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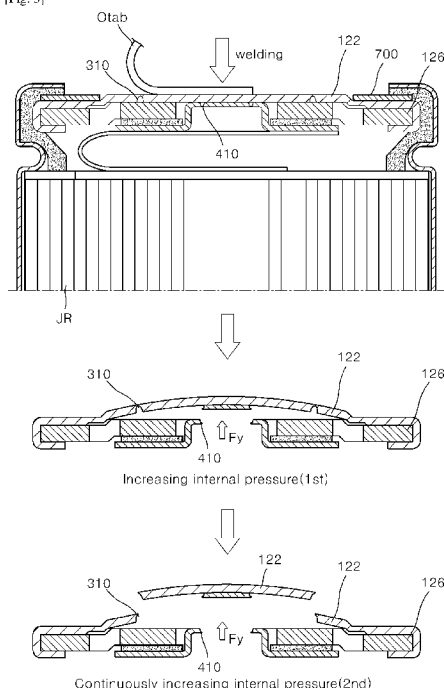
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(54) Title: CAP ASSEMBLY FOR SECONDARY BATTERY AND SECONDARY BATTERY INCLUDING THE CAP ASSEMBLY

[Fig. 3]



(57) Abstract: Disclosed are a cap assembly for a secondary battery and a secondary battery including the cap assembly. The cap assembly includes: a safety vent made of a circular metal plate and consisting of a central portion corresponding to the central area of the metal plate and a peripheral surrounding the central portion, the central portion including a current-carrying contact forming a first conductive path through which an electric current generated from a power generating device flows to the outside and a breakable junction forming a second conductive path at the center of the central portion; a cap-down opposite to the safety vent, having a central hole through which the breakable junction is exposed, and including a support member in close contact with the peripheral portion; and a sub-plate joined to the breakable junction and having a notch formed around the breakable junction, the outer circumferential surface of the sub-plate and the cap-down interposing an insulating layer therebetween. The cap assembly can be used to increase the capacity of the power generating device in the secondary battery compared to when used in other secondary batteries of the same size, minimizes the contact resistance between terminals, is constructed at reduced cost, and can protect a gasket disposed between a battery can and the safety vent from being melted or lost by energy or force generated upon external electrical shorting to prevent electrical shorting of the secondary battery.

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Description

Title of Invention: CAP ASSEMBLY FOR SECONDARY BATTERY AND SECONDARY BATTERY INCLUDING THE CAP ASSEMBLY

Technical Field

- [1] The present invention relates to a cap assembly for a secondary battery and a secondary battery including the cap assembly. More specifically, the present invention relates to a cap assembly for a secondary battery that is used to increase the capacity of a power generating device in the secondary battery compared to when used in other secondary batteries of the same size, does not undergo any deformation when a pack-tab is welded thereto, minimizes the contact resistance between terminals, is constructed at reduced cost, and can protect a gasket disposed between a battery can and a safety vent from being melted or lost by energy or force generated upon external electrical shorting to prevent electrical shorting of the secondary battery, and a secondary battery including the cap assembly.

[2]

Background Art

- [3] Secondary batteries are classified into cylindrical, prismatic, and pouch types depending on the shape of battery cases they employ. The cylindrical batteries include an electrode assembly accommodated in a cylindrical metal can. The prismatic batteries include an electrode assembly accommodated in a prismatic metal can. The pouch type batteries include an electrode assembly accommodated in a pouch type case made of an aluminum laminate sheet.
- [4] Electrode assemblies accommodated in battery cases are power generating devices capable of repeated charge/discharge cycles that have a cathode/separator/anode laminate structure. Electrode assemblies are classified into jelly-roll and stack types by their structure. The jelly-roll type structure is constructed by interposing a separator between an anode and a cathode, each of which is in the form of a long sheet coated with an active material, and winding the laminate in a roll form. The stack type structure is constructed by sequentially stacking a plurality of electrode units, each of which includes a cathode having a predetermined size, an anode having a predetermined size, and a separator interposed therebetween. The jelly-roll type electrode assemblies are most widely used in secondary batteries due to their ease of construction and high energy density per unit weight. The jelly-roll type electrode assemblies are usually employed in cylindrical batteries.
- [5] Secondary batteries employing jelly-roll type electrode assemblies are likely to

deform because the jelly-roll type electrode assemblies undergo repeated swelling and shrinkage during charge/discharge. This deformation may cause internal short circuits. Heat generated by internal short circuits decomposes organic solvents to produce gases. The gases increase the internal gas pressure of batteries to burst the batteries.

- [6] An increase in the internal gas pressure of batteries may take place also when internal short circuits are caused by an external impact.
- [7] Many attempts have been made to solve the safety problems of batteries. For example, known is a cap assembly for a cylindrical battery having a structure in which a safety vent, safety devices, and a top cap are fixed by a gasket. High-pressure gases are released through the safety vent. The safety devices include a PTC device adapted to interrupt the flow of electric current at high temperature and a current interrupt device (CID) adapted to interrupt the flow of electric current when the internal pressure of the battery increases. The top cap forms a protruding terminal adapted to protect the safety devices. Examples of such attempts are disclosed in many patent publications, for example, Japanese Patent Publication Nos. 2006-286561, 2005-100927, and 2002-373711 and Korean Patent Publication Nos. 2012-0103394 and 1999-67165. In each of the cap assemblies disclosed in these publications, the gasket serves to seal the interface between the can and the cap assembly while surrounding the outer circumferences of the safety devices, but the structure of the top cap limits the capacity of the power generating device, permits the release of a limited amount of gases when the safety vent ruptures, causes an increase in contact resistance, and increases in the construction cost of the cap assembly.
- [8] In a cylindrical secondary battery 100 illustrated in Fig. 9, a power generating jelly roll JR is accommodated in a battery can 110 such that a tab is connected to a sub-plate 128. This connection enables power supply through the battery can and a terminal of a cap-up 124. An open end (e) of the battery can is clamped to fix a cap assembly 120. A safety vent 122 of the cap assembly 120 is bent to surround the cap-up 124. Alternatively, the cap assembly may have a structure in which the safety vent is not bent and the cap-up is exposed to the top so as to be in direct contact with a gasket 130. When a module consisting of the secondary battery and one or more other secondary batteries is used in an electric vehicle or an energy storage system (ESS), energy or force generated by electrically shorting of the other secondary batteries or a power grid can melt or structurally weaken the gasket 130 interposed between the clamped battery can 110 and the cap-up 124 or the safety vent 122, and as a result, the battery can 110 comes into contact with the safety vent, causing short circuits. The short circuits increase the risk of leakage of an electrolyte from the secondary battery or safety accidents, such as explosion.

[9]

Disclosure of Invention

Technical Problem

- [10] A first object of the present invention is to provide a cap assembly for a secondary battery that is used to increase the capacity of a power generating device in the secondary battery compared to when used in other secondary batteries of the same size, does not undergo any deformation when a pack-tab is welded thereto, minimizes the contact resistance between terminals, is constructed at reduced cost, and can protect a gasket disposed between a battery can and a safety vent from being melted or lost by energy or force generated upon external electrical shorting to prevent electrical shorting of the secondary battery.
- [11] A second object of the present invention is to provide a secondary battery including a cap assembly that is used to increase the capacity of a power generating device in the secondary battery compared to when used in other secondary batteries of the same size, minimizes the contact resistance between terminals, is constructed at reduced cost, and can protect a gasket disposed between a battery can and a safety vent from being melted or lost by energy or force generated upon external electrical shorting to prevent electrical shorting of the secondary battery.

[12]

Solution to Problem

- [13] A first aspect of the present invention provides a cap assembly for a secondary battery including: a safety vent made of a circular metal plate and consisting of a central portion corresponding to the central area of the metal plate and a peripheral surrounding the central portion, the central portion including a current-carrying contact forming a first conductive path through which an electric current generated from a power generating device flows to the outside and a breakable junction forming a second conductive path at the center of the central portion; a cap-down opposite to the safety vent, having a central hole through which the breakable junction is exposed, and including a support member in close contact with the peripheral portion; and a sub-plate joined to the breakable junction and having a notch formed around the breakable junction, the outer circumferential surface of the sub-plate and the cap-down interposing an insulating layer therebetween.
- [14] According to one embodiment of the present invention, the safety vent may be bent downwardly and extend to form a bent portion.
- [15] According to a further embodiment of the present invention, the breakable junction may be welded to a protrusion of the sub-plate entering the central hole formed in the support member.
- [16] According to another embodiment of the present invention, the protrusion may

include a portion that protrudes upwardly opposite to the central portion and is opposite and melt-bonded to the breakable junction.

[17] According to another embodiment of the present invention, the notch may be formed in the shape of a long home on the outer circumference of the portion opposite to the breakable junction.

[18] According to another embodiment of the present invention, the protrusion may include a portion that protrudes upwardly opposite to the central portion and is opposite to and in close contact with the current-carrying contact.

[19] According to another embodiment of the present invention, the portion opposite to the current-carrying contact may be formed on the outer circumference of the notch.

[20] According to another embodiment of the present invention, a breakable notch may be formed at the bottom of the peripheral portion such that the safety vent is bent by a rupture pressure.

[21] According to another embodiment of the present invention, the cap assembly may further include a bending-relieving portion adjacent to the breakable notch to space the current-carrying contact from the cap-down and forming a space where a rupture pressure is applied to the breakable junction.

[22] According to another embodiment of the present invention, the bottom width of the bending-relieving portion may be larger than that of the breakable notch.

[23] According to another embodiment of the present invention, the cap-down may include a through-hole that is spaced apart from and formed around the central hole and through which internal gases and liquids pass.

[24] According to another embodiment of the present invention, the insulating layer may extend beyond the end of the sub-plate and may reach the end of the cap-down.

[25] According to another embodiment of the present invention, the insulating layer may have a through-hole opposite to the through-hole of the cap-down.

[26] According to another embodiment of the present invention, spacer bridges may be formed across the opposite through-hole.

[27] According to another embodiment of the present invention, a short-circuit preventing layer may be formed at a position opposite to the end of the battery can through a gasket of the safety vent.

[28] According to another embodiment of the present invention, the short-circuit preventing layer may include a polymeric or organic material that is resistant to heat at a temperature of 300 °C or more.

[29] According to another embodiment of the present invention, the short-circuit preventing layer may be an oxide or nitride film formed by surface treatment with high energy, such as a laser, after removal of a plating layer.

[30] According to another embodiment of the present invention, the short-circuit

preventing layer may be made of an anodized ring-shaped aluminum material.

[31] According to another embodiment of the present invention, the aluminum material may be melt-bonded to an adherend by soldering.

[32] According to another embodiment of the present invention, the cap-down and the sub-plate between which the insulating layer is interposed may have rough sides opposite to each other.

[33] A second aspect of the present invention provides a secondary battery including the cap assembly.

[34]

Advantageous Effects of Invention

[35] The cap assembly of the present invention can be used to increase the capacity of a power generating device in a secondary battery compared to when used in other secondary batteries of the same size, does not undergo any deformation when a pack-tab is welded thereto, minimizes the contact resistance between terminals, is constructed at reduced cost, and can protect a gasket disposed between a battery can and a safety vent from being melted or lost by energy or force generated upon external electrical shorting to prevent electrical shorting of the secondary battery.

[36]

Brief Description of Drawings

[37] Fig. 1 is a plan view illustrating a cap assembly of the present invention.

[38] Fig. 2 is a cross-sectional view of the cap assembly of Fig. 1.

[39] Fig. 3 is a cross-sectional view illustrating a state in which a pack-tab (Otab) is welded to a secondary battery fabricated by assembly of a cap assembly according to the present invention and a battery can.

[40] Fig. 4 is a cross-sectional view illustrating states in which a safety vent of a cap assembly according to the present invention is deformed at operating and rupture pressures.

[41] Fig. 5 is a cross-sectional view illustrating a state in which an electrode tab attached to a sub-plate of a cap assembly according to the present invention is deformed in a battery can and is in close contact with a cap-down through an insulating layer interposed therebetween.

[42] Fig. 6 is a detailed plan view of the insulating layer of Fig. 5.

[43] Fig. 7 is a cross-sectional view illustrating a state in which a safety vent and a cap-down of a cap assembly according to the present invention are assembled together without the need for forging.

[44] Fig. 8 is a cross-sectional view illustrating a state in which a safety vent and a cap-down of a cap assembly according to the present invention are assembled together

without the need for forging.

- [45] Fig. 9 is a cross-sectional view of a secondary battery mounted with a conventional cap assembly and illustrates a state in which the end of a battery is in contact with a safety vent as a result of melting or damage of a gasket by thermal energy generated in an external circuit or load and a state in which a cap-down is in contact with the safety vent as a result of melt-bonding of an insulating layer.

[46]

Best Mode for Carrying out the Invention

- [47] The present invention will now be described in more detail.

- [48] Technical terms used in this specification are used to merely illustrate specific embodiments, and should be understood that they are not intended to limit the present disclosure.

- [49] As far as not being defined differently, all terms used herein including technical or scientific terms may have the same meaning as those generally understood by an ordinary person skilled in the art to which the present disclosure belongs to, and should not be construed in an excessively comprehensive meaning or an excessively restricted meaning.

- [50] In addition, if a technical term used in the description of the present disclosure is an erroneous term that fails to clearly express the idea of the present disclosure, it should be replaced by a technical term that can be properly understood by the skilled person in the art. In addition, general terms used in the description of the present disclosure should be construed according to definitions in dictionaries or according to its front or rear context, and should not be construed to have an excessively restrained meaning. A singular representation may include a plural representation as far as it represents a definitely different meaning from the context. Terms "include" or "has" used herein should be understood that they are intended to indicate an existence of several components or several steps, disclosed in the specification, and it may also be understood that part of the components or steps may not be included or additional components or steps may further be included. In the description of the present invention, detailed explanations of related art are omitted when it is deemed that they may unnecessarily obscure the essence of the invention. In the accompanying drawings, those components are rendered the same reference numeral that are the same or are in correspondence, regardless of the figure number, and redundant explanations are omitted.

- [51] Fig. 1 is a plan view illustrating a cap assembly of the present invention, Fig. 2 is a cross-sectional view of the cap assembly of Fig. 1, Fig. 3 is a cross-sectional view illustrating a state in which a pack-tab (Otab) is welded to a secondary battery fabricated

by assembly of a cap assembly according to the present invention and a battery can, Fig. 4 is a cross-sectional view illustrating states in which a safety vent of a cap assembly according to the present invention is deformed at operating and rupture pressures, Fig. 5 is a cross-sectional view illustrating a state in which an electrode tab attached to a sub-plate of a cap assembly according to the present invention is deformed in a battery can and is in close contact with a cap-down through an insulating layer interposed therebetween, Fig. 6 is a detailed plan view of the insulating layer of Fig. 5, and Fig. 7 is a cross-sectional view illustrating a state in which a safety vent and a cap-down of a cap assembly according to the present invention are assembled together without the need for forging.

[52] A cap assembly 120 for a secondary battery according to the present invention includes: a safety vent 122 made of a circular metal plate and consisting of a central portion 200 corresponding to the central area of the metal plate and a peripheral portion 300 surrounding the central portion, the central portion including a current-carrying contact 210 forming a first conductive path through which an electric current generated from a power generating device JR flows to the outside and a breakable junction 220 forming a second conductive path at the center of the central portion; a cap-down 126 opposite to the safety vent, having a central hole 510 through which the breakable junction is exposed, and including a support member 500 in close contact with the peripheral portion; and a sub-plate 400 joined to the breakable junction and having a notch 410 formed around the breakable junction, the outer circumferential surface of the sub-plate and the cap-down interposing an insulating layer 600 therebetween.

[53] The current-carrying contact 210 in the central portion 200 functions to reduce the contact resistance due to the formation of the conductive path and imparts a support force against a pressure applied when a pack-tab is attached to the cap assembly. The breakable junction 220 included in the central portion 200 may be welded to a protrusion 420 of the sub-plate entering the central hole 510 formed in the central portion surrounded by the support member. The welding may be performed by various bonding processes. Preferably, laser welding or melt-bonding is used such that the welded portion is not detached even under high internal pressures (for example, 1st pressure and 2nd pressure) generated upon abnormal operation of the secondary battery.

[54] That is to say, the protrusion 420 of the sub-plate 400 protrudes upward opposite to the central portion 200. Specifically, the protrusion 420 enters the central hole 510 and is welded to the breakable junction 220. For the prevention of short circuits, the protrusion 420 and the central hole should be spaced apart from each other such that they do not come into contact and in electrical communication with each other.

- [55] Furthermore, the insulating layer 600 has a central hole 620 opposite to the central hole 510 and through which the central portion 200 is exposed and a standing portion 625 in the form of a barrier protruding along the circumference of the central hole 620. Due to this structure, the risk of short circuits between the protrusion 420 of the sub-plate and the central hole 510 during assembly can be completely avoided.
- [56] The support member 500 of the cap-down 126 is opposite to and in close contact with the peripheral portion 300 of the safety vent 122. This arrangement reduces the contact resistance when power is applied from the power generating device JR to the outside, ensuring good current-carrying properties. In addition, the support member 500 serves to prevent the cap assembly from being deformed caused by an excessive load or pressure during welding of a pack-tab (Otab) to a package module in which the battery is connected in series or parallel with one or more other batteries.
- [57] Furthermore, the protrusion 420 is in close contact with and supports the central portion 200 over a large area. This arrangement is advantageous in preventing the cap assembly from being deformed when a pack-tab is welded to the secondary battery. Thus, the protrusion 420 is designed to have a portion 220' opposite and welded to the breakable junction 220 and a portion 210' opposite to the current-carrying contact around the circumference of the portion 220'. The portion 210' is formed in close contact with the current-carrying contact other than the notch 410 in the form of a recessed long home that is broken by high pressures upon abnormal operation of the secondary battery and permits the release of internal gases into the outside. Due to this design, a support force by the portion 210' is ensured and the conductive paths can be maintained, which is beneficial in terms of current-carrying properties.
- [58] The cap-down 126 includes a through-hole 530 spaced apart from but adjacent to the central hole 510 and through which internal gases and liquids are released into the outside. The through-hole 530 is filled with high-pressure gases, liquids, and a flowable electrolyte upon abnormal operation of the secondary battery, and as a result, operating and rupture pressures are applied to the safety vent 122 therethrough.
- [59] Here, the operating pressure refers to a 1st pressure at which the contact and junction between the current-carrying contact 210 of the safety vent and the portion 210' opposite thereto and between the breakable junction 220 of the safety vent and the portion 220' opposite thereto are released to block the application of power to the outside. The rupture pressure refers to a 2nd pressure at which the safety vent 122 ruptures so that the internal gases leak out before explosion of the secondary battery.
- [60] Accordingly, it is necessary for the operating pressure to be smaller than the rupture pressure. The operating pressure is designed to be much larger than the rupture pressure. For example, the operating pressure and the rupture pressure may be adjusted to about 16 kgf/cm² and about 30 kgf/cm², respectively, to clearly distinguish the

operation and rupture of the cap assembly. The structural behaviors of such operation and rupture will be discussed in detail. The internal pressure of the secondary battery increases continuously upon internal abnormal operation of the secondary battery. By the operating pressure, the current-carrying contact 210 is detached from the portion 210' opposite thereto and the breakable junction 220 is detached from the portion 220' opposite thereto. A flowable electrolyte, liquids, and gases passes through the through-hole 530 of the support member to increase the internal pressure and directly lifts the safety vent 122 because the breakable junction is welded to the protrusion 420. A vertical force (F_y) to detach the breakable junction in the upward and downward directions and a horizontal force (F_x) in the horizontal direction are effective in providing a force (F) to break the portion 220' opposite to the breakable junction. By the rupture force (F), the notch 410 is broken to interrupt the flow of electric current in the secondary battery.

[61] That is, the detachment of the current-carrying contact and the breakage of the breakable junction can be accomplished by a combination of the vertical force (F_y) and the horizontal force (F_x).

[62] Even after the notch 410 is broken by the operating pressure to interrupt the flow of electric current, the 2nd pressure of the secondary battery may increase continuously. Since the increasing 2nd pressure increases the danger of explosion, it is necessary to reduce the internal pressure beforehand by the removal of internal gases and liquids (outgasing).

[63] To this end, a breakable notch 310 in the form of a long home is formed in the peripheral portion of the safety vent. The breakable notch 310 is designed to be broken by the internal pressure of the secondary battery. The safety vent is in close contact with the cap-down, making it difficult to bend or break the breakable notch 310. Thus, a bending-relieving portion 320 in the shape of a long home or groove is formed adjacent to the breakable notch 310. Due to its shape, the bending-relieving portion 320 can vary the bending angle (θ) of the breakable notch, enabling efficient breakage of the breakable notch. The bending-relieving portion is designed to have a bottom area (G) larger than that (N) of the breakable notch. This design is advantageous in varying the bending angle (θ) of the breakable notch to freely form a space between the bending-relieving portion and the cap-down opposite thereto, thus being effective in deforming or breaking the breakable notch.

[64] The breakable notch 310 and the bending-relieving portion 320 may be arranged concentrically around the center of the central portion on the bottom of the peripheral portion of the safety vent. The internal pressure increases continuously even after interruption of the flow of electric current by the 1st pressure and reaches the 2nd pressure at which the breakable notch is broken, and as a result, the secondary battery can be

protected from explosion.

- [65] The safety vent 122 may be bent downwardly and extend to form a bent portion 1221 that surrounds the cap-down 126. The formation of the bent portion is beneficial in ensuring adhesion of the safety vent 122 to the cap-down 126. The extension length of the bent portion on the bottom of the cap-down is limited to increase the power generation capacity of the secondary battery.
- [66] The power generating device JR is a device that produces electrical energy through chemical reactions. For example, in the case of a secondary lithium-ion battery, the power generating device JR may be a jelly-roll type electrode assembly including an anode material, a cathode material, an electrolyte, and a center pin. One of the electrodes is in electrical communication with the cap assembly 120 through an electrode tab. Power generated in the electrode assembly is supplied to an external circuit or load through the electrode tab.
- [67] The insulating layer 600 extends beyond the end of the sub-plate 400 and reaches the end of the cap-down. Thus, the insulating layer 600 precludes an extension of the electrode tab other than the portion welded to the sub-plate 400 from being bent up toward the cap assembly 120 and coming into contact with the cap-down 126 to prevent the occurrence of electrical shorting during fabrication of the secondary battery and use in an application.
- [68] The insulating layer 600 is interposed between and insulates the cap-down and the sub-plate and can prevent the electrode tab from being in electrical communication with the cap-down. However, the insulating layer 600 may impede the flow of gases through the through-hole 530, which is solved by the arrangement of a through-hole 610 at a position opposite to the through-hole 530. Spacer bridges 612 extend across the opposite through-hole to space the electrode tab from the cap-down. The spacer bridges can be understood as bar-type bridges traversing the opposite through-hole.
- [69] As explained previously, the central hole 620 of the insulating layer 600 is formed opposite to the central hole 510 such that the central portion 200 is exposed. The sub-plate 400 is insertable into the insulating layer 600 through the central hole 620. The standing portion 625 in the form of a barrier protrudes along the circumference of the central hole 620 to prevent short circuits.
- [70] For better attachment and adhesion of the insulating layer 600 between the cap-down 126 and the sub-plate 400, the cap-down and the sub-plate have long homes 1265 and 4005 in the form of depressions or grooves at sides opposite to each other, respectively. The insulating layer is interposed between the cap-down and the sub-plate, followed by pressing or thermal pressing to form a filling portion 615 in which the insulating layer is filled in the long homes.
- [71] A gasket 130 is disposed between the battery can 110 and the safety vent 122. The

gasket 130 should be protected from being melted or lost by the application of energy or force generated upon external electrical shorting to prevent electrical shorting of the secondary battery. To this end, a short-circuit preventing layer 700 can be interposed between the safety vent and a gasket 130 at a position opposite to the end of the battery can.

- [72] Any insulating material may be used without particular limitation for the short-circuit preventing layer 700. For example, the short-circuit preventing layer may be made of a metallic, nonferrous metallic or non-metallic material. The surface of the short-circuit preventing layer made of a metallic or nonferrous metallic material is preferably insulated.
- [73] The material for the insulating layer is insulated by wet or dry physical or chemical process in such a manner that the surface chemical composition is changed to increase insulating properties. For example, aluminum is a current-carrying material but its insulating properties increase when an oxide layer is formed on the surface. An oxide film is formed on the surface of a metallic or nonferrous metallic material, for example, by dipping in an acidic or basic solution, electrolysis, anodizing or laser irradiation.
- [74] Particularly, a dry process by laser irradiation may have difficulty in processing the insulating layer or film whose surface is plated. In this case, after removal of the plating layer, high-energy laser beams are irradiated to form an oxide or nitride film on the surface of the insulating layer or film, achieving good insulating properties.
- [75] Alternatively, the short-circuit preventing layer 700 may be formed using a polymeric material. Since the short-circuit preventing layer 700 is required to have a sufficient physical support force in a high-temperature environment where the gasket 130 is melted or structurally weakened by thermal energy or force generated upon external short circuits, the material for the short-circuit preventing layer 700 should be resistant to heat at a temperature of 300 °C or more. However, the material is not particularly limited so long as its physical properties are maintained at a temperature of 300 °C or more.
- [76] The short-circuit preventing layer 700 may include an inorganic material. For example, the short-circuit preventing layer may be formed using an inorganic material or may be an insulating layer whose surface is coated with an inorganic material, for example, a powder of inorganic particles, to form an inorganic layer (not shown).
- [77] The short-circuit preventing layer 700 may take the form of a ring made of an oxidized or anodized metallic or nonferrous metallic material, for example, an aluminum material. The insulating layer acts as a kind of spacer that maintains the interval between the end (e) of the battery can and the safety vent 122 to prevent short circuits. The short-circuit preventing layer 700 may be provided in plurality. In this

case, the number of the short-circuit preventing layers is not limited so long as they are arranged between the end (e) of the battery can and the safety vent 122. It is beneficial from the viewpoint of production processability that the short-circuit preventing layer 700 is in the form of a ring. The short-circuit preventing layer 700 may be fixed to the safety vent 122 by soldering.

- [78] On the other hand, the present invention provides a secondary battery including the cap assembly. The secondary battery of the present invention may be fabricated by assembling an anode material, a cathode material, an electrolyte, a center pin, a jelly roll, etc. together in a battery can and aligning the cap assembly at the open end of the battery can (clamping). The fabrication method of the secondary battery is generally known in the art and detailed description thereof is thus omitted.

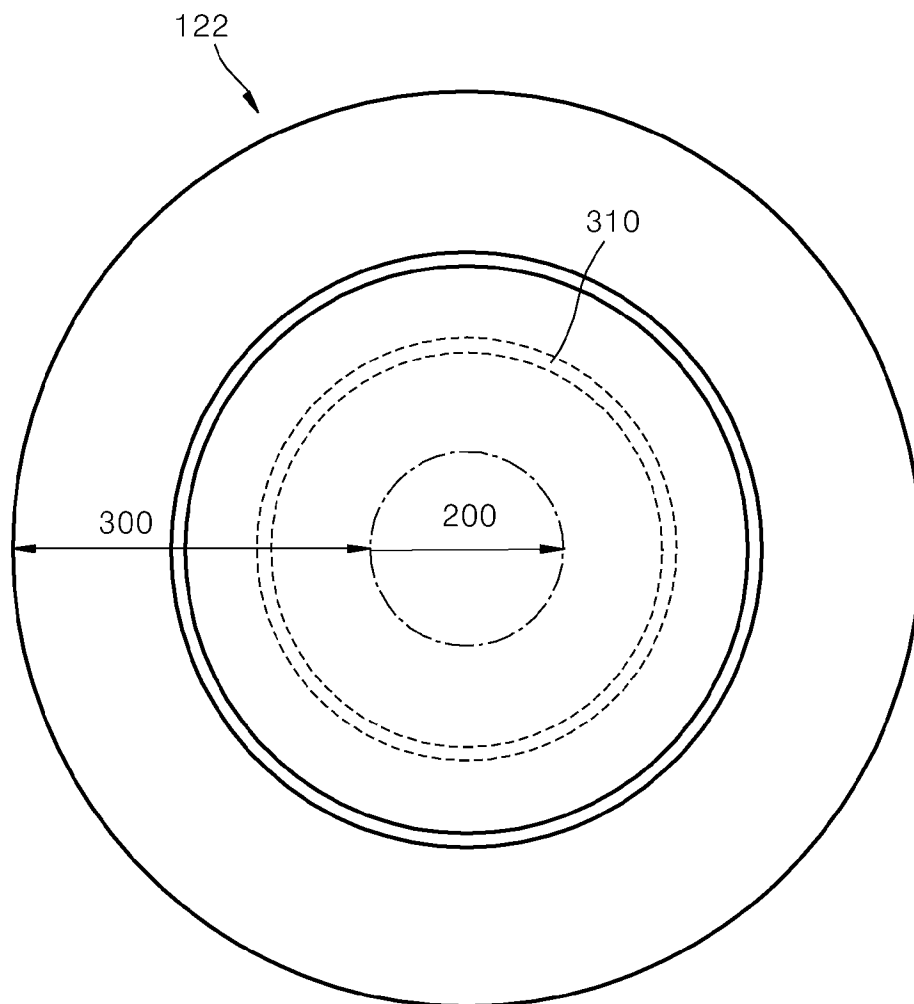
Claims

- [Claim 1] A cap assembly for a secondary battery comprising: a safety vent made of a circular metal plate and consisting of a central portion corresponding to the central area of the metal plate and a peripheral surrounding the central portion, the central portion comprising a current-carrying contact forming a first conductive path through which an electric current generated from a power generating device flows to the outside and a breakable junction forming a second conductive path at the center of the central portion; a cap-down opposite to the safety vent, having a central hole through which the breakable junction is exposed, and comprising a support member in close contact with the peripheral portion; and a sub-plate joined to the breakable junction and having a notch formed around the breakable junction, the outer circumferential surface of the sub-plate and the cap-down interposing an insulating layer therebetween.
- [Claim 2] The cap assembly according to claim 1, wherein the safety vent is bent downwardly and extends to form a bent portion.
- [Claim 3] The cap assembly according to claim 1, wherein the breakable junction is welded to a protrusion of the sub-plate entering the central hole formed in the support member.
- [Claim 4] The cap assembly according to claim 3, wherein the protrusion comprises a portion that protrudes upwardly opposite to the central portion and is opposite and melt-bonded to the breakable junction.
- [Claim 5] The cap assembly according to claim 4, wherein the notch is formed in the shape of a long home on the outer circumference of the portion opposite to the breakable junction.
- [Claim 6] The cap assembly according to claim 3, wherein the protrusion comprises a portion that protrudes upwardly opposite to the central portion and is opposite to and in close contact with the current-carrying contact.
- [Claim 7] The cap assembly according to claim 6, wherein the portion opposite to the current-carrying contact is formed on the outer circumference of the notch.
- [Claim 8] The cap assembly according to claim 1, wherein a breakable notch is formed at the bottom of the peripheral portion such that the safety vent is bent by a rupture pressure.
- [Claim 9] The cap assembly according to claim 8, further comprising a bending-

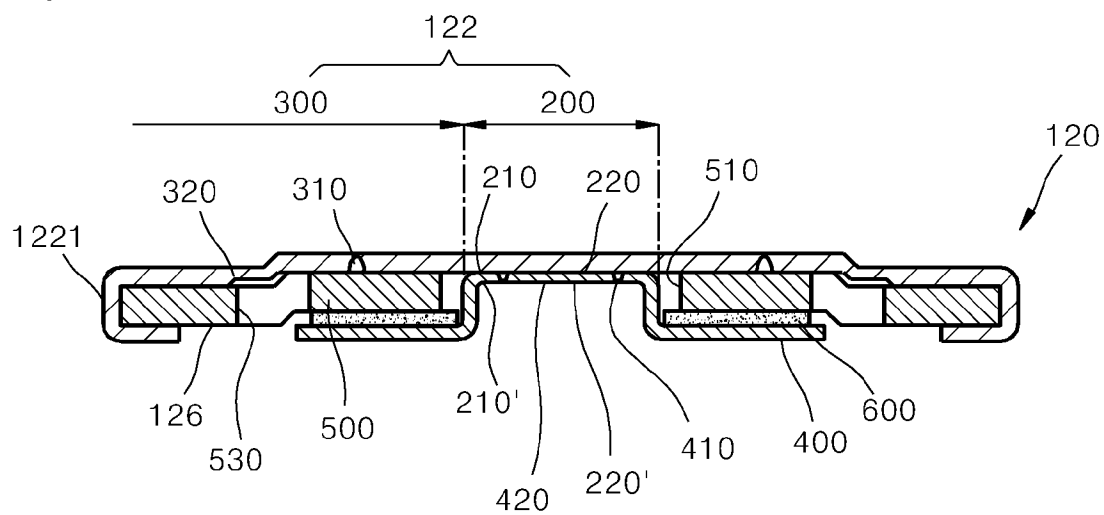
relieving portion adjacent to the breakable notch to space the current-carrying contact from the cap-down and forming a space where a rupture pressure is applied to the breakable junction.

- [Claim 10] The cap assembly according to claim 9, wherein the bottom width of the bending-relieving portion is larger than that of the breakable notch.
- [Claim 11] The cap assembly according to claim 1, wherein the cap-down comprises a through-hole that is spaced apart from and formed around the central hole and through which internal gases and liquids pass.
- [Claim 12] The cap assembly according to claim 1, wherein the insulating layer extends beyond the end of the sub-plate and reaches the end of the cap-down.
- [Claim 13] The cap assembly according to claim 12, wherein the insulating layer has a through-hole opposite to the through-hole of the cap-down.
- [Claim 14] The cap assembly according to claim 13, wherein spacer bridges are formed across the opposite through-hole.
- [Claim 15] The cap assembly according to claim 1, wherein a short-circuit preventing layer is formed at a position opposite to the end of the battery can through a gasket of the safety vent.
- [Claim 16] A secondary battery comprising the cap assembly according to any one of claims 1 to 15.

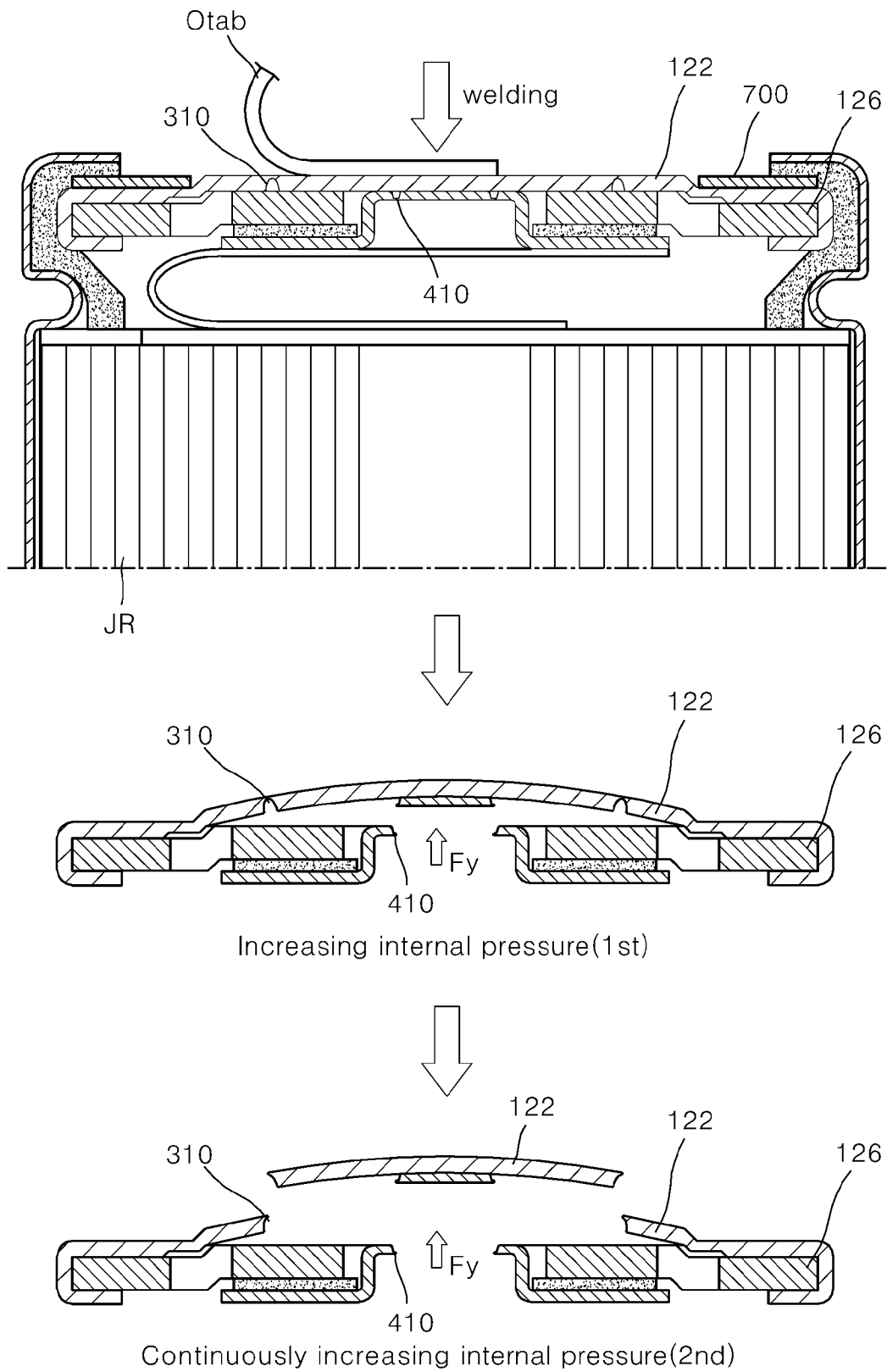
[Fig. 1]



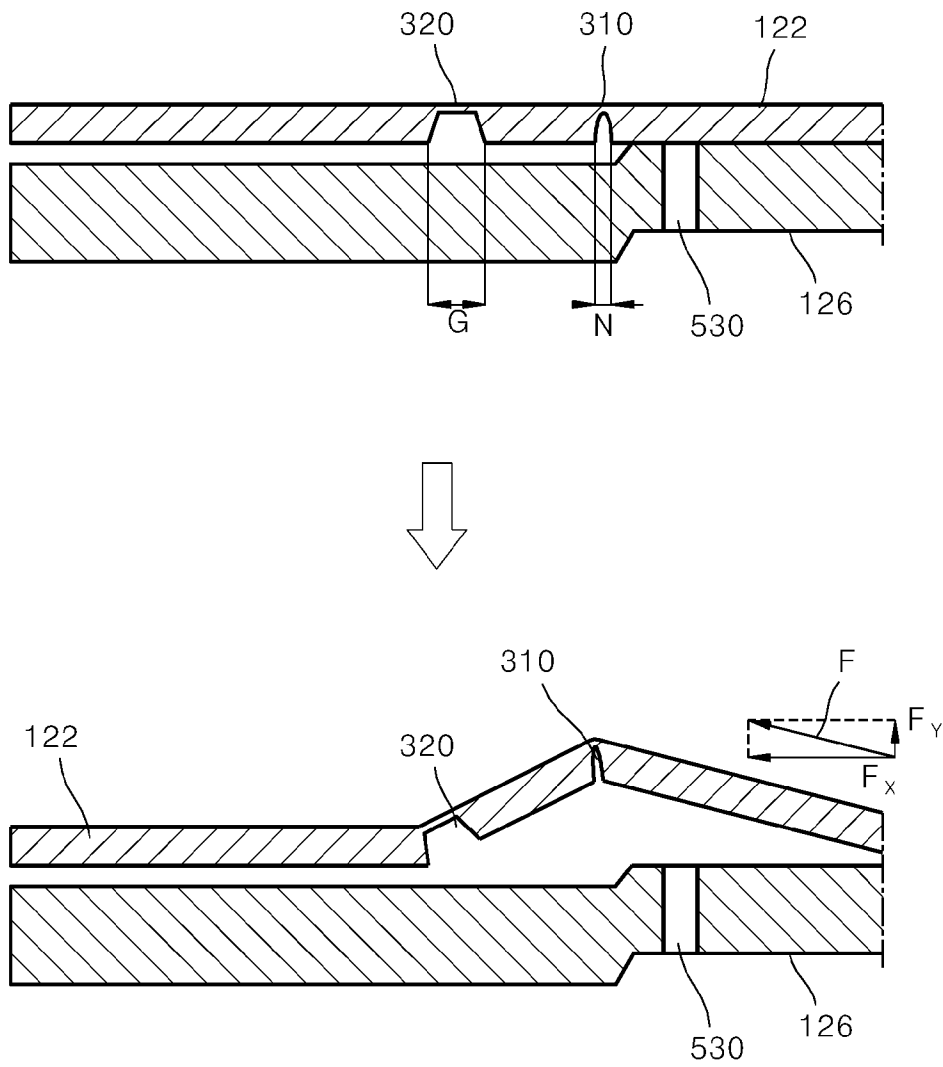
[Fig. 2]



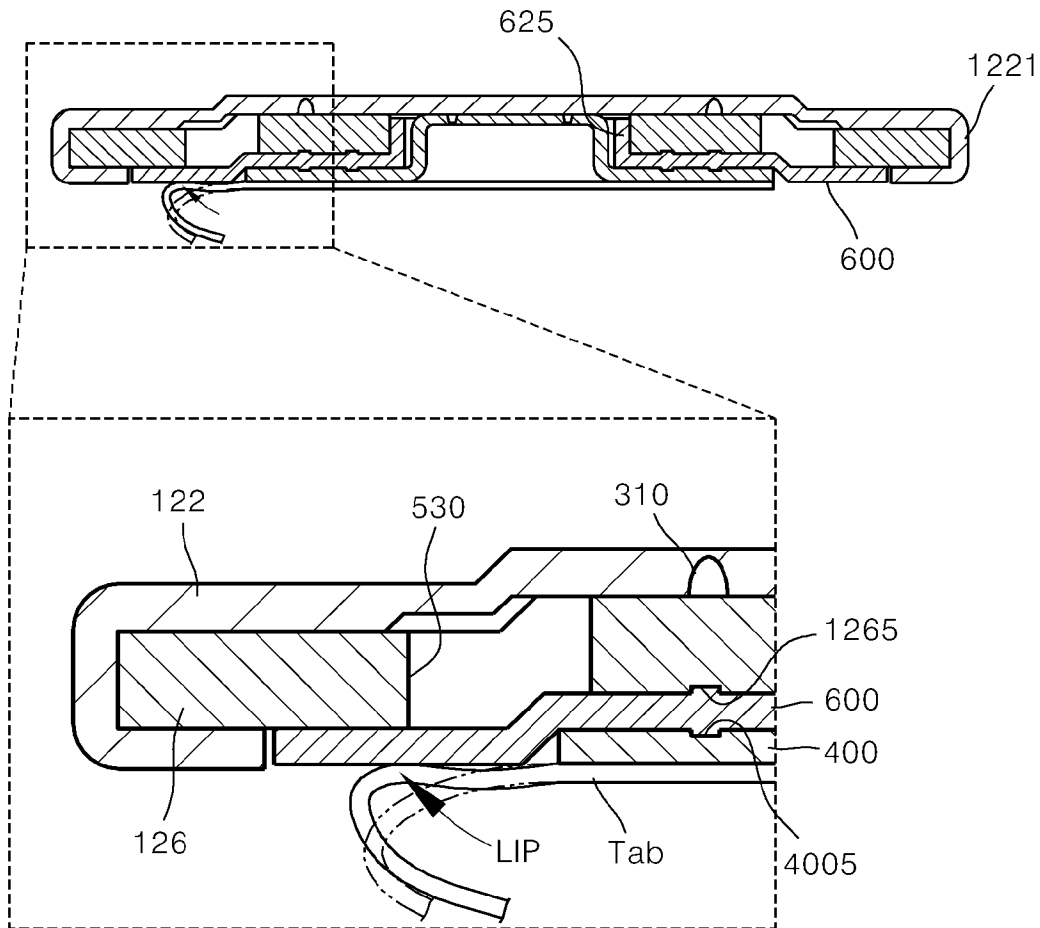
[Fig. 3]



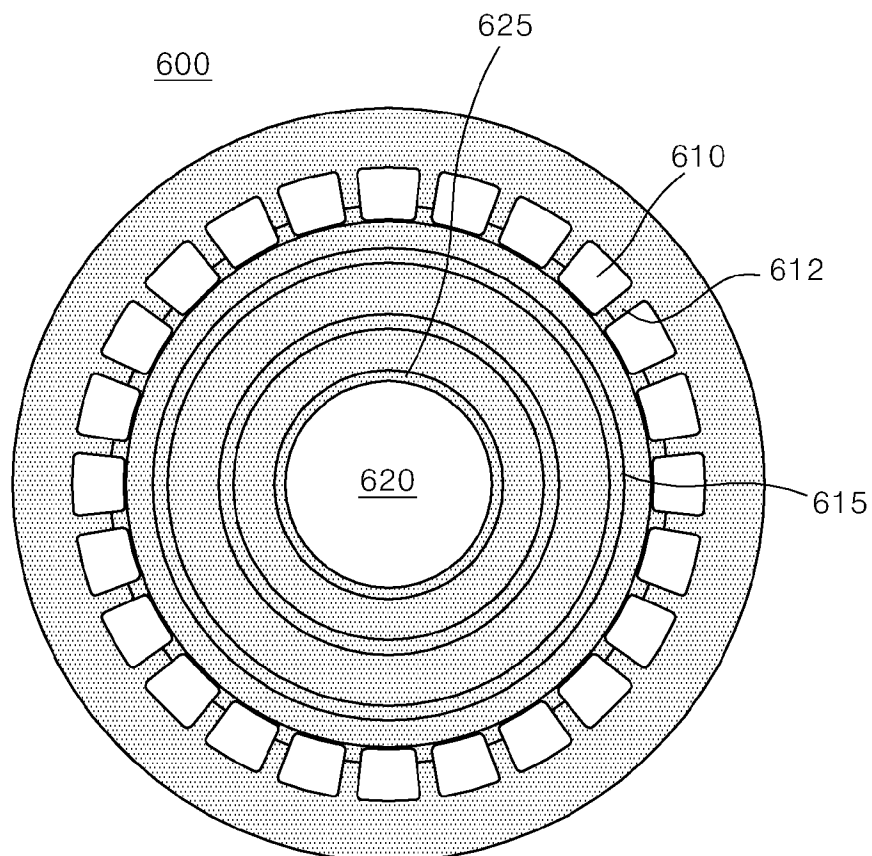
[Fig. 4]



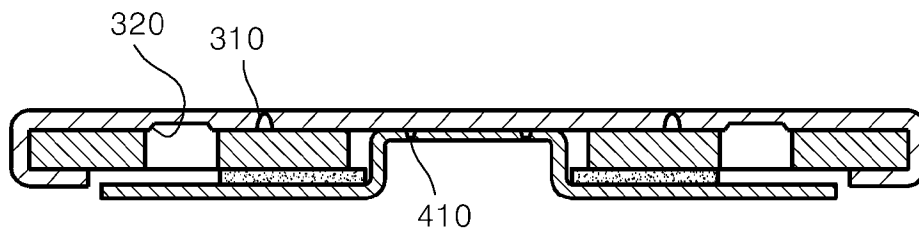
[Fig. 5]



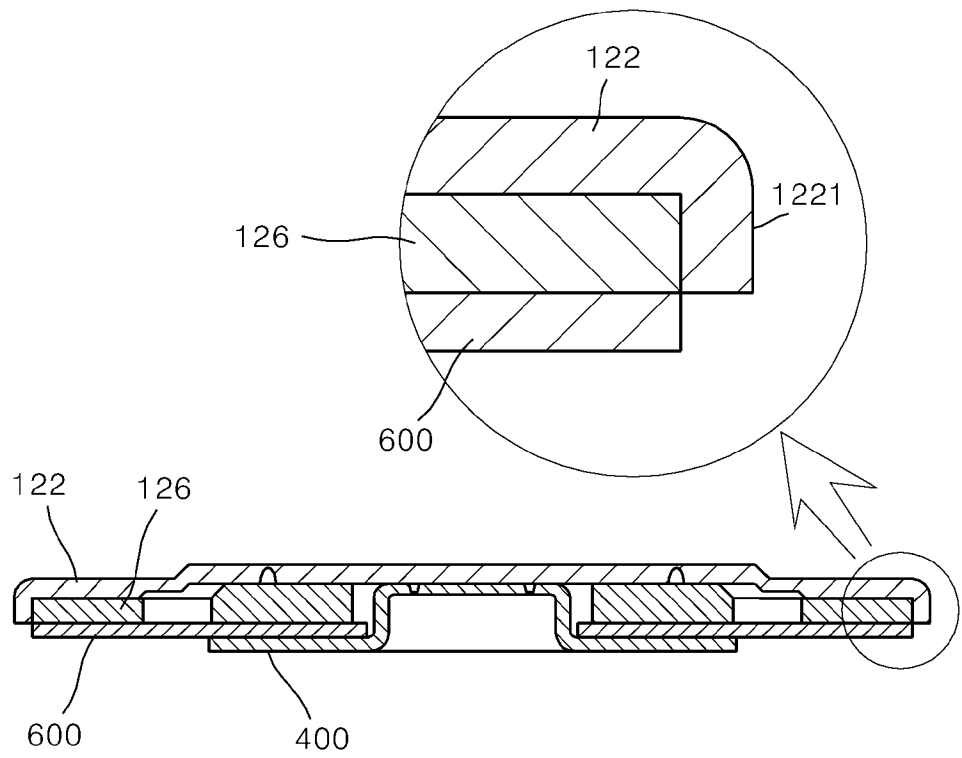
[Fig. 6]



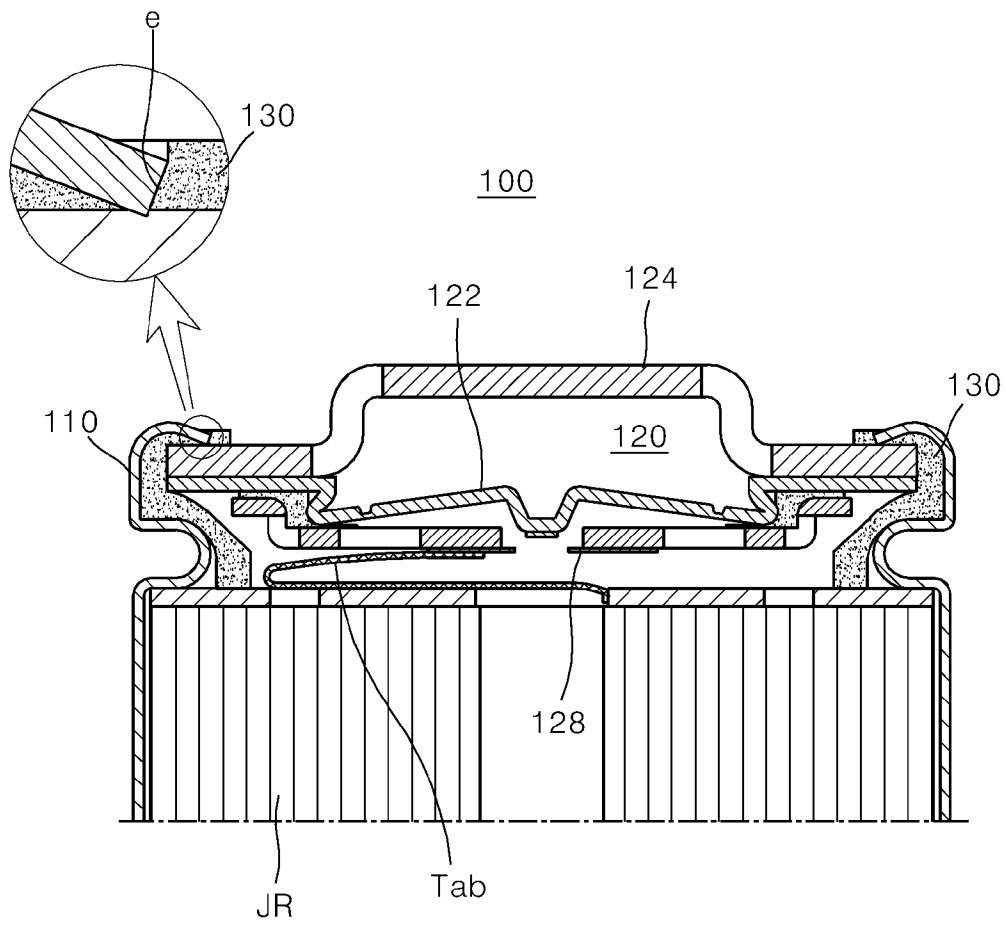
[Fig. 7]



[Fig. 8]



[Fig. 9]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2017/008736**A. CLASSIFICATION OF SUBJECT MATTER****H01M 2/04(2006.01)i, H01M 2/12(2006.01)i, H01M 10/04(2006.01)i**

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 2/04; H01M 2/12; H01M 2/08; H01M 2/34; H01M 2/20; H01M 2/26; H01M 2/10; H01M 2/02; H01M 10/04

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & keywords: cap assembly, secondary battery, safety bent, shorting, notch

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2016-0034794 A (SHIN HEUNG ENERGY & ELECTRONIC CO., LTD.) 30 March 2016 See figures 1-7; and claims 1-2.	1-16
A	US 2011-0206958 A1 (KIYAMA, A. et al.) 25 August 2011 See the entire document.	1-16
A	JP 2005-100927 A (MATSUSHITA ELECTRIC INDUSTRY CO., LTD.) 14 April 2005 See the entire document.	1-16
A	KR 10-2010-0062886 A (SAMSUNG SDI CO., LTD.) 10 June 2010 See the entire document.	1-16
A	KR 10-2006-0065378 A (LG CHEM, LTD.) 14 June 2006 See the entire document.	1-16



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

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Date of mailing of the international search report

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Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea

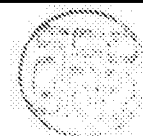


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International application No.

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