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[Continued on next page]

(54) Title: IMPROVED CELL CASSETTE WITH INBUILT CELL TAB STRESS RELIEVING STRUCTURE

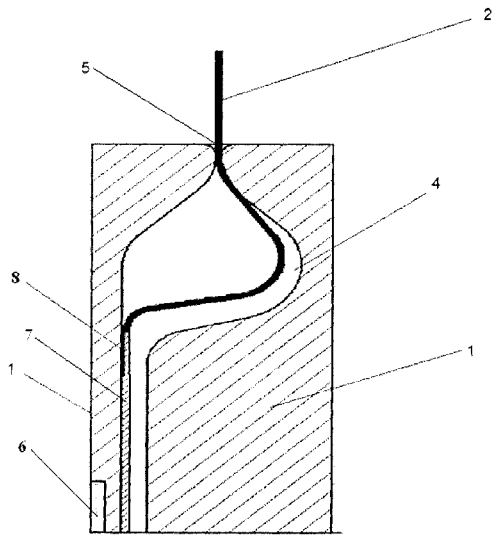

Figure 4

(57) Abstract: This invention presents a cassette design v to allow the cell tabs to acquire stress relieving structure (4) which is of great importance for vibration resistance. In this design, the cell tabs (2) acquire a special stress relieving structure (4) which provides vibration resistance and prevents the weld failure between cell tabs (2) and current collector (7). Such kind of vibration resistant packaging strategy is very important for transportation batteries. This invention also discusses the packaging strategy of curved tabs. A cassette design assembly process which excludes the extra efforts needed to create stress relieving structure (4) in the tab (2). This design acts as a mould for tab (2) to acquire stress relieving structure (4) when packaged. Tab support feature is in-built in the cassette.

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IMPROVED CELL CASSETTE WITH INBUILT CELL TAB STRESS RELIEVING STRUCTURE

FIELD OF INVENTION

This invention relates to an improved cassette cell with inbuilt cell tab stress relieving structure for battery module and a method of assembling the same.

BACKGROUND OF INVENTION

Generally, pouch cells are hard to handle in terms of retaining into a battery pack system. The cell-pouch is flexible and a pack design will have to allow the cell-pouch to expand and contract. The cell-pouch has two foil tabs usually in two different materials, most often Aluminium and Nickel-coated Copper. The tabs are connected to current collectors inside the cell-pouch. Usually, ultrasonic welding is used to join the Nickel coated Copper tabs to Copper current collectors and and Aluminium tabs to Aluminium current collectors. The perforated weld pattern of ultrasonic weld does not offer strong mechanical strength against external stresses, such as vibrations. Previous patents in this area present the concept of bent tabs and cell connectors that absorbs forces. The prior arts as discussed above present the idea of tab bending in order to sustain stresses. In most of the cases, stress relieving structure was created by bending either current collector or tabs inside the pouch cell. Packing of cells in a battery module is an important step. None of the previous invention discusses about the packaging strategy of the cell with bent tabs.

The regular cassette (with straight opening) used for packing of cells does not offer any considerable resistance against the external stresses. The cells packed in regular cassettes show failure of the weld during the vibration test. Bend tabs of the cell can be considered as stress relieving structure but it is not possible to package a cell in a cassette with regular opening.

Existing cassette designs used for packaging the cells do not offer resistance to external stresses. They are designed to allow only flat tabs. The previous patents on stress relieving

structure of cells were focused on bending the tab but do not offer any packaging strategies on the cassette level.

Existing cassette design with straight opening for the tabs is not capable of resisting stresses or of allowing movement of pouch cells to relieve external stresses. The cell cassettes with regular straight opening are not resistant to external stresses and often a weld failure between the current collectors and the cell tab is observed.

PRIOR ARTS:

US 7410723, US 7875382, US 2009 0162749

The aforesaid patent applications US 7410723, US 7875382 and US 2009 0162749 are on curved electrodes/lead/tabs inside the pouch. Designs with curved electrodes belong to cell manufacturing. However, none of them discloses about the special cassette design which provides a stress resistant packaging of the cells.

WO2010012322A1, WO2010142679A1

The aforesaid patent applications WO2010012322A1, WO2010142679A1 present the inventions on using the curved connectors but fail to disclose a method to fit the tabs in a cassette which is capable of relieving stresses.

US 4521498

A different design for different type of cell (lead acid batteries) is presented in US 4521498. The present design is to connect Li ion cells and the electrode films of same polarity are connected to single tab. In US 4521498, multiple tabs are connected to electrodes of same polarity.

US 2002-0094478

The patent application US 2002-0094478 presents the solution to design with different arrangement.

OBJECT OF INVENTION:

The main object of present invention is to provide an improved inbuilt cell tab stress relieving structure for a battery module and method of assembling the same.

Another object of present invention is to improve the integrity of the cell/cassette/module (battery) assembly by reducing the stress in the weld and connections.

Yet another object of present invention is to provide a cassette design which allows the tab to flex without any mechanical failure and stress points.

SUMMARY OF INVENTION:

The present invention discloses a new cassette design which acts as a mould for a tab to acquire a stress relieving structure and support them. Invention discloses an inbuilt cell tabs stress relieving structure in a battery cassette module. The cassette module comprising at least one cassette (1) having cell-tabs (2) connected to anode and cathode films inside the cell and a plate (6) ; at least one cell-pouch (3) configured to be accommodated in said cassette (1); and at least one stress relieving structure (4) in the cassette (1) configured to provide a predetermined profile to the cell tab (2) and to provide the clamping force on a straight section (5) of the cell-tab (2) below a bus-bar(not shown) to sustain external stresses. The tabs are welded or soldered to busbars (not shown). The cells are supported by plates (6). Since, pouch cells have flexible surface, these plates (6) provide mechanical support. These plates (6) also contribute in thermal management (distribution of heat within the battery module).

A predetermined profile generated by the bend on the cell-tab (2) is configured to develop a stress concentration on the cell tab (2). The stress concentration generated by the bend on the cell-tab (2) is configured to direct the deflection of the cell tab (2) ensuring the absorption of the movement of the cell-pouch (3) in the bend, safeguarding the welded joint (8) of current collector (7) and the cell-tabs (2). The stress concentration is configured to provide stresses within the safe limit of the material by controlling the radius and the angular extent of the bend on the cell tab (2). The current collector (7) and the cell-tabs (2) are configured to be connected by ultrasonic welding (8).

The cell-tabs (2) are configured to sustain any external stresses, such as the stress arising from vibrations. The predetermined profile and features of the cassette (1) act as a support to relieve stresses.

The cassette (1) comprises of PA66 33GF polished material at critical points. The plate comprises of 0.5 mm – 1 mm thick un-anodized Aluminium 1050 or 5052 or 0.5 mm – 1 mm Aluminium 1050 or 5052 anodized up to 15μm width. The cell-pouch (3) comprises of outer layer PET and the cell tab (2) comprises of copper, Ni plated copper, Nickel, Nickel plated Aluminium, or Aluminium. The cassette (1) comprises of PA66 33GF polished material at critical points is framed around a plate. The plate comprises of 0.5 mm – 1 mm thick un-anodized Aluminium 1050 or 5052 or 0.5 mm – 1 mm Aluminium 1050 or 5052 anodized up to 15μm width.

The dimensions of cell-pouch (3) are configured with the bend "A" with a range of 3.9 – 5.0 mm minimum to center, the tab position "B" with a range of 3.5 – 5.0 mm or center of cassette and the relieving structure height "C" with a range of 5.0 – 10.0 mm depending on necessary movement of relief needed. The tab bend radius is 0.9 minimum inside bend radius. The tab thickness is a nominal thickness of 0.2 mm. The cell-tabs (2) comprises of Copper or Nickel coated Copper tab for anodes and Aluminium or Nickel plated Aluminum tab for cathodes.

Thus, this invention disclosure is about improving the integrity of the cell/cassette/module (battery) assembly, by reducing the stress in the weld and connections. The cassette design allows the cell-tab (2) to flex without any mechanical failure and stress points. Further, fewer processes are involved in creating stress relieving feature in a battery module, more specifically in the cassette design.

BRIEF DESCRIPTION OF DRAWINGS:

Figure-01 shows a front view of the cassette with cell-tabs connected to anode and cathode films inside the cell.

Figure-02 shows a cross section view of the cell-pouch showing stress relieving structure in the cassette acquiring a special shape to sustain external stresses.

Figure-03 shows an enlarged view of a portion of the cross section view of the cell-pouch of Figure-02.

Figure-04 shows the material details of the cell-pouch with stress relieving structure in the cassette.

Figure-05 shows the method of mounting of cell tab in stress relieving manner in the cassette.

STATEMENT OF INVENTION:

Accordingly the present invention discloses an improved cell cassette with inbuilt cell tab stress relieving structure comprising at least one cell cassette (1) having plurality of cell-tabs (2) connected to anode and cathode films inside the cell and a plate (6); at least one cell-pouch (3) configured to be accommodated in said cell cassette (1); at least one stress relieving structure (4) configured to be packaged in the cell cassette (1) with a predetermined profile is provided to support similar profile structure of cell tab (2) wherein the stress relieving structure (4) further provides the clamping force on a straight section of cell tab (2) to sustain external stresses.

The predetermined profile generated by a bend on the cell-tab (2) is configured to develop a stress concentration on the cell tab (2) provided to absorb the movement of the cell-pouch (3) by directing the deflection of the cell tab (2) in the bend. Also due to bend the stress is developed in the bend which increases the strength of the cell tab by providing good resistance to vibrations.

The predetermined profile generated by a bend on the cell-tab (2) is adapted to safeguards the welded joint (8) of current collector (7) and the cell-tabs (2) by allowing the cell-tab (2) to flex without any mechanical failure and stress points.

The profile generated by the bend on the cell-tab (2) is configured to provide stresses within the safe limit of the material of cell tab (2) by controlling the radius and the angular extent of the bend on the cell tab (2).

The cell-tabs (2) are configured to sustain any external stresses, such as the stress arising from vibrations. The cell-tabs (2) are configured to be connected to the respective current collectors (7) by ultrasonic welding (8).

The dimension of the bend with range (A) of 3.9 – 5.0 mm minimum to center. The dimension of the tab position of the bend is in a range (B) of 3.5 – 5.0 mm or at the center of cassette. The height of the relieving structure is in a range (C) of 5.0 – 10.0 mm on the basis of the necessary movement of relief needed. The tab bend radius is in a range 0.5 1.2 mm minimum inside bend radius and the tab thickness is approximately in a range of 0.1 - 0.3 mm.

DETAILED DESCRIPTION OF INVENTION:

Referring now to the drawings wherein the showings are for the purpose of illustrating a preferred embodiment of the invention only, and not for the purpose of limiting the same.

This invention relates to a new cassette design used for packing the cells in a battery module. Cell tabs (2) of the present invention, are configured to acquire a stress relieving structure (4) by packaging it in this specially designed cassette (1) without any stress points. In case of any external stresses like during vibration test, the special feature of the cassette (1) acts as a support to relieve stresses.

In accordance with the present invention, Figure 1 is a front view of the cassette (1) with the cell-tabs (2) connected to anode and cathode films inside the cell. Usually, a Cu or Ni coated Cu tab is used for anodes while an Aluminium or Ni coated Aluminum tab is used for cathodes. The current collector and the cell-tabs (2) are joined ultrasonic welding. Ultrasonic welding is widely being used to join Copper or Nickel coated Cu tab to Cu current collector and Aluminum or Nickel coated Aluminum current collectors to Aluminium tabs but its perforated pattern does not offer sufficient mechanical strength against external stresses such as vibrations. Hence in this invention, both the tabs are proposed to fit in a specially designed cassette in which tabs acquire special bend shape which resists the stresses.

Figure 2 shows the cross section view of the cell-pouch (3), viewed along the line A-A in Fig 1, the bend cell-tab (2) and the stress relieving structure (4) in the cassette (1) in which the cell-tab (2) acquires a special shape to sustain external stresses.

Figure 3 is the enlarged view (B). The stress relieving structure (4) incorporated in the cassette (1) and the special shape acquired by the cell-tabs (2) while fitting into the cassette (1). Each cassette contains similar structure for the other cell-tab.
Figure- 3 is also showing the dimensions of cell-pouch (3) with stress relieving structure in the cassette (1). Figure shows the bend with range (A) of 3.9 – 5.0 mm minimum to center, and the tab position range (B) is specified as 3.5 – 5.0 mm or center of cassette. Figure also shows the relieving structure height (C) as 5.0 – 10.0 mm depending on necessary movement of relief needed. The tab bend radius is 0.9 minimum inside bend radius. The tab thickness is a nominal thickness of 0.2 mm.

Figure 4 provides the material details of the cell-pouch (3) with stress relieving structure in the cassette (1). The cassette (1) normally comprises of PA66 33GF polished material at critical points is framed around a plate (6). The plate (6) comprises of Aluminium 1050 or 5052 with or without a 15μm thick anodized layer. The cell-pouch (3) comprises of outer layer of PET. The cell tab (2) comprises a Copper or Nickel plated Copper c, Nickel plated Aluminium , or Aluminium.

Figure-05 (5a, 5b and 5c) shows the method of manufacturing and mounting of the cell-tab (2) in stress relieving manner in the cassette (1). The stress concentration is created while bending the cell-tab (2). This stress concentration can be used for stress relieving purposes together with an applied clamping force on the straight section (5) of the cell-tab (2), below a bus-bar (not shown).

The clamping force ensures the straight section (5) of the cell-tab (2) containing the welded joint (8) to the bus-bar remains unaffected by the movement of the cell-pouch (3). The stress concentration created by the bend directs the deflection of the tab, ensuring the movement of the cell-pouch (3) is absorbed in the bend before the movement reaches the welded joint (8). By controlling the radius and the angular extent of the bend, the stress concentration can be

designed to give stresses within the safe limit of the material, ensuring a safe and reliable design.

This invention presents a cassette design to allow the cell-tabs (2) to acquire stress relieving structure which is of great importance for vibration resistance. In this design, the cell-tabs (2) acquire a special stress relieving structure (4) [ref: Figure 2] which provides vibration resistance and prevents the weld failure between the cell-tabs (2) and current collector (7). Such kind of vibration resistant packaging strategy is very important for transportation batteries. This invention also discusses the packaging strategy of curved tabs. A cassette design assembly process which excludes the extra efforts needed to create stress relieving structure in the tab. This design acts as a mould for the cell-tab (2) to acquire stress relieving structure when packaged. Tab support feature is in-built in the cassette.

The foregoing description is a specific embodiment of the present invention. It should be appreciated that this embodiment is described for purpose of illustration only, and that numerous alterations and modifications may be practiced by those skilled in the art without departing from the spirit and scope of the invention. It is intended that all such modifications and alterations be included insofar as they come within the scope of the invention as claimed or the equivalents thereof.

CLAIMS:

1. Improved cell cassette with inbuilt cell tab stress relieving structure comprising

at least one cell cassette (1) having plurality of cell-tabs (2) connected to anode and cathode films inside the cell and a plate (6);

at least one cell-pouch (3) configured to be accommodated in said cell cassette (1);

at least one stress relieving structure (4) configured to be packaged in the cell cassette (1) with a predetermined profile is provided to support similar profile structure of cell tab (2) wherein the stress relieving structure (4) further provides the clamping force on a straight section of cell tab (2) to sustain external stresses.

2. Improved cell cassette with inbuilt cell tab stress relieving structure as claimed in claim 1, wherein the predetermined profile generated by a bend on the cell-tab (2) is configured to develop a stress concentration on the cell tab (2) provided to absorb the movement of the cell-pouch (3) by directing the deflection of the cell tab (2) in the bend.

3. Improved cell cassette with inbuilt cell tab stress relieving structure as claimed in claim 1, wherein the predetermined profile generated by a bend on the cell-tab (2) is adapted to safeguards the welded joint (8) of current collector (7) and the cell-tabs (2) by allowing the cell-tab (2) to flex without any mechanical failure and stress points.

4. Improved cell cassette with inbuilt cell tab stress relieving structure as claimed in claim 1, wherein the profile generated by the bend on the cell-tab (2) is configured to provide stresses within the safe limit of the material of cell tab (2) by controlling the radius and the angular extent of the bend on the cell tab (2).

5. Improved cell cassette with inbuilt cell tab stress relieving structure as claimed in claim 1, wherein the cell-tabs (2) are configured to sustain any external stresses, such as the stress arising from vibrations.

6. Improved cell cassette with inbuilt cell tab stress relieving structure as claimed in claim 1, wherein the cell-tabs (2) are configured to be connected to the respective current collectors (7) by ultrasonic welding (8).

7. Improved cell cassette with inbuilt cell tab stress relieving structure as claimed in claim 1, wherein the dimension of the bend with range (A) of 3.9 – 5.0 mm minimum to center.

8. Improved cell cassette with inbuilt cell tab stress relieving structure as claimed in claim 1, wherein the dimension of the tab position of the bend is in a range (B) of 3.5 – 5.0 mm or at the center of cassette.

9. Improved cell cassette with inbuilt cell tab stress relieving structure as claimed in claim 1, wherein the height of the relieving structure is in a range (C) of 5.0 – 10.0 mm on the basis of the necessary movement of relief needed.

10. Improved cell cassette with inbuilt cell tab stress relieving structure as claimed in claim 1, wherein said the tab bend radius is in a range 0.5 1.2 mm minimum inside bend radius and the tab thickness is approximately in a range of 0.1 - 0.3 mm.

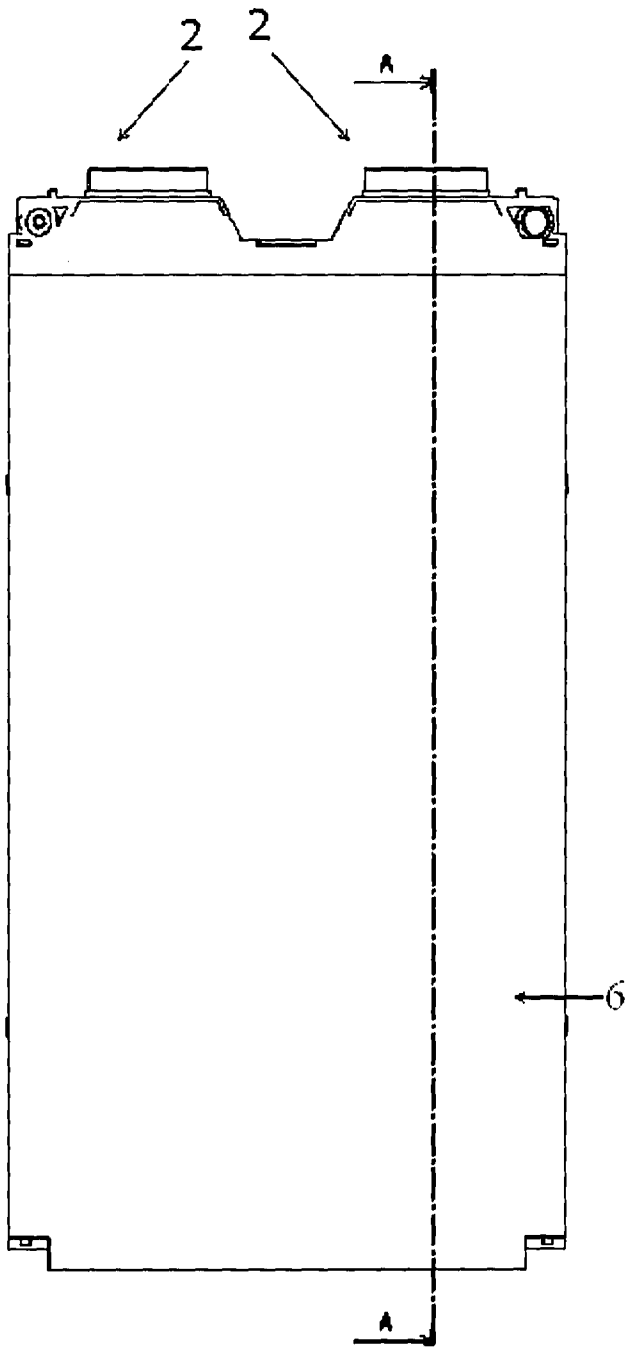


Figure 1

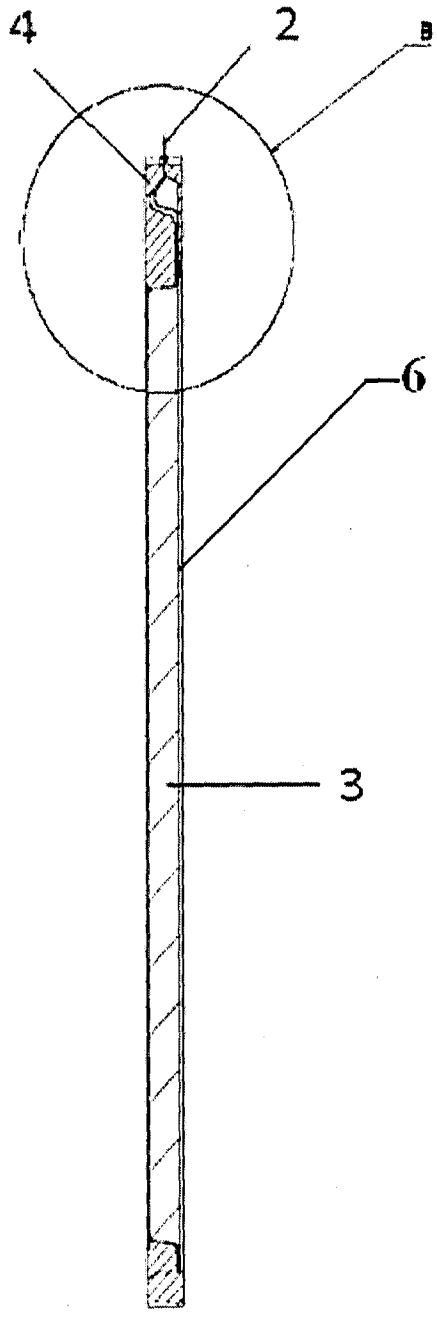


Figure 2

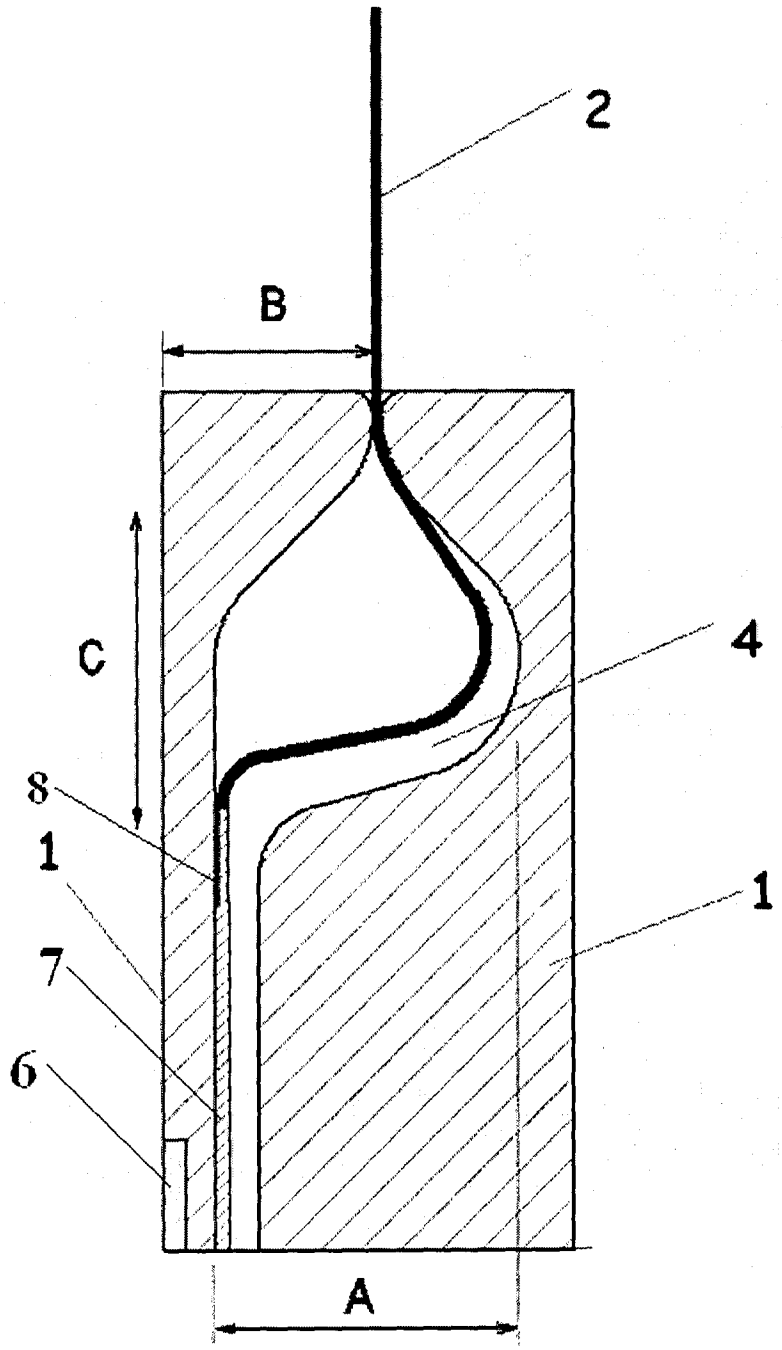


Figure 3

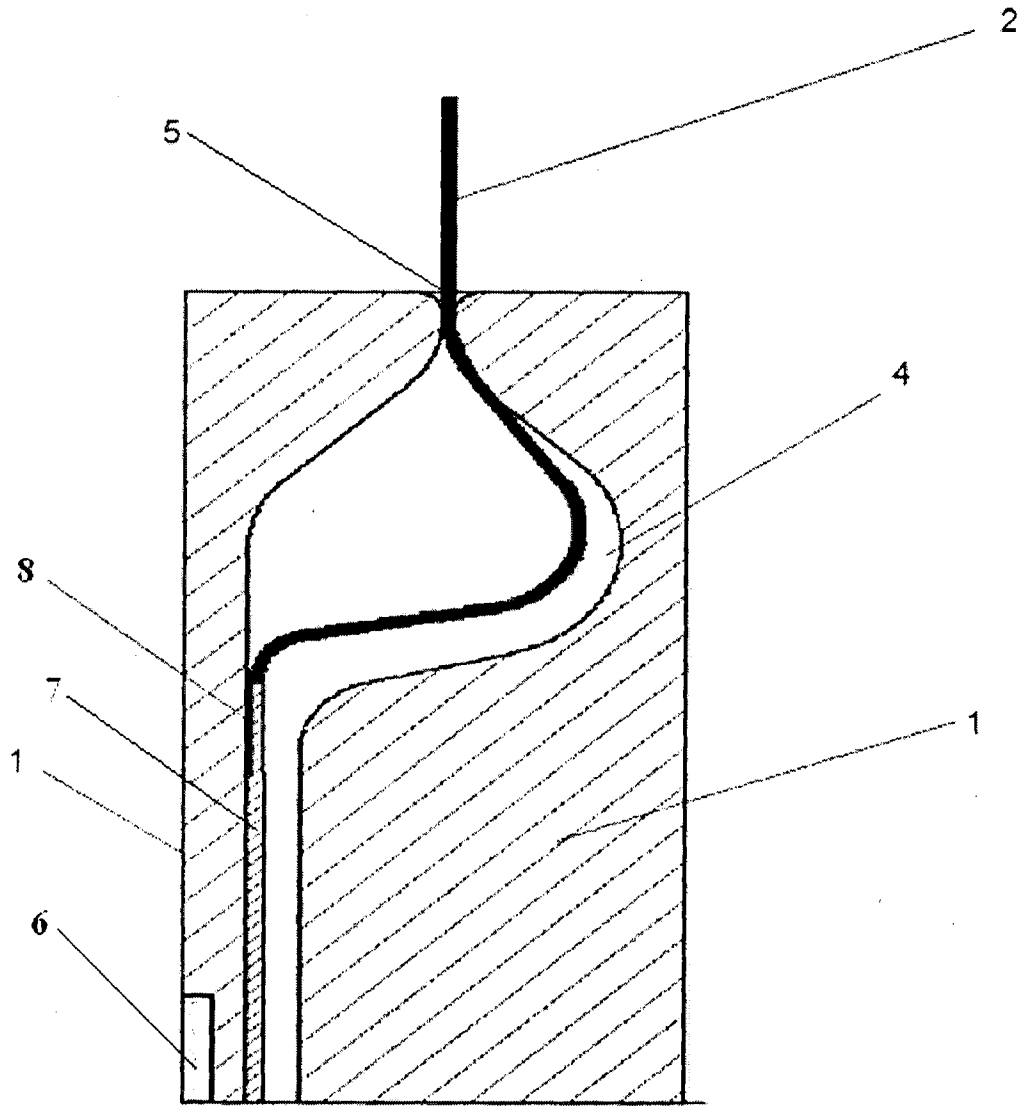
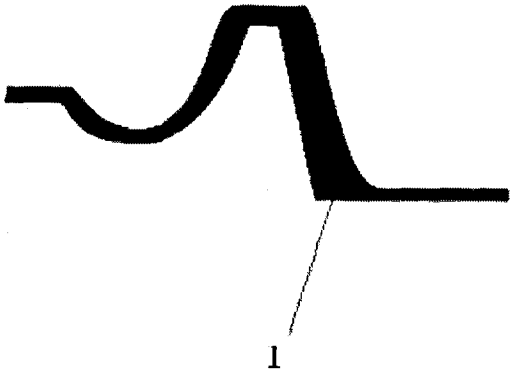
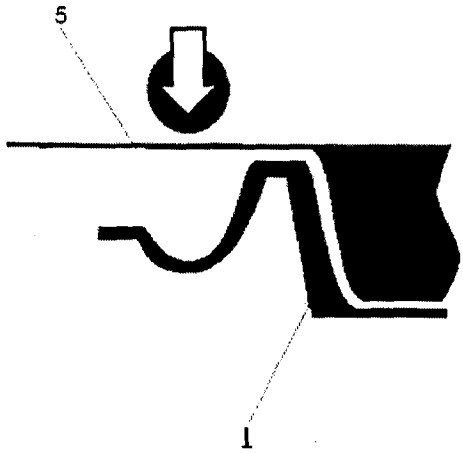


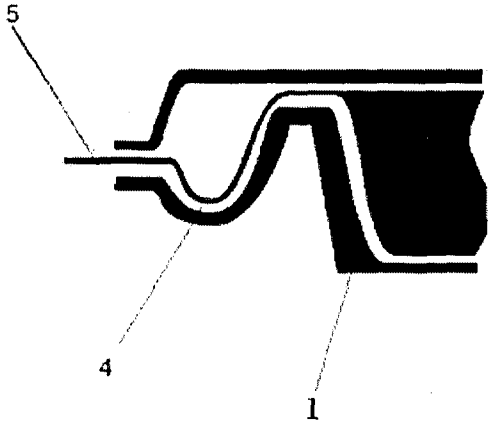
Figure 4



5(a)



5(b)



5 (c)

Figure 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/000064

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01M2/02 H01M2/26 H01M2/30 H01M10/04
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)
EPO-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 2009/197160 A1 (FUJIWARA MASAYUKI [JP] ET AL) 6 August 2009 (2009-08-06) the whole document	1-10
X	EP 2 006 935 A1 (NEC CORP [JP]) 24 December 2008 (2008-12-24) the whole document	1-10

☐ 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

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 May 2013	29/05/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Koessler, Jean-Luc

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2013/000064

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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