, of the order of 5 mm, inwards from the leading end edge (22) of the heat dissipating fin. This leaves a narrow pillar formation (26) connecting an elevated part (27) of the heat dissipating fin with the heat sink itself in order to contribute significantly to the robustness of the heat dissipating fin and heat sink. The fin thus consists of a single fin located predominantly towards one side of the heat sink so that coolant air travels firstly across the aperture section without becoming significantly heated and then along the uninterrupted fin to carry out the main heat removal activity.

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It has been found that with this arrangement the temperature distribution within the cell contact surface is more uniform. Since temperature uniformity across the cell is improved, charging and discharging of the cells are also more uniform thereby making cell management more efficient. Temperature uniformity furthermore results in more uniform cell aging, a factor that is highly significant.

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Numerous variations may be made to the embodiment of the invention described above without departing from the scope hereof.

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CLAIMS:

1. A cell tray comprising an injection moulded plastic frame and a thermally conductive heat sink panel, the cell tray being characterized in that the injection moulded plastic frame is moulded onto the heat sink panel in a manner permanently attaching the heat sink panel to the injection moulded plastic frame.
2. A cell tray as claimed in claim 1 in which the plastic frame has a depth relative to the heat sink panel corresponding to a major part of the thickness of a cell to be received therein with the balance of the thickness of the cell corresponding to the thickness of plastic material that flows around the edges of the heat sink panel to locate such edges relative to the heat sink panel in a manner such that, in use, the space between two juxtaposed heat sink panels substantially equals the thickness of a cell.
3. A cell tray as claimed in either one of claims 1 or 2 in which the plastic frame surrounds three sides of a rectangular heat sink panel with the heat sink panel projecting beyond a fourth side of the rectangular frame to provide a heat dissipating fin arrangement projecting beyond the confines of an assembled cell stack that includes a plurality of cells and cell trays.
4. A cell tray as claimed in claim 3 in which the heat sink panel has a row of perforations in line with said fourth side of the rectangular plastic frame so that molten plastic material passes through the perforations to lock the panel to the plastic of the frame once it is set.
5. A cell tray as claimed in any one of the preceding claims in which the plastic frame includes projections and cooperating sockets for aligning a plurality of cell trays in a stacked cooperating relationship.

6. A cell tray as claimed in any one of the preceding claims in which the plastic frame has moulded into it formations for receiving terminals of cells located in the cell trays, in use.
- 5
7. A cell tray as claimed in either one of claims 3 or 4 in which the heat dissipating fin has gaps extending inwardly from the free edge of the heat sink panel with the gaps terminating short of the said fourth side of the rectangular frame so that the heat dissipating fin is effectively
- 10 divided into a plurality of adjacent sections along its length.
8. A cell tray as claimed in either one of claims 3 or 4 in which the heat dissipating fin has a portion thereof nearer a leading end edge removed to render the surface area of the heat dissipating fin
- 15 asymmetric about a position in between the leading end edge and a coolant air departure region of the heat dissipating fin wherein the leading end edge of the heat dissipating fin is that end edge that is to be first contacted by coolant air that flows along the length of the heat dissipating fin, in use.
- 20
9. A cell tray as claimed in claim 8 in which the portion of the fin that is removed is defined by a rectangular aperture through the fin in the half thereof nearer the leading end edge of the fin.
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10. A cell tray as claimed in any one of claims 3, 4, 7, 8 and 9 in which the heat dissipating fin extends along one of the longer sides of the rectangular plastic frame.
- 30
11. A cell tray as claimed in any one of the preceding claims in which the heat sink panel is made of sheet aluminium that is die-cut and punched to provide the required features of the heat sink panel.

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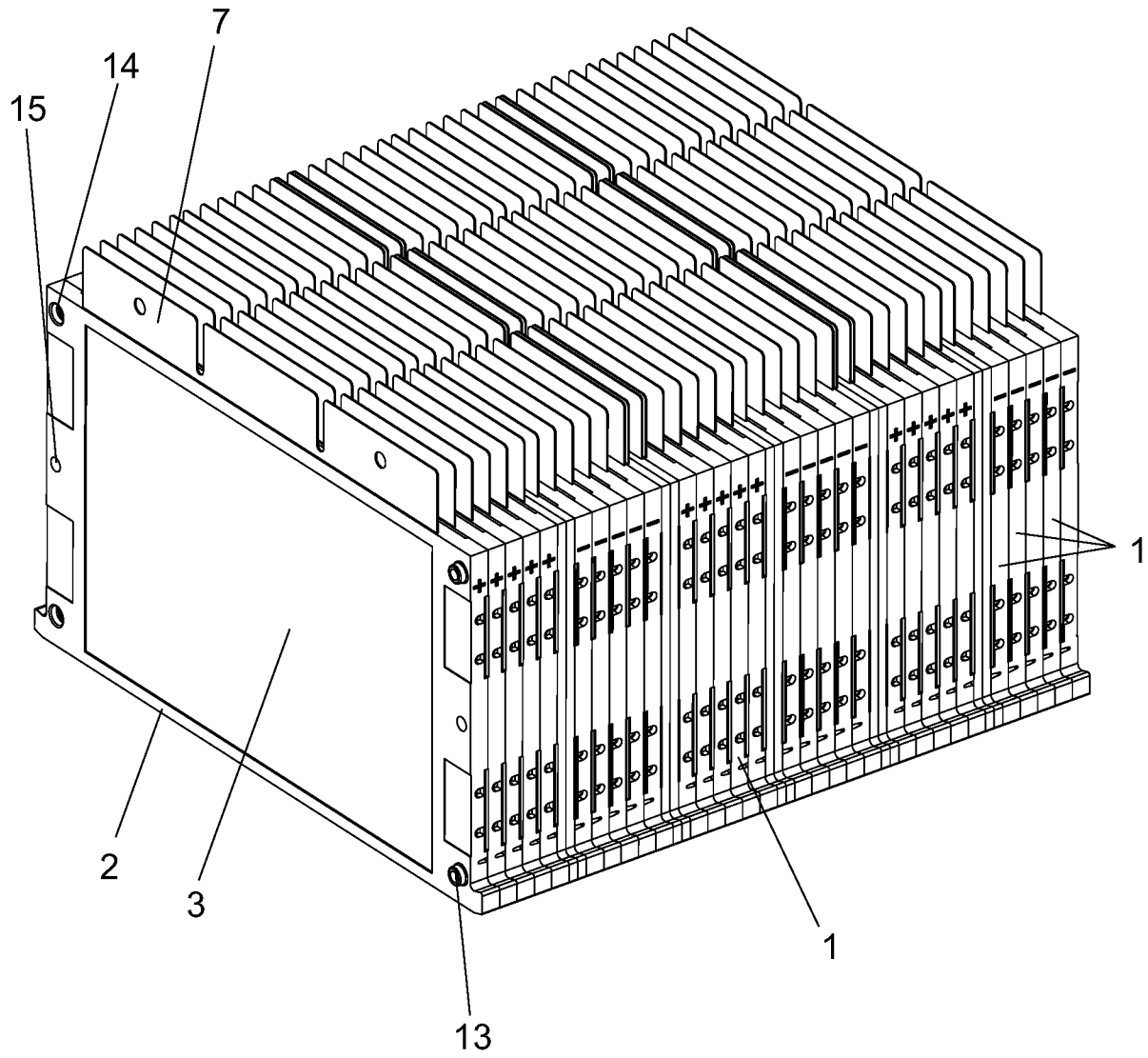


Figure 1

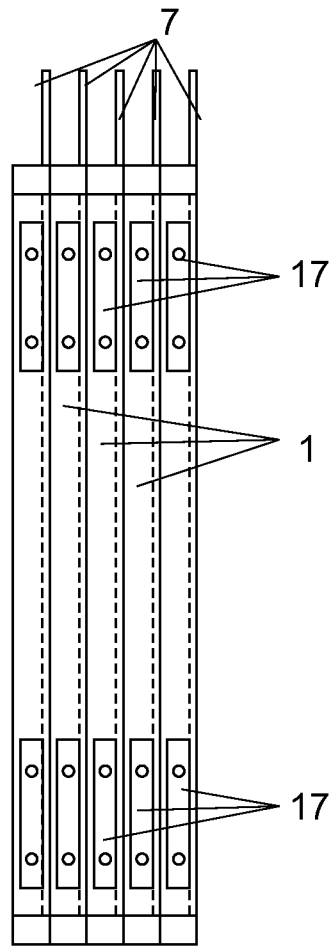


Figure 2

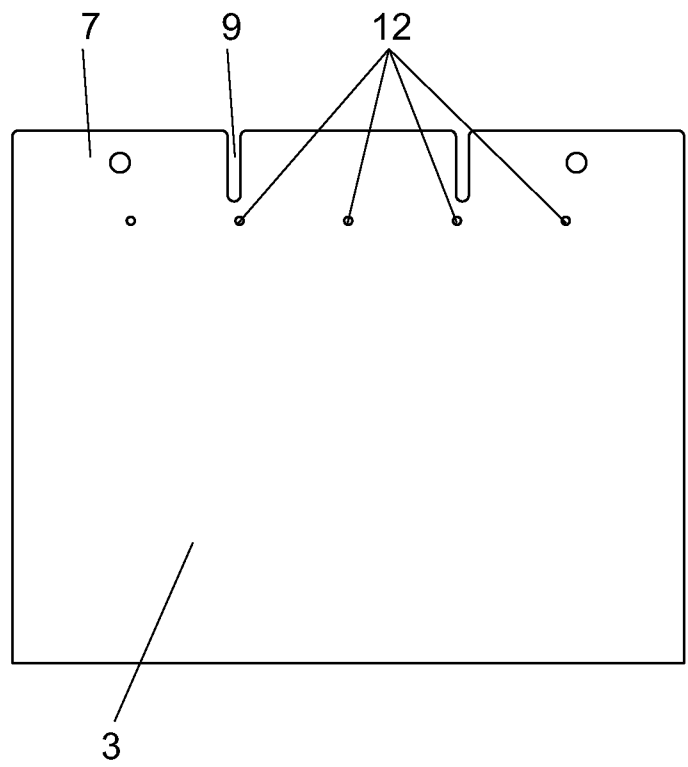


Figure 3

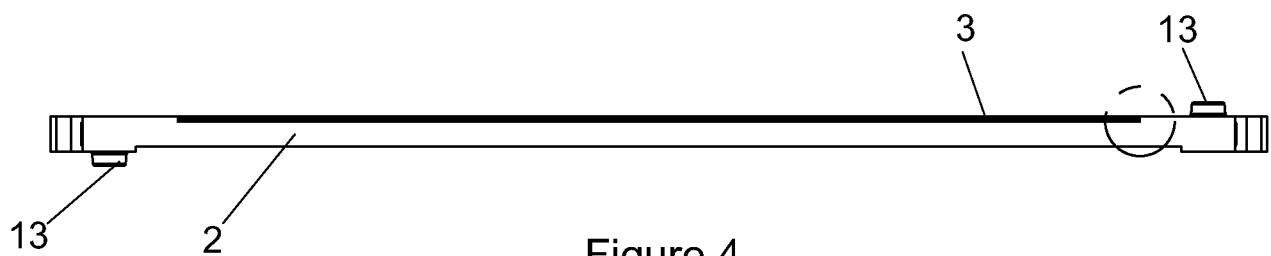


Figure 4

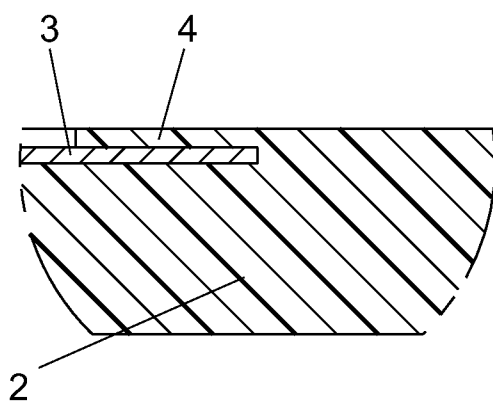


Figure 5

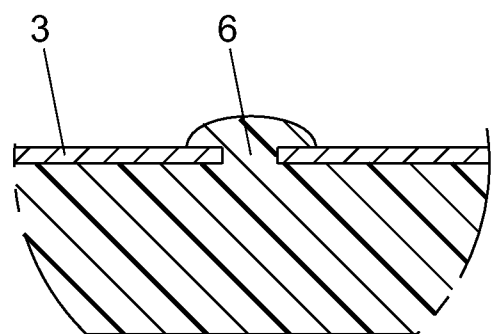


Figure 6

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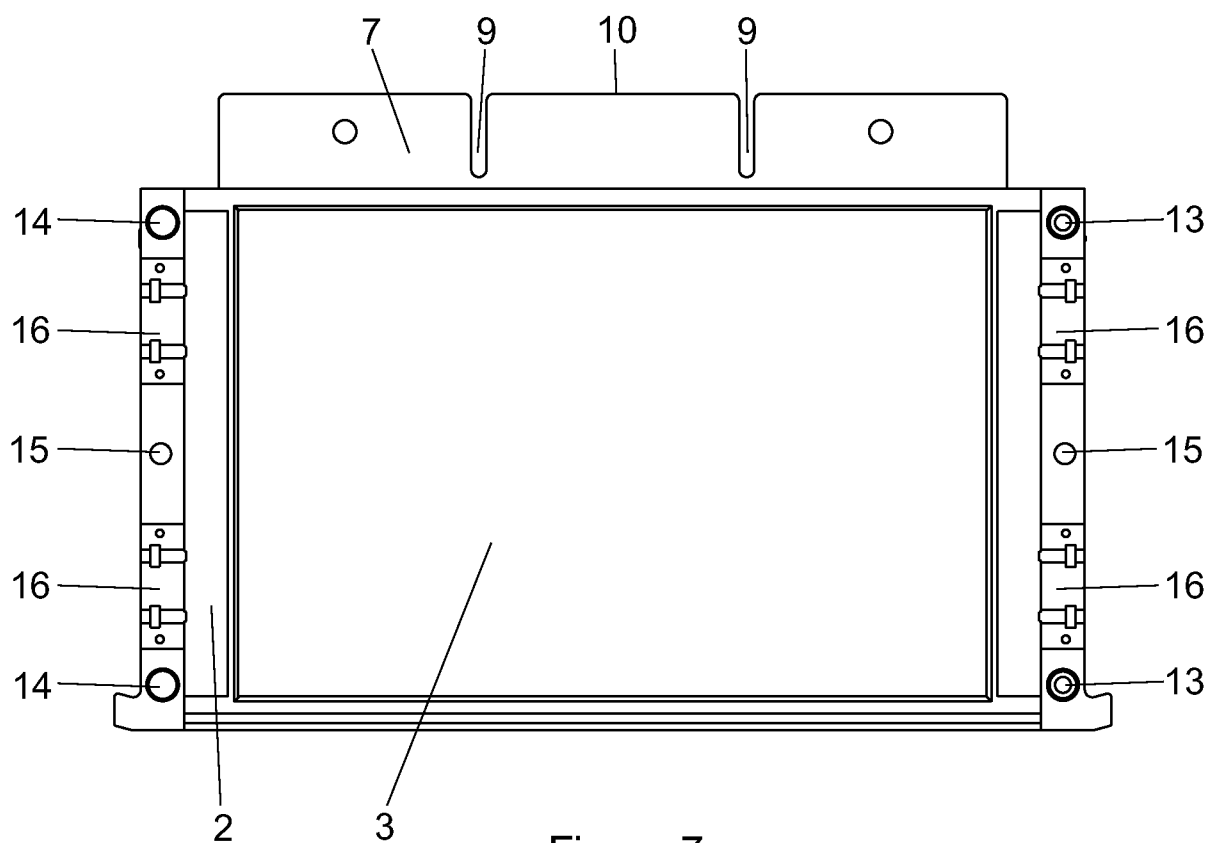


Figure 7

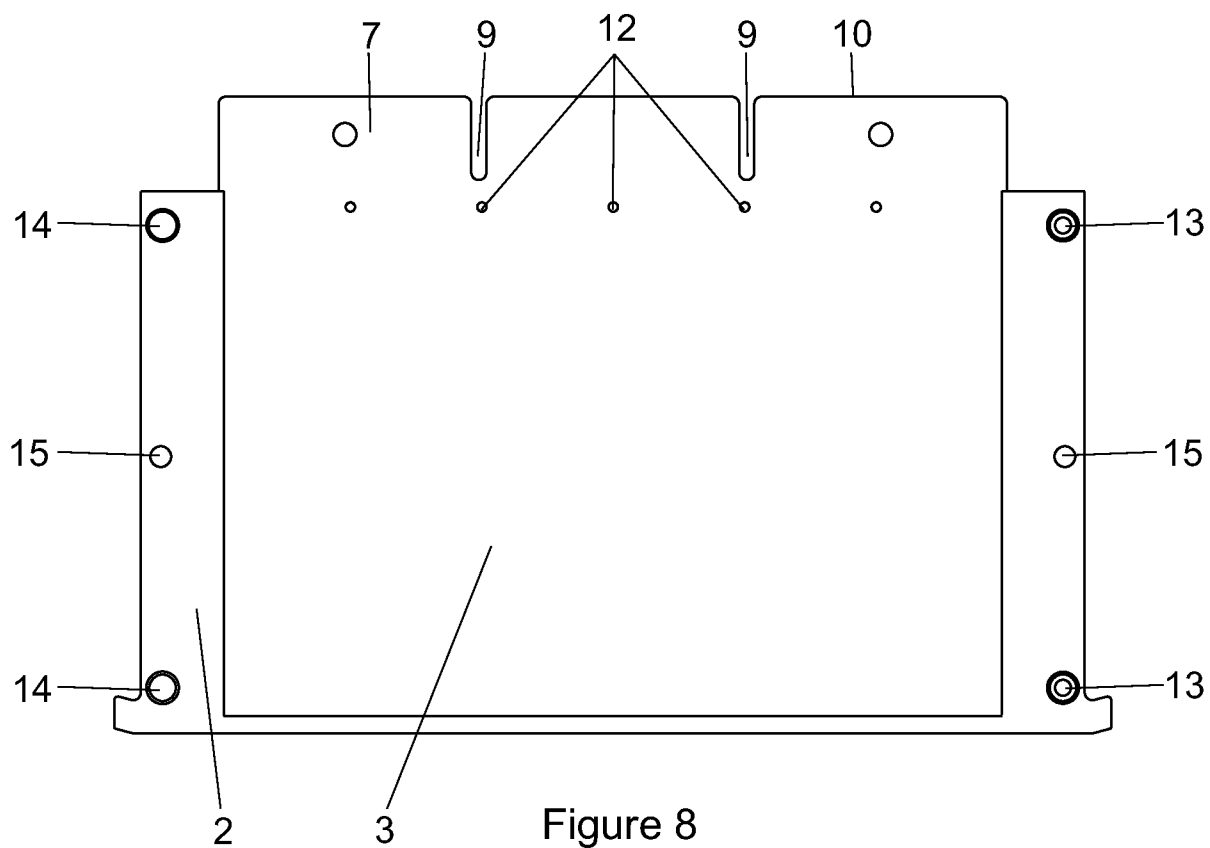


Figure 8

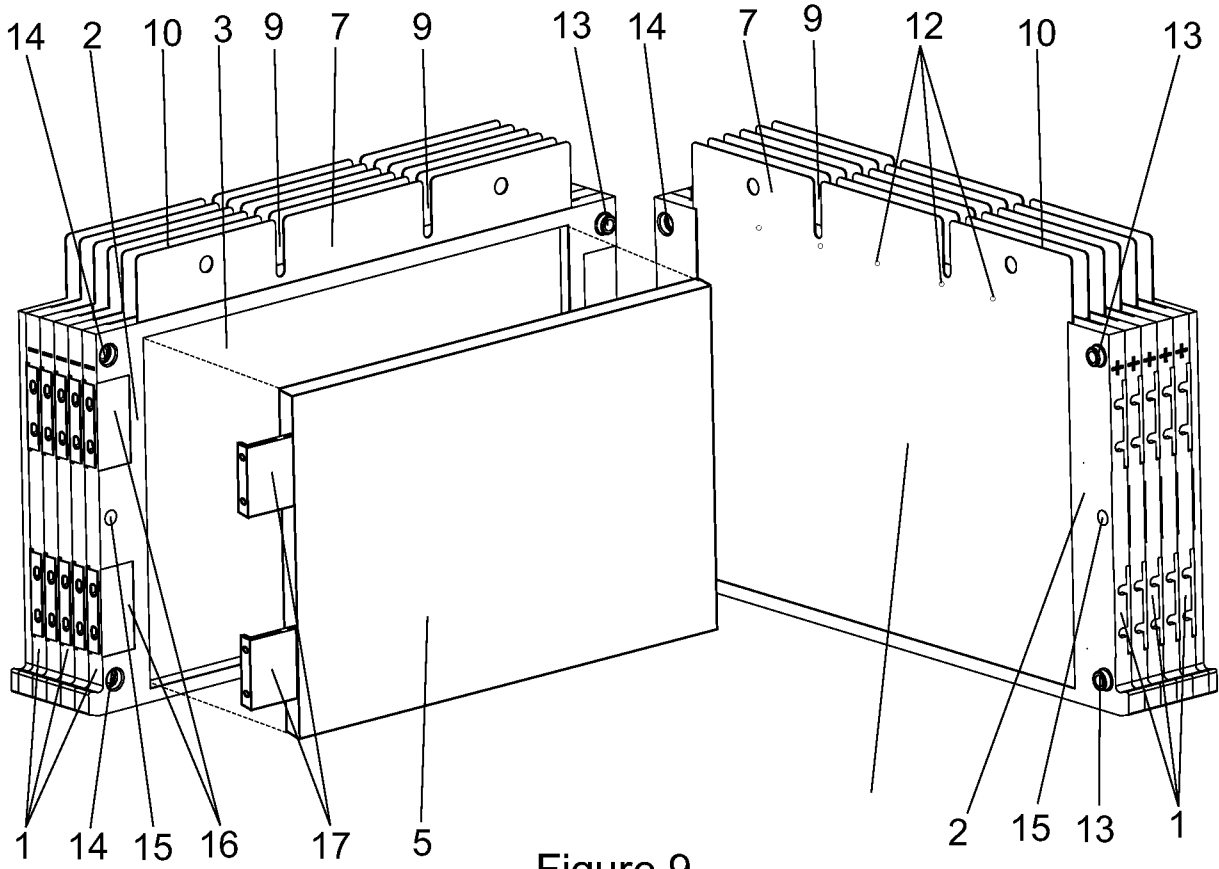


Figure 9

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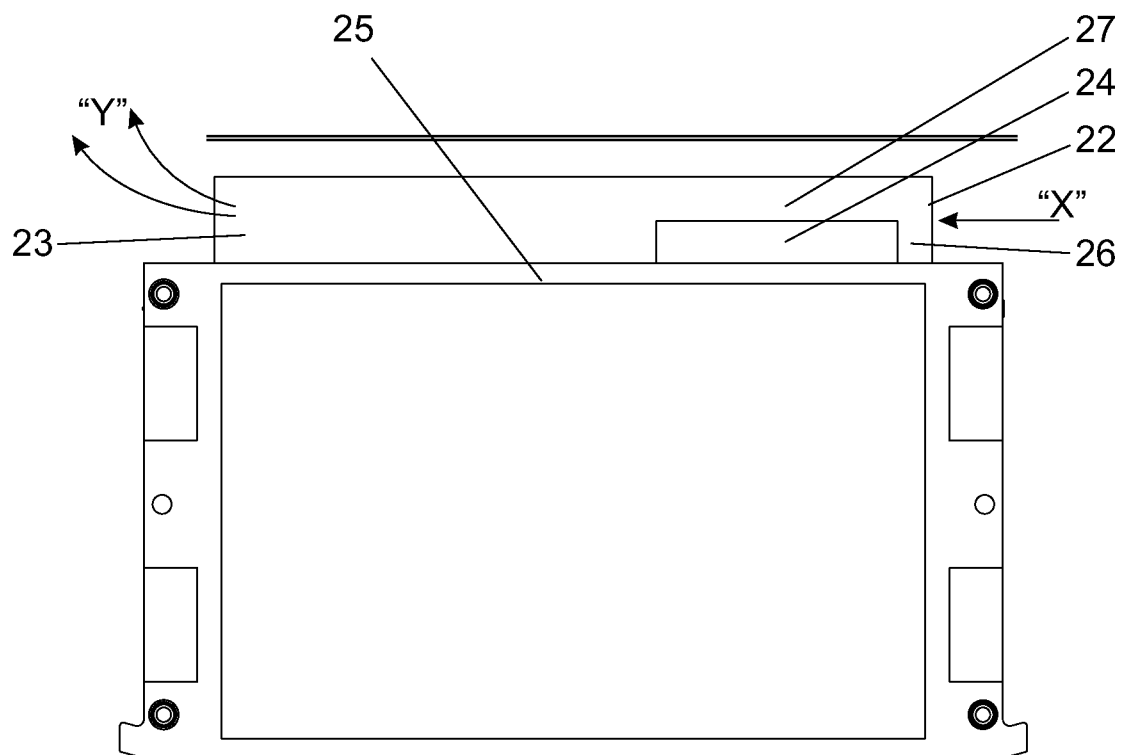


Figure 10

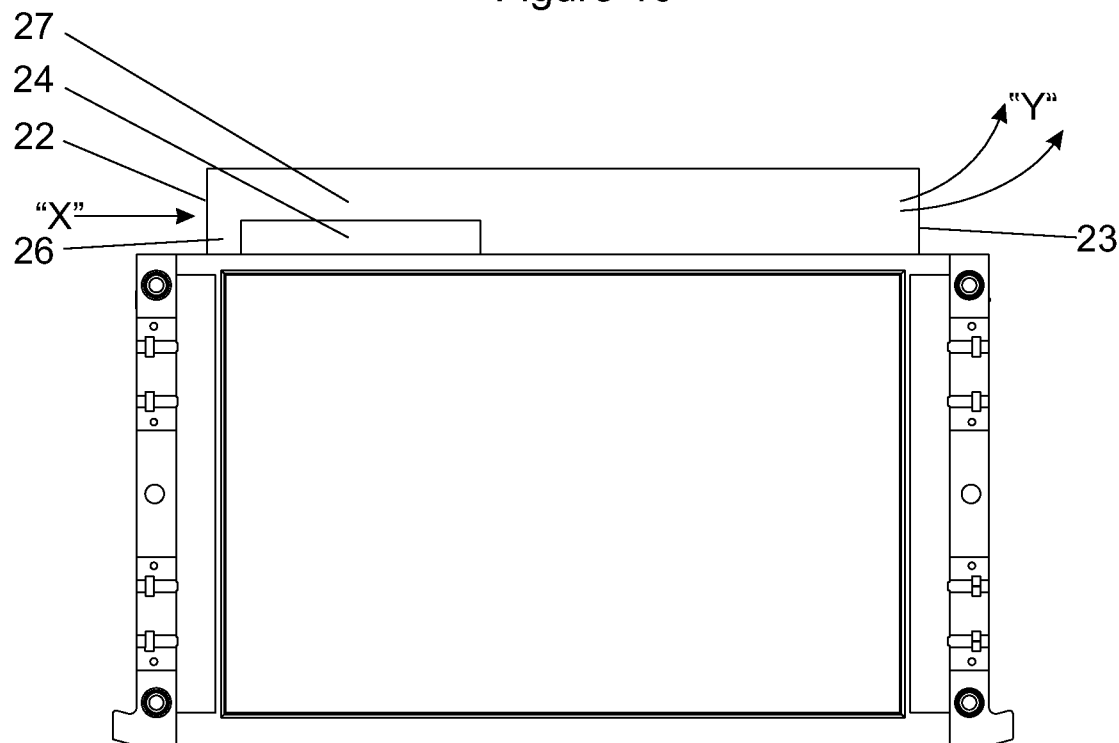


Figure 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2012/051561

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01M10/50 H01M2/18
ADD.

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)
H01M

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

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

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/061299 A1 (UCHIDA YASUNORI [JP] ET AL) 5 March 2009 (2009-03-05) abstract; figures 1-5 paragraph [0044] -----	1
X Y A	US 2010/304203 A1 (BUCK DERRICK S [US] ET AL) 2 December 2010 (2010-12-02) abstract; figures 2-6 -----	1-3,5-8, 10,11 4 9
Y	US 2004/096730 A1 (KUROKI YUICHI [JP] ET AL) 20 May 2004 (2004-05-20) abstract; figure 6 -----	4
A	US 2008/090137 A1 (BUCK DERRICK SCOTT [US] ET AL) 17 April 2008 (2008-04-17) abstract; figures 6-17 paragraph [0057] -----	1-11

☐

Further documents are listed in the continuation of Box C.

☒

See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

15 June 2012

Date of mailing of the international search report

25/06/2012

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2012/051561

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009061299 A1	05-03-2009	CN 101378141 A EP 2031672 A1 JP 4508221 B2 JP 2009054403 A US 2009061299 A1	04-03-2009 04-03-2009 21-07-2010 12-03-2009 05-03-2009
US 2010304203 A1	02-12-2010	CN 101855775 A EP 2218131 A1 JP 2011503800 A KR 20100100859 A US 2010304203 A1 WO 2009061451 A1	06-10-2010 18-08-2010 27-01-2011 15-09-2010 02-12-2010 14-05-2009
US 2004096730 A1	20-05-2004	AU 6060601 A AU 2001260606 B2 CA 2424212 A1 CN 1476646 A EP 1341249 A1 JP 3940920 B2 US 2004096730 A1 US 2006166076 A1 WO 0243172 A1	03-06-2002 19-10-2006 21-03-2003 18-02-2004 03-09-2003 04-07-2007 20-05-2004 27-07-2006 30-05-2002
US 2008090137 A1	17-04-2008	AT 533203 T CA 2666312 A1 EP 2087548 A2 JP 2010507198 A KR 20090082212 A US 2008090137 A1 US 2009214941 A1 WO 2008048751 A2	15-11-2011 24-04-2008 12-08-2009 04-03-2010 29-07-2009 17-04-2008 27-08-2009 24-04-2008