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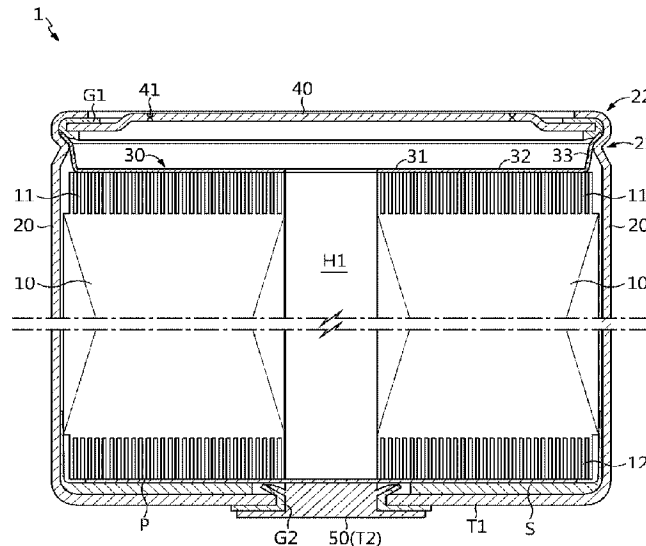
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(54) **Titre : BATTERIE, COLLECTEUR DE COURANT APPLIQUE A CELLE-CI, ET BLOC-BATTERIE ET AUTOMOBILE  
 COMPRENANT CETTE BATTERIE**  
 (54) **Title: BATTERY AND CURRENT COLLECTOR APPLIED THERETO, AND BATTERY PACK AND VEHICLE INCLUDING THE  
 BATTERY**

FIG. 1a



(57) **Abrégé/Abstract:**

A battery according to an embodiment of the present disclosure includes: an electrode assembly having a structure in which a first electrode and a second electrode are wound around a winding axis along with a separator interposed therebetween to define a core and an outer circumferential, the first electrode comprising an active material portion coated with an active material and a first uncoated portion not coated with an active material along a winding direction, at least a part of the first uncoated portion being used as an electrode tab by itself; a battery housing which the electrode assembly accommodates through an opening portion formed at a side thereof; a current collector including a tab coupling portion to the first uncoated portion and a housing coupling portion extending from the tab coupling portion and electrically coupled to an inner surface of the battery housing; and a cap covering the opening portion.

- (30) **Priorités(suite)/Priorities(continued):** 2021/04/09 (KR10-2021-0046798); 2021/05/04 (KR10-2021-0058183); 2021/06/14 (KR10-2021-0077046); 2021/06/28 (KR10-2021-0084326); 2021/10/01 (KR10-2021-0131225); 2021/10/01 (KR10-2021-0131215); 2021/10/01 (KR10-2021-0131205); 2021/10/01 (KR10-2021-0131208); 2021/10/01 (KR10-2021-0131207); 2021/10/14 (KR10-2021-0137001); 2021/10/15 (KR10-2021-0137856); 2021/10/22 (KR10-2021-0142196); 2021/11/09 (KR10-2021-0153472); 2021/11/19 (KR10-2021-0160823); 2021/11/24 (KR10-2021-0163809); 2021/11/26 (KR10-2021-0165866); 2021/12/03 (KR10-2021-0172446); 2021/12/10 (KR10-2021-0177091); 2021/12/31 (KR10-2021-0194593); 2021/12/31 (KR10-2021-0194610); 2021/12/31 (KR10-2021-0194572); 2021/12/31 (KR10-2021-0194612); 2021/12/31 (KR10-2021-0194611); 2022/01/05 (KR10-2022-0001802)
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ABSTRACT

A battery according to an embodiment of the present disclosure includes: an electrode assembly having a structure in which a first electrode and a second electrode are wound around a winding axis along with a separator interposed therebetween to define a core and an outer circumference, the first electrode comprising an active material portion coated with an active material and a first uncoated portion not coated with an active material along a winding direction, at least a part of the first uncoated portion being used as an electrode tab by itself; a battery housing in which the electrode assembly is accommodated through an opening portion formed at a side thereof; a current collector including a tab coupling portion coupled to the first uncoated portion and a housing coupling portion extending from the tab coupling portion and electrically coupled to an inner surface of the battery housing; and a cap covering the opening portion.

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## DESCRIPTION

### TITLE OF INVENTION

BATTERY AND CURRENT COLLECTOR APPLIED THERETO, AND  
5 BATTERY PACK AND VEHICLE INCLUDING THE BATTERY

### TECHNICAL FIELD

The present disclosure relates to a battery and a current collector applied thereto,  
and a battery pack and a vehicle including the battery.

10 The present application claims priority to Korean Patent Application No. 10-2021-  
0007278 filed on January 19, 2021, Korean Patent Application No. 10-2021-0022897 filed  
on February 19, 2021, Korean Patent Application No. 10-2021-0022894 filed on February  
19, Korean Patent Application No. 10-2021-0022891 filed on February 19, 2021, Korean  
Patent Application No. 10-2021-0022881 filed on February 19, 2021, Korean Patent  
15 Application No. 10-2021-0024424 filed on February 23, 2021, Korean Patent Application  
No. 10-2021-0030300 filed on March 8, 2021, Korean Patent Application No. 10-2021-  
0030291 filed on March 8, 2021, Korean Patent Application No. 10-2021-0046798 filed on  
April 9, 2021, Korean Patent Application No. 10-2021-0058183 filed on May 4, 2021,  
Korean Patent Application No. 10-2021-0077046 filed on June 14, 2021, Korean Patent  
20 Application No. 10-2021-0084326 filed on June 28, 2021, Korean Patent Application No.  
10-2021-0131225 filed on October 1, 2021, Korean Patent Application No. 10-2021-  
0131215 filed on October 1, 2021, Korean Patent Application No. 10-2021-0131205 filed

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on October 1, 2021, Korean Patent Application No. 10-2021-0131208 filed on October 1, 2021, Korean Patent Application No. 10-2021-0131207 filed on October 1, 2021, Korean Patent Application No. 10-2021-0137001 filed on October 14, 2021, Korean Patent Application No. 10-2021-0137856 filed on October 15, 2021, Korean Patent Application No. 10-2021-0142196 filed on October 22, 2021, Korean Patent Application No. 10-2021-0153472 filed on November 9, 2021, Korean Patent Application No. 10-2021-0160823 filed on November 19, 2021, Korean Patent Application No. 10-2021-0163809 filed on November 24, 2021, Korean Patent Application No. 10-2021-0165866 filed on November 26, 2021, Korean Patent Application No. 10-2021-0172446 filed on December 3, 2021, Korean Patent Application No. 10-2021-0177091 filed on December 10, 2021, Korean Patent Application No. 10-2021-0194593 filed on December 31, 2021, Korean Patent Application No. 10-2021-0194610 filed on December 31, 2021, Korean Patent Application No. 10-2021-0194572 filed on December 31, 2021, Korean Patent Application No. 10-2021-0194612 filed on December 31, 2021, Korean Patent Application No. 10-2021-0194611 filed on December 31, 2021, and Korean Patent Application No. 10-2022-0001802 filed on January 5, 2022, the disclosures of which are incorporated herein by reference.

## BACKGROUND ART

A battery according to the related art generally has a structure in which a tab for connecting a jelly-roll type electrode assembly to an external terminal is welded and connected to a foil of the electrode assembly. The battery having the above structure has a limited current path and has very high resistance of the electrode assembly itself.

Accordingly, a method of reducing the resistance by increasing the number of tabs for connecting the electrode assembly to the external terminal has been attempted, but there is a limitation in reducing the resistance to a desired level and sufficiently securing current paths only by increasing the number of tabs.

5           Therefore, it is demanded to develop a new electrode assembly structure for reducing self-resistance of the electrode assembly and to develop a current collector structure suitable for the new electrode assembly structure. In particular, the necessity for application of the electrode assembly and the current collector having a new structure is much required for a device, e.g., an electric vehicle, which needs a battery pack having high  
10           output/high capacity.

Also, there is a need to develop a battery having a structure in which a coupling force between a current collector and a battery housing is improved and maintained at an improved level, and a current collector applied to the battery.

In addition, there is a need to develop a battery having improved energy density, by  
15           minimizing a dead space in a battery housing when a current collector and the battery housing are coupled to each other.

As a battery has recently been applied to an electric vehicle, a form factor of the battery has increased. That is, a diameter and a height of a battery have increased when compared to a conventional battery having a form factor of 1865, 2170, or the like. An  
20           increase in a form factor leads to increased energy density, enhanced safety against thermal runaway, and improved cooling efficiency.

The energy density of a battery may be further increased when an unnecessary space

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in a battery housing is minimized along with an increase in a form factor. Accordingly, it is necessary to design an entire structure of a battery as a low-resistive structure so that a current collector minimizes the amount of heat generated during rapid charging while increasing the capacity of a battery.

5

## DISCLOSURE

### Technical Problem

The present disclosure is designed to solve the problems of the related art, and therefore the present disclosure is directed to providing a current collector having a structure  
10 suitable for an electrode assembly having a low-resistive structure, and a battery including the current collector.

The present disclosure is also directed to providing a current collector having a structure capable of improving a coupling force of a coupling portion between the current collector and a battery housing, and a battery including the current collector.

15 The present disclosure is also directed to providing a current collector having a structure capable of improving the energy density of a battery, and a battery including the current collector.

The present disclosure is also directed to providing a current collector having a structure capable of improving convenience in a welding process for electrical connection  
20 between a battery housing and the current collector and improving productivity when a battery is manufactured, and a battery including the current collector.

However, the technical purpose to be solved by the present disclosure are not limited

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to the above, and other objects not mentioned herein will be clearly understood by one of ordinary skill in the art from the following disclosure.

### Technical Solution

5           A battery according to an embodiment of the present disclosure includes: an electrode assembly having a structure in which a first electrode and a second electrode are wound around a winding axis along with a separator interposed therebetween to define a core and an outer circumference, the first electrode comprising an active material portion coated with an active material and a first uncoated portion not coated with an active material  
10 along a winding direction, at least a part of the first uncoated portion being used as an electrode tab by itself;

          a battery housing in which the electrode assembly is accommodated through an opening portion formed at a side thereof;

          a current collector including a tab coupling portion coupled to the first uncoated  
15 portion and a housing coupling portion extending from the tab coupling portion and electrically coupled to an inner surface of the battery housing; and

          a cap covering the opening portion.

          Preferably, the battery housing may include a beading portion formed on an end portion adjacent to the opening portion and press-fitted inward.

20           Preferably, the battery housing may include a crimping portion formed at a position closer to the opening portion than the beading portion, and extending and bent toward the opening portion.



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In particular, the housing coupling portion may be press-fixed by the crimping portion.

In an aspect of the present disclosure, the housing coupling portion may include: a contact portion coupled to the beading portion of the battery housing; and a connecting  
5 portion configured to connect the tab coupling portion to the contact portion.

Preferably, the connecting portion may have a structure that is convex upward based on an imaginary straight line that connects an end portion of the contact portion to an end portion of the tab coupling portion.

In another aspect of the present disclosure, the connecting portion may have a  
10 structure that moves upward to be over the beading portion.

Preferably, the connecting portion may include at least one bent part.

Preferably, the bent part may be located over an imaginary plane that passes through a center of the imaginary straight line that connects the end portion of the contact portion to the end portion of the tab coupling portion, and is parallel to a bottom surface of the battery  
15 housing.

In another aspect of the present disclosure, the at least one bent part may be bent at an obtuse angle so as not to overlap, when viewed along a longitudinal axis of the battery housing.

In another aspect of the present disclosure, a boundary point between the contact  
20 portion and the connecting portion may be bent at an obtuse angle.

In another aspect of the present disclosure, an inclination of the connecting portion may be reduced stepwise or gradually toward the beading portion.

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In another aspect of the present disclosure, an angle between the tab coupling portion and the connecting portion may range from 0° to 90°.

In another aspect of the present disclosure, the connecting portion may support the cap.

5 In another aspect of the present disclosure, the tab coupling portion and the contact portion may be located at a same height.

In another aspect of the present disclosure, the contact portion may include a flat surface coupled to a top surface of the beading portion facing the opening portion.

10 In another aspect of the present disclosure, the beading portion may include: a beading portion top surface located over an innermost point that is press-fitted inward; and a beading portion bottom surface located under the innermost point that is press-fitted inward.

Preferably, at least one tab coupling portion of the current collector may be located at a lower position than the beading portion bottom surface.

15 In another aspect of the present disclosure, at least one of the beading portion top surface and the beading portion bottom surface may be inclined at a certain angle with respect to a bottom surface of the battery housing.

In this case, the contact portion may be mounted on an inclined top surface of the beading portion.

20 In another aspect of the present disclosure, at least one of the beading portion top surface and the beading portion bottom surface may be parallel to a bottom surface of the battery housing in at least a region.

In another aspect of the present disclosure, the beading portion top surface and the

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beading portion bottom surface may be asymmetric with respect to an imaginary reference plane that passes through the innermost point of the beading portion to be parallel to a bottom surface of the battery housing.

5 Preferably, the contact portion may be mounted on a flat top surface of the beading portion.

In another aspect of the present disclosure, when a press-fitting depth of the beading portion is PD, a minimum value of a radius of curvature of the beading portion is  $R_{1,min}$ , a minimum value of a welding bead width is  $W_{bead,min}$ , and a minimum value of a radius of curvature at a boundary region between the beading portion and the inner surface of the battery housing is  $R_{2,min}$ ,

$$PD \geq R_{1,min} + R_{2,min} + W_{bead,min}.$$

10 Preferably, a press-fitting depth of the beading portion may range from 0.2 mm to 10 mm.

In another aspect of the present disclosure, when a press-fitting depth of the beading portion is PD, a maximum value of the press-fitting depth is  $PD_{max}$ , an overlap length that is a shortest distance from an end portion of the contact portion to a vertical line that passes through an innermost point of the beading portion is OV, a minimum value of a radius of curvature of the beading portion is  $R_{1,min}$ , a minimum value of a welding bead width is  $W_{bead,min}$ , and a minimum value of a radius of curvature at a boundary region between the beading portion and the inner surface of the battery housing is  $R_{2,min}$ ,

$$(R_{1,min} + W_{bead,min}) / PD_{max} \leq OV / PD \leq (PD_{max} - R_{2,min}) / PD_{max}.$$

20 In another aspect of the present disclosure, the contact portion may be welded to the

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beading portion.

Preferably, the contact portion may be welded to a flat top surface of the beading portion.

More preferably, a welding region between the contact portion and the beading  
5 portion may be narrower than the flat top surface of the beading portion.

In another aspect of the present disclosure, when a press-fitting depth of the beading portion is PD, a maximum value of the press-fitting depth is PD<sub>max</sub>, a distance from an innermost point of the beading portion to a central point of an outermost welding bead in a radial direction is W, an overlap length that is a shortest distance from an end portion of the  
10 contact portion to a vertical line that passes through the innermost point of the beading portion is OV, a minimum value of the overlap length OV is OV<sub>min</sub>, a maximum value of the overlap length OV is OV<sub>max</sub>, and a minimum value of a welding bead width is W<sub>bead,min</sub>,

$$(OV_{\min}-0.5*W_{\text{bead,min}})/PD_{\max} \leq W/PD \leq (OV_{\max}-0.5*W_{\text{bead,min}})/PD_{\max}.$$

In another aspect of the present disclosure, at least one welding bead may be formed  
15 between the beading portion and the contact portion,

Preferably, the at least one welding bead may form a welding pattern having a straight line shape extending in a circumferential direction.

In another aspect of the present disclosure, at least one welding bead may be formed between the beading portion and the contact portion, wherein the at least one welding bead  
20 forms a welding pattern having an arc shape extending in a circumferential direction.

In another aspect of the present disclosure, a welding bead formed between the beading portion and the contact portion may form a welding pattern, wherein the welding

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pattern has a linear shape in which spot welding is connected.

In another aspect of the present disclosure, a plurality of welding beads formed between the beading portion and the contact portion may be formed in a same contact portion.

In another aspect of the present disclosure, a width of a welding bead formed  
5 between the beading portion and the contact portion may be equal to or greater than 0.1 mm.

In another aspect of the present disclosure, the first uncoated portion and the tab coupling portion may be welded in a radial direction of the electrode assembly.

In another aspect of the present disclosure, the tab coupling portion may be welded to the first uncoated portion while being parallel to a bottom surface of the battery housing.

In another aspect of the present disclosure, a plurality of welding beads formed  
10 between the first uncoated portion and the tab coupling portion may form a welding pattern having a straight line shape extending in the radial direction of the electrode assembly.

In another aspect of the present disclosure, a welding bead formed between the first uncoated portion and the tab coupling portion may form a welding pattern, wherein the  
15 welding pattern has a linear shape in which spot welding is connected.

In another aspect of the present disclosure, a width of a welding bead formed between the first uncoated portion and the tab coupling portion may be equal to or greater than 0.1 mm.

In another aspect of the present disclosure, at least a part of the first uncoated portion  
20 may include a plurality of segments divided in a winding direction of the electrode assembly.

Preferably, the plurality of segments may be bent in a radial direction of the electrode assembly to form a bent surface.

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Preferably, the plurality of segments may overlap in multiple layers in the radial direction of the electrode assembly to form the bent surface.

More preferably, the bent surface may include a stack number increasing section in which the number of overlapping layers of the segments is sequentially increased to a maximum value from an outer circumference to a core of the electrode assembly and a stack number uniform section from a radius point at which the number of overlapping layers is the maximum value to a radius point at which an innermost segment exists.

Preferably, the tab coupling portion may be coupled to the bent surface to overlap the stack number uniform section.

More preferably, the number of overlapping layers in the stack number uniform section may be 10 or more.

More preferably, the tab coupling portion may be welded to the bent surface, and a welding region of the tab coupling portion may overlap the stack number uniform section by at least 50% in the radial direction of the electrode assembly.

In another aspect of the present disclosure, the current collector may include a circular current collector hole at a central portion of the current collector.

Preferably, a diameter of the current collector hole may be equal to or greater than a diameter of a winding central hole formed in a core of the electrode assembly.

In another aspect of the present disclosure, the battery may include a sealing gasket provided between the battery housing and the cap.

Preferably, the contact portion may be located between the sealing gasket and the beading portion.

More preferably, a thickness of the sealing gasket may vary in a circumferential direction.

Preferably, a thickness of the sealing gasket may be alternately increased and decreased in a circumferential direction.

5 In an aspect of the present disclosure, the sealing gasket may have a same compressibility in a region where the sealing gasket contact the contact portion and in a region where the sealing gasket does not contact the contact portion.

In another aspect of the present disclosure, a compressibility of the sealing gasket in a region where the sealing gasket does not contact the contact portion may be less than a  
10 compressibility of the sealing gasket in a region where the sealing gasket contacts the contact portion.

Preferably, a thickness of the sealing gasket in a region where the sealing gasket does not contact the contact portion may be greater than a thickness of the sealing gasket in a region where the sealing gasket contacts the contact portion.

15 In another aspect of the present disclosure, the current collector may have a leg structure extending in a radial direction in a state where the tab coupling portion and the housing coupling portion are connected to each other.

Preferably, a plurality of leg structures may be provided.

Preferably, the leg structures may be arranged in a radial shape, a cross shape, or a  
20 combined shape thereof about a central portion of the current collector.

In another aspect of the present disclosure, a plurality of housing coupling portions may be provided, wherein the plurality of housing coupling portions are connected to one

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another and integrally formed.

In another aspect of the present disclosure, the connecting portion may include at least one bending portion whose extension direction is changed at least once.

5 Preferably, a protruding outermost point of the bending portion may be spaced apart by a certain interval from an innermost point of the beading portion.

In another aspect of the present disclosure, due to the bending portion, an angle between the contact portion and the connecting portion may be an acute angle.

In another aspect of the present disclosure, the connecting portion may be elastically biased upward by the bending portion.

10 In another aspect of the present disclosure, a circumferential length of the contact portion may be same as a circumferential length of the tab coupling portion.

In another aspect of the present disclosure, a circumferential length of the contact portion may be same as a circumferential length of the connecting portion.

15 In another aspect of the present disclosure, a circumferential length of the contact portion may be greater than a circumferential length of the tab coupling portion.

In another aspect of the present disclosure, a circumferential length of the contact portion may be greater than a circumferential length of the connecting portion.

In another aspect of the present disclosure, the contact portion may have an arc shape extending in a circumferential direction along the beading portion of the battery housing.

20 In another aspect of the present disclosure, the contact portion may have an arc shape extending in opposite directions along a circumferential direction, from an intersection between the connecting portion and the contact portion.



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In another aspect of the present disclosure, a sum of lengths of the contact portions extending in the circumferential direction may correspond to a length of an inner circumference of the battery housing.

5 In another aspect of the present disclosure, the connecting portion may have an arc shape extending in the circumferential direction along the contact portion.

In another aspect of the present disclosure, a boundary region between the tab coupling portion and the housing coupling portion may be bent so that an end portion of the housing coupling portion faces the beading portion.

10 In another aspect of the present disclosure, a connected portion between the contact portion and the connecting portion may be bent.

In another aspect of the present disclosure, a connected portion between the contact portion and the connecting portion may have a complementary shape corresponding to an inner surface of the beading portion.

15 In another aspect of the present disclosure, a connected portion between the contact portion and the connecting portion may be coupled to the beading portion while having a shape matching an inner surface of the beading portion.

In another aspect of the present disclosure, a boundary region between the tab coupling portion and the housing coupling portion may be located more inside than an innermost point of the beading portion formed on the battery housing.

20 Preferably, when viewed along a longitudinal axis of the battery housing, the tab coupling portion may not overlap the beading portion.

In another aspect of the present disclosure, the second electrode may include a

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second uncoated portion that is not coated with an active material layer and is exposed to the outside of the separator at a long side end thereof, at least a part of the second uncoated portion being used as an electrode tab by itself, wherein the battery further includes a terminal provided opposite to the opening portion and electrically connected to the second  
5 uncoated portion.

Preferably, the battery may further include a second current collector formed between the second uncoated portion and the terminal and including a tab coupling portion coupled to the second uncoated portion and a terminal coupling portion coupled to the terminal.

10 Preferably, the terminal coupling portion may cover a winding central hole of the electrode assembly.

Preferably, a longest radius from a center of the terminal coupling portion of the second current collector to an end of the tab coupling portion may be greater than a longest radius from a central portion of the current collector to an end of the tab coupling portion.

15 In another aspect of the present disclosure, the tab coupling portion of the second current collector may be coupled to a bent end portion of the second uncoated portion.

Preferably, a welding region for coupling the tab coupling portion of the second current collector to the bent end portion of the second uncoated portion may be further formed, wherein a distance from a center of the terminal coupling portion of the second  
20 current collector to the welding region is same as or has a distance deviation of 5% or less from a distance from a central portion of the current collector to a welding region on the tab coupling portion.

Preferably, the welding region of the second current collector may have a length greater than a length of the welding region on the tab coupling portion of the current collector.

In another aspect of the present disclosure, one or more holes for injecting an electrolytic solution may be formed in the tab coupling portion.

5 In another aspect of the present disclosure, a form factor ratio obtained by dividing a diameter of the battery by a height may be greater than 0.4.

In another aspect of the present disclosure, resistance measured between a positive electrode and a negative electrode may be equal to or less than 4 milliohm (mohm).

A battery pack according to an embodiment of the present disclosure includes a  
10 plurality of cylindrical secondary batteries according to an embodiment of the present disclosure as described above.

Preferably, a plurality of cylindrical secondary batteries may be arranged in a certain number of columns, wherein a terminal and an outer surface of a bottom of a battery housing of each battery are located to face upward.

15 In an aspect of the present disclosure, the battery pack may further include a plurality of bus bars configured to connect the plurality of cylindrical secondary batteries in series and in parallel, wherein each of the plurality of bus bars is located over adjacent cylindrical secondary batteries, wherein each of the plurality of bus bars includes: a body portion extending between adjacent terminals; a plurality of first bus bar terminals extending from a  
20 side of the body portion and electrically coupled to an electrode terminal of a battery located at the side; and a plurality of second bus bar terminals extending from the other side of the body portion and electrically connected to an outer surface of a bottom of a battery housing

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of a battery located at the other side.

A vehicle according to an embodiment of the present disclosure includes the battery pack according to an embodiment of the present disclosure.

A current collector according to an embodiment of the present disclosure includes:  
5 at least one tab coupling portion coupled to a first uncoated portion of an electrode assembly;  
and at least one housing coupling portion extending from the tab coupling portion and  
electrically coupled to a beading portion of a battery housing.

A battery according to another embodiment of the present disclosure includes: an  
electrode assembly having a structure in which a first electrode and a second electrode each  
10 having a sheet shape and a separator located between the first and second electrodes are  
wound in one direction, the first electrode including a first uncoated portion not coated with  
an active material layer and exposed to the outside of the separator at a long side end thereof,  
at least a part of the first uncoated portion being used as an electrode tab by itself; a battery  
housing in which the electrode assembly is accommodated through an opening portion  
15 formed at a side thereof; a current collector electrically connected to the first uncoated  
portion and an inner surface of the battery housing; and a sealing gasket located between the  
opening portion of the battery housing and the current collector, wherein a portion of the  
current collector contacting the inner surface of the battery housing is located between the  
inner surface of the battery housing and the sealing gasket.

20 Preferably, the battery housing may include a beading portion formed on an end  
portion adjacent to the opening portion and press-fitted inward.

In another aspect of the present disclosure, an extension direction of a welding

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pattern formed between the first uncoated portion and the tab coupling portion and an extension direction of a welding pattern formed between the beading portion and the contact portion may be perpendicular to each other.

In another aspect of the present disclosure, an innermost point of the beading portion  
5 may be located more inside in a radial direction than a distal point of the crimping portion.

In another aspect of the present disclosure, the sealing gasket may surround the cap, wherein a radial length of a portion of the sealing gasket covering a bottom surface of the cap is less than a radial length of a portion of the sealing gasket covering a top surface of the cap.

In another aspect of the present disclosure, when a total radial length of the tab  
10 coupling portion is T, an outer diameter of the electrode assembly is JR, and a height of an outermost segment of the electrode assembly is F,

$$JR - 2 * F \leq T < JR.$$

In another aspect of the present disclosure, when a minimum value of a distance  
15 from the innermost point of the beading portion to the central point of the outermost welding bead in the radial direction is W1, and when a distance from the innermost point of the beading portion to the central point of an outermost welding bead in the radial direction when the overlap length is OV is W,

$$W1 = R1 + 0.5 * W_{\text{bead,min}}, \text{ and}$$

20 
$$W = OV - 0.5 * W_{\text{bead,min}}.$$

In another aspect of the present disclosure, the beading portion may have a flat section parallel to a bottom surface of the battery housing in at least a region, and when the

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overlap length is  $OV$  and a radius of curvature of the beading portion is  $R1$ , a length of the flat section of the beading portion contacting the current collector may be  $OV - R1$ .

Preferably, a radial width length of a welding pattern formed between the beading portion and the contact portion may be equal to or greater than  $W_{\text{bead,min}}$  and equal to or less than  $OV - R1$ .

In another aspect of the present disclosure, a ratio of the radial width length of the welding pattern to a length of the flat section may range from 10% to 40%.

In another aspect of the present disclosure, a ratio of an area where the current collector does not contact a top surface of the electrode assembly to an area of a circle having an outer diameter of the electrode assembly as a diameter may be equal to or greater than 30% and less than 100%.

More preferably, a ratio of an area where the current collector does not contact the electrode assembly to an area of a circle having an outer diameter of the electrode assembly as a diameter may be equal to or greater than 60% and less than 100%.

In another aspect of the present disclosure, a diameter of the current collector hole may be less than a diameter of a winding central hole formed in a core of the electrode assembly.

Preferably, when a diameter of the winding central hole is  $R3$ , a diameter of the current collector hole may be equal to or greater than  $0.5 \cdot R3$  and less than  $R3$ .

More preferably, when a diameter of the winding central hole is  $R3$ , a diameter of the current collector hole may be equal to or greater than  $0.7 \cdot R3$  and less than  $R3$ .

In another aspect of the present disclosure, the connecting portion may extend in a

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radial direction and a winding axis direction.

In another aspect of the present disclosure, the tab coupling portion, the connecting portion and the contact portion may have the same width along an extending direction.

Alternatively, the contact portion may have a greater width than the connecting  
5 portion.

In another aspect of the present disclosure, the connecting portion may have a smaller width than the tab coupling portion.

Alternatively, the connecting portion may have a greater width than the tab coupling  
portion.

10

#### Advantageous Effects

According to the present disclosure, resistance may be greatly reduced in electrical connection between an electrode assembly and a battery housing.

Also, according to the present disclosure, a coupling force of a coupling portion  
15 between a current collector and a battery housing may be improved.

In addition, according to the present disclosure, the energy density of a battery may be improved.

Also, according to the present disclosure, when a battery is manufactured, convenience in a welding process for electrical connection between a battery housing and a  
20 current collector may be improved, and thus, productivity may be improved.

However, effects obtainable from the present disclosure may be non-limited by the above-mentioned effect. Other unmentioned effects may be clearly understood from the

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following description by one of ordinary skill in the art to which the present disclosure pertains.

#### DESCRIPTION OF DRAWINGS

5           The accompanying drawings illustrate a preferred embodiment of the present disclosure and together with the foregoing disclosure, serve to provide further understanding of the technical features of the present disclosure, and thus, the present disclosure is not construed as being limited to the drawing.

          FIG. 1a is a longitudinal sectional view illustrating a part of a battery, according to  
10 an embodiment of the present disclosure.

          FIG. 1b is a longitudinal sectional view illustrating a part of a battery, according to another embodiment of the present disclosure.

          FIG. 1c is an enlarged view illustrating an upper portion of an electrode assembly of FIG. 1b.

15           FIG. 1d is an enlarged view illustrating an upper portion of a first uncoated portion of FIG. 1c.

          FIG. 2 is a longitudinal sectional view illustrating a part of a battery, according to another embodiment of the present disclosure.

          FIG. 3 is a longitudinal sectional view illustrating a part of a battery, according to  
20 another embodiment of the present disclosure.

          FIG. 4a is a view for describing a current collector included in the battery of FIG. 3.

          FIG. 4b is a view for describing an embodiment where a bending portion is omitted



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in the current collector of FIG. 4a.

FIG. 5 is a view for describing a current collector, according to another embodiment of the present disclosure.

FIG. 6 is a view for describing a current collector, according to another embodiment  
5 of the present disclosure.

FIG. 7 is a view for describing a relationship between a current collector hole and a winding hole.

FIG. 8a is a view for describing a welding region between a current collector and a first uncoated portion and a welding region between the current collector and a beading  
10 portion of FIG. 4a.

FIG. 8b is a view for describing a welding region between a current collector and a first uncoated portion and a welding region between the current collector and a beading portion of FIG. 4b.

FIG. 9 is a view for describing a welding region between a current collector and a  
15 first uncoated portion and a welding region between the current collector and a beading portion of FIG. 5.

FIG. 10 is a view for describing a welding region between a current collector and a first uncoated portion and a welding region between the current collector and a beading portion of FIG. 6.

FIG. 11 is a view for describing a position, a length, and a width of a welding bead  
20 formed in a welding region between a contact portion and a beading portion.

FIG. 12 is a view for describing a relationship between a diameter of an inner surface

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of a battery housing and a total diameter of a current collector.

FIG. 13a is a view for describing a welding process of a current collector.

FIG. 13b is a view for describing a beading process of a battery housing.

FIG. 13c is a view for describing a crimping process of a battery housing.

5 FIG. 13d is a view for describing a sizing process of a battery housing.

FIG. 13e is a view for describing a change in a current collector after a sizing process according to a shape of the current collector before a sizing process.

FIG. 13f is a view for describing a shape of a current collector for maintaining a welding region even after a sizing process.

10 FIG. 13g is a view for describing a shape of a current collector for maintaining a welding region even after a sizing process.

FIG. 14 is a plan view illustrating an electrode plate structure, according to a preferred embodiment of the present disclosure.

15 FIG. 15 is a cross-sectional view illustrating an electrode assembly in which an uncoated portion segmentation structure of an electrode plate is applied to a first electrode plate and a second electrode plate, taken along a longitudinal direction Y, according to an embodiment of the present disclosure.

20 FIG. 16a is a cross-sectional view illustrating an electrode assembly in which an uncoated portion is bent, taken along the longitudinal direction Y, according to an embodiment of the present disclosure.

FIG. 16b is a perspective view illustrating an electrode assembly in which an uncoated portion is bent, according to an embodiment of the present disclosure.

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FIG. 17 is a top plan view illustrating a state where a plurality of battery packs are connected in series and in parallel by using a bus bar, according to an embodiment of the present disclosure.

FIG. 18a is a view for describing a second current collector, according to an  
5 embodiment of the present disclosure.

FIG. 18b is a view for describing a second current collector, according to another embodiment of the present disclosure.

FIG. 19 is a view for describing a battery pack including a battery, according to an embodiment of the present disclosure.

10 FIG. 20 is a view for describing a vehicle including the battery pack of FIG. 19.

### BEST MODE

Hereinafter, preferred embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. Prior to the description, it should be  
15 understood that the terms used in the specification and the appended claims should not be construed as limited to general and dictionary meanings, but interpreted based on the meanings and concepts corresponding to technical aspects of the present disclosure on the basis of the principle that the inventor is allowed to define terms appropriately for the best explanation. Therefore, the description proposed herein is just a preferable example for the  
20 purpose of illustrations only, not intended to limit the scope of the disclosure, so it should be understood that other equivalents and modifications could be made thereto without departing from the scope of the disclosure.

In addition, in order to help the understanding of the present disclosure, the accompanying drawings are not drawn to scale, but dimensions of some components may be exaggerated. Also, the same reference signs may be assigned to the same components in different embodiments.

5           When it is explained that two objects are identical, this means that these objects are ‘substantially identical’. Accordingly, the substantially identical objects may include deviations considered low in the art, for example, deviations within 5%. Also, when it is explained that certain parameters are uniform in a certain region, this may mean that the parameters are uniform in terms of an average.

10           Although the terms first, second or the like are used to describe different elements, these elements are not limited by the terms. These terms are used to distinguish one element from another, and unless stated to the contrary, a first element may be a second element.

15           Throughout the specification, unless stated otherwise, each element may be singular or plural.

          When an element is "above (or under)" or "on (or below)" another element, the element can be on an upper surface (or a lower surface) of the other element, and intervening elements may be present between the element and the other element on (or below) the element.

20           Additionally, when an element is referred to as being "connected", "coupled" or "linked" to another element, the element can be directly connected or coupled to the other element, but it should be understood that intervening elements may be present between each

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element, or each element may be "connected", "coupled" or "linked" to each other through another element.

Throughout the specification, "A and/or B" refers to either A or B or both A and B unless expressly stated otherwise, and "C to D" refers to C or greater and D or smaller unless  
5 expressly stated otherwise.

For convenience of description, a direction that goes along a lengthwise direction of a winding axis of an electrode assembly wound in a roll shape is herein referred to as an axis direction Y. Additionally, a direction around the winding axis is herein referred to as a circumferential or peripheral direction X. Additionally, a direction that gets closer to or  
10 faces away from the winding axis is referred to as a radial direction. Among them, in particular, the direction that gets closer to the winding axis is referred to as a centripetal direction, and the direction that faces away from the winding axis is referred to as a centrifugal direction.

15 Referring to FIG. 1a, a battery 1 according to an embodiment of the present disclosure includes an electrode assembly 10, a battery housing 20, a current collector (first current collector) 30, and a cap 40. The battery 1 may further include a terminal 50 and/or a sealing gasket G1 and/or an insulating gasket G2 and/or a current collector (second current collector) P and/or an insulator S. The terminal 50 may be provided opposite to an opening  
20 portion, and may be electrically connected to a second uncoated portion 12.

The electrode assembly 10 includes a first uncoated portion 11 and the second uncoated portion 12. In more detail, the electrode assembly may be manufactured by

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winding a stack formed by sequentially stacking a first electrode, a separator, a second electrode, and a separator at least once. That is, the electrode assembly 10 applied to the present disclosure may be a winding-type electrode assembly. In this case, an additional separator may be provided on an outer circumferential surface of the electrode assembly 10  
5 for insulating from the battery housing 20. The electrode assembly 10 may have a winding structure well known in the related art without limitation.

The electrode assembly 10 may be an electrode assembly 10 in which a first electrode and a second electrode are wound together with a separator interposed therebetween based on a winding axis to define a core and an outer circumference. Here,  
10 the first electrode may include an active material layer coated with an active material and a first uncoated portion 11 not coated with an active material, along the winding direction.

More specifically, the electrode assembly 10 may be a winding-type electrode assembly having a structure in which a first electrode and a second electrode each having a sheet shape and a separator interposed between the first and second electrodes are wound in  
15 one direction. The first electrode may include the first uncoated portion 11 that is not coated with an active material layer and is exposed to the outside of the separator at a long side end thereof. The second electrode may include the second uncoated portion 12 that is not coated with an active material layer and is exposed to the outside of the separator at a long side end thereof. At least a part of the first uncoated portion 11 may be used as an  
20 electrode tab by itself. At least a part of the second uncoated portion 12 itself may be used as an electrode tab by itself.

In detail, the first electrode includes a first electrode current collector and a first

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electrode active material coated on one surface or both surfaces of the first electrode current collector. An uncoated portion on which the first electrode active material is not coated exists at one end in a width direction of the first electrode current collector (direction parallel to a height direction of the battery 1 of FIG. 1a). The uncoated portion functions as a first electrode tab. The first uncoated portion 11 is provided in an upper portion of the electrode assembly 10 accommodated in the battery housing 20 in a height direction (direction parallel to a height direction of the battery 1 of FIG. 1a). The first uncoated portion 11 may be, for example, a negative electrode tab.

The second electrode includes a second electrode current collector and a second electrode active material coated on one surface or both surfaces of the electrode current collector. An uncoated portion on which the second electrode active material is not coated exists at the other end in a width direction of the second electrode current collector (direction parallel to the height direction of the battery 1 of FIG. 1a). The uncoated portion functions as a second electrode tab. The second uncoated portion 12 is provided on a lower portion in a height direction of the electrode assembly 10 accommodated in the battery housing 20. The second uncoated portion 12 may be, for example, a positive electrode tab.

In the present disclosure, a positive electrode active material coated on a positive electrode plate and a negative electrode active material coated on a negative electrode plate may be any type of active material, provided that the active material is well known in the art.

In an example, the positive active electrode active material may include an alkali metal compound expressed by a general chemical formula  $A[A_xM_y]O_{2+z}$  (A includes at least one of Li, Na, and K; M includes at least one element selected from Ni, Co, Mn, Ca, Mg, Al,

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Ti, Si, Fe, Mo, V, Zr, Zn, Cu, Al, Mo, Sc, Zr, Ru, and Cr;  $x \geq 0$ ,  $1 \leq x+y \leq 2$ ,  $-0.1 \leq z \leq 2$ ;

and stoichiometric coefficients  $x$ ,  $y$ , and  $z$  are selected so that the compound maintains electrically neutral).

In another embodiment, the positive electrode active material may be an alkali metal  
5 compound  $x\text{LiM}^1\text{O}_2(1-x)\text{Li}_2\text{M}^2\text{O}_3$  ( $\text{M}^1$  includes at least one element having an average oxide state of 3;  $\text{M}^2$  includes at least one element having an average oxidation state of 4; and  $0 \leq x \leq 1$ ) disclosed in US 6,677,082, US 6,680,143, etc.

In another example, the positive electrode active material may be lithium metal phosphate expressed by a general chemical formula  $\text{Li}_a\text{M}^1_x\text{Fe}_{1-x}\text{M}^2_y\text{P}_{1-y}\text{M}^3_z\text{O}_{4z}$  ( $\text{M}^1$  includes  
10 at least one element selected from Ti, Si, Mn, Co, Fe, V, Cr, Mo, Ni, Nd, Al, Mg, and Al;  $\text{M}^2$  includes at least one element selected from Ti, Si, Mn, Co, Fe, V, Cr, Mo, Ni, Nd, Al, Mg, Al, As, Sb, Si, Ge, V, and S;  $\text{M}^3$  includes an element of a halogen group selectively containing F;  $0 < a \leq 2$ ,  $0 \leq x \leq 1$ ,  $0 \leq y < 1$ ,  $0 \leq z < 1$ ; and stoichiometric coefficients  $a$ ,  $x$ ,  $y$ , and  $z$  are selected so that the compound maintains electrically neutral), or  $\text{Li}_3\text{M}_2(\text{PO}_4)_3$  [ $\text{M}$   
15 includes at least one element selected from Ti, Si, Mn, Fe, Co, V, Cr, Mo, Ni, Al, Mg, and Al].

Preferably, the positive electrode active material may include primary particles and/or secondary particles in which the primary particles are aggregated.

In an example, the negative electrode active material may use a carbon material,  
20 lithium metal or lithium metal compounds, silicon or silicon compounds, tin or tin compounds, etc. Metal oxide such as  $\text{TiO}_2$  or  $\text{SnO}_2$  having a potential of less than 2 V may be also used as the negative electrode active material. As the carbon material, low



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crystalline carbon and high crystalline carbon may be used.

The separator may include a porous polymer film, for example, made of a polyolefin-based polymer such as an ethylene homopolymer, a propylene homopolymer, an ethylene/butene copolymer, an ethylene/hexene copolymer, or an ethylene/methacrylate copolymer, in a single or stack structure thereof. In another example, the separator may be a common porous non-woven fabric, for example, a non-woven fabric made of glass fiber having a high melt point or polyethylene terephthalate fiber.

At least one surface of the separator may include a coating layer of inorganic particles. Otherwise, the separator itself may be made of a coating layer of inorganic particles. The inorganic particles included in the coating layer may be coupled to a binder so that an interstitial volume exists between adjacent inorganic particles.

The inorganic particles may include an inorganic material having a dielectric constant of 5 or more. In a non-limiting example, the inorganic particles may include at least one material selected from the group consisting of  $\text{Pb}(\text{Zr},\text{Ti})\text{O}_3$  (PZT),  $\text{Pb}_{1-x}\text{La}_x\text{Zr}_{1-y}\text{Ti}_y\text{O}_3$  (PLZT),  $\text{PB}(\text{Mg}_3\text{Nb}_{2/3})\text{O}_3\text{-PbTiO}_3$  (PMN-PT),  $\text{BaTiO}_3$ , hafnia ( $\text{HfO}_2$ ),  $\text{SrTiO}_3$ ,  $\text{TiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{ZrO}_2$ ,  $\text{SnO}_2$ ,  $\text{CeO}_2$ ,  $\text{MgO}$ ,  $\text{CaO}$ ,  $\text{ZnO}$ , and  $\text{Y}_2\text{O}_3$ .

An electrolyte may be a salt having a structure such as  $\text{A}^+\text{B}^-$ . Here,  $\text{A}^+$  includes an alkali metal cation such as  $\text{Li}^+$ ,  $\text{Na}^+$ , or  $\text{K}^+$  or a combination thereof. In addition,  $\text{B}^-$  includes at least one anion selected from the group consisting of  $\text{F}^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{NO}_3^-$ ,  $\text{N}(\text{CN})_2^-$ ,  $\text{BF}_4^-$ ,  $\text{ClO}_4^-$ ,  $\text{AlO}_4^-$ ,  $\text{AlCl}_4^-$ ,  $\text{PF}_6^-$ ,  $\text{SbF}_6^-$ ,  $\text{AsF}_6^-$ ,  $\text{BF}_2\text{C}_2\text{O}_4^-$ ,  $\text{BC}_4\text{O}_8^-$ ,  $(\text{CF}_3)_2\text{PF}_4^-$ ,  $(\text{CF}_3)_3\text{PF}_3^-$ ,  $(\text{CF}_3)_4\text{PF}_2^-$ ,  $(\text{CF}_3)_5\text{PF}^-$ ,  $(\text{CF}_3)_6\text{P}^-$ ,  $\text{CF}_3\text{SO}_3^-$ ,  $\text{C}_4\text{F}_9\text{SO}_3^-$ ,  $\text{CF}_3\text{CF}_2\text{SO}_3^-$ ,  $(\text{CF}_3\text{SO}_2)_2\text{N}^-$ ,  $(\text{FSO}_2)_2\text{N}^-$ ,  $\text{CF}_3\text{CF}_2(\text{CF}_3)_2\text{CO}^-$ ,  $(\text{CF}_3\text{SO}_2)_2\text{CH}^-$ ,  $(\text{SF}_5)_3\text{C}^-$ ,  $(\text{CF}_3\text{SO}_2)_3\text{C}^-$ ,

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$\text{CF}_3(\text{CF}_2)_7\text{SO}_3^-$ ,  $\text{CF}_3\text{CO}_2^-$ ,  $\text{CH}_3\text{CO}_2^-$ ,  $\text{SCN}^-$ , and  $(\text{CF}_3\text{CF}_2\text{SO}_2)_2\text{N}^-$ .

The electrolyte may also be dissolved in an organic solvent. The organic solvent may use propylene carbonate (PC), ethylene carbonate (EC), diethyl carbonate (DEC), dimethyl carbonate (DMC), dipropyl carbonate (DPC), dimethyl sulfoxide, acetonitrile, 5 dimethoxyethane, diethoxyethane, tetrahydrofuran, N-methyl-2-pyrrolidone (NMP), ethyl methyl carbonate (EMC),  $\gamma$ -butyrolactone, or a mixture thereof.

The battery housing 20 is a receiving body of a substantially cylindrical shape having an opening portion at one side thereof, and includes a metal material having conductivity. A side surface of the battery housing 20 and a bottom surface of the battery 10 housing 20, opposite to the opening portion, are generally integrally formed with each other. That is, the battery housing 20 is generally formed so that an upper end in a height direction is opened and a lower end except for a central portion is closed. The bottom surface of the battery housing 20 may have a substantially flat shape. The battery housing 20 may receive the electrode assembly 10 through the opening portion formed at one side in the height 15 direction thereof. The battery housing 20 may also receive the electrolyte through the opening portion.

The battery housing 20 may include a beading portion 21 that is formed on an end portion adjacent to the opening portion and is press-fitted inward. The battery housing 20 may include a crimping portion 22 that is formed at a position closer to the opening portion 20 than the beading portion 21 and extends and is bent toward the opening portion.

In detail, the battery housing 20 may include the beading portion 21 formed on an upper end portion thereof. The battery housing 20 may further include the crimping portion

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22 formed above the beading portion 21. The beading portion 21 is formed by press-fitting an outer circumference of the battery housing 20 to a certain depth. The beading portion 21 is formed over the electrode assembly 10. An inner diameter of the battery housing 20 at a region where the beading portion 21 is formed is less than a diameter of the electrode  
5 assembly 10.

The beading portion 21 provides a support surface on which the cap 40 may be mounted. Also, the beading portion 21 may provide a support surface on which at least a part of a circumferential edge of the current collector 30 described below may be mounted and coupled. That is, on a top surface of the beading portion 21, at least a part of a  
10 circumferential edge of the current collector 30 of the present disclosure and a circumferential edge of the cap 40 of the present disclosure may be mounted. As shown in FIGS. 2 and 3, in order to stably support at least a part of the circumferential edge of the current collector 30 and/or the circumferential edge of the cap 40, at least a part of the top surface of the beading portion 21 may extend in a direction substantially parallel to the  
15 bottom surface of the battery housing 20, that is, a direction substantially perpendicular to a sidewall of the battery housing 20.

The beading portion 21 may include: a beading portion top surface located over an innermost point that is press-fitted inward; and a beading portion bottom surface located under the innermost point that is press-fitted inward.

20 For example, a press-fitting depth PD of the beading portion 21 may range from about 0.2 mm to about 10 mm. For a minimum value of the press-fitting depth PD of the beading portion 21, a radius of curvature R1 of the beading portion 21, a welding bead width

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$W_{\text{bead}}$ , and a radius of curvature  $R_2$  at a boundary region between the beading portion 21 and an inner surface of the battery housing 20 should be considered. For example, referring to FIG. 11, in order to enable welding, an additional space in addition to the radius of curvature  $R_1$  of the beading portion 21 and the radius of curvature  $R_2$  at the boundary region between the beading portion 21 and the inner surface of the battery housing 20 is required. This is because, when the press-fitting depth  $PD$  is  $R_1+R_2$ , a flat section  $F$  does not exist in the beading portion. Furthermore, in order to enable welding, an additionally required space should be equal to or greater than a minimum width  $W_{\text{bead,min}}$  of a welding bead  $BD$ . Accordingly, the minimum value of the press-fitting depth  $PD$  satisfies the following relation.

10 
$$PD \geq R_{1,\text{min}} + R_{2,\text{min}} + W_{\text{bead,min}}$$

For example, minimum values of  $R_{1,\text{min}}$  and  $R_{2,\text{min}}$  may each be about 0.05 mm, and  $W_{\text{bead,min}}$  may be about 0.1 mm. In this case, the minimum value of the press-fitting depth  $PD$  may be equal to or greater than about 0.2 mm.

In another aspect, a maximum value of the press-fitting depth  $PD$  of the beading portion 21 may vary according to a material and a thickness of the battery housing 20. In an example, when a material of the battery housing 20 is a steel material and a maximum thickness of the battery housing 20 is about 1 mm, the maximum value of the press-fitting depth  $PD$  of the beading portion 21 may be about 10 mm. Accordingly, in an embodiment, the press-fitting depth  $PD$  of the beading portion 21 may have a value between about 0.2 mm and about 10 mm.

In another aspect of the present disclosure, as shown in FIG. 1a, at least one of the beading portion top surface and the beading portion bottom surface may be inclined at a

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certain angle with respect to the bottom surface of the battery housing 20. Alternatively, as shown in FIGS. 2 and 3, at least one of the beading portion top surface and the beading portion bottom surface may include a section parallel to the bottom surface of the battery housing 20 in at least a region. That is, the beading portion top surface and the beading  
5 portion bottom surface may include the flat section F (see FIG. 3) in at least a part.

The crimping portion 22 is formed over the beading portion 21. The crimping portion 22 extends and is bent to surround a circumferential edge of the cap 40 located over the beading portion 21. Due to this bent shape of the crimping portion 22, the cap 40 is fixed to the beading portion 21.

10 In another aspect, an innermost point of the beading portion 21 may be located more inside in a radial direction than a distal point of the crimping portion 22. For example, referring to FIG. 2, the distal point of the crimping portion 22 may be located more outside in the radial direction than the innermost point of the beading portion 21. According to this structure, the flat beading portion 21 may be maintained even after a sizing process. For  
15 example, when the innermost point of the beading portion 21 is located more outside in the radial direction than the distal point of the crimping portion 22, a radial length of a top surface of the crimping portion 22 is greater than a radial length of the beading portion 21. In this case, the area of the top surface of the crimping portion 22 to which pressure is applied in the sizing process may be increased, and thus, the beading portion 21 may not be flat after  
20 the sizing process. Accordingly, in the present disclosure, it is preferable that the innermost point of the beading portion 21 is located more inside than a distal end of the crimping portion 22 in the radial direction.

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Also, the crimping portion 22 may be omitted, and the cap 40 may be fixed while covering the opening portion of the battery housing 20 through another fixing structure. For example, a battery in which a beading portion is omitted is disclosed in Patent Application Publication No. KR 10-2019-0030016 A of the present applicant, and such a  
5 structure may be applied to the present disclosure.

The current collector (first current collector) 30 according to an embodiment of the present disclosure will now be described with reference to FIGS. 3 and 4a.

First, referring to FIG. 3, the current collector 30 according to an embodiment of the present disclosure is accommodated in the battery housing 20, and is electrically connected  
10 to the electrode assembly 10 and is also electrically connected to the battery housing 20. That is, the current collector 30 electrically connects the electrode assembly 10 to the battery housing 20. Preferably, the current collector 30 may be electrically coupled to the first uncoated portion 11 and the beading portion 21 of the battery housing 20. At least one tab coupling portion 32 of the current collector 30 may be located at a lower position than the  
15 beading portion bottom surface.

The current collector 30 includes the tab coupling portion 32 coupled to the first uncoated portion 11, and a housing coupling portion 33 extending from the tab coupling portion 32 and electrically coupled to the beading portion 21 on an inner surface of the battery housing 20. A boundary region between the tab coupling portion 32 and the  
20 housing coupling portion 33 may be bent so that an end portion of the housing coupling portion 33 faces the beading portion 21. That is, referring to FIG. 2 or the like, the boundary region between the tab coupling portion 32 and the housing coupling portion 33

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may be bent upward. Meanwhile, the housing coupling portion 33 may be press-fixed by the crimping portion 22.

Optionally, the current collector 30 may further include a central portion 31, in a core region of the current collector 30. The central portion 31 may have a substantially circular shape. For example, the central portion 31 may have a loop-shaped portion that forms a loop shape surrounding the periphery of the winding axis of the electrode assembly 10. The loop-shaped portion may have one or more cut portions along the circumferential direction. Meanwhile, the central portion 31 may be selectively coupled to the first uncoated portion 11.

Optionally, the current collector 30 may further include a cover portion configured to extend from the loop-shaped portion and disposed to surround a partial region of the first uncoated portion 11. The contact area between the first uncoated portion 11 and the current collector 30 may be increased due to the cover portion. Accordingly, the internal resistance of the battery may be reduced further.

In another embodiment of the present disclosure, the current collector 30 may have at least one leg structure extending in the radial direction in a state where the tab coupling portion 32 and the housing coupling portion 33 are connected to each other. Preferably, a plurality of leg structures may be provided. For example, referring to FIGS. 4a through 6, the current collector 30 may include four leg structures. When a plurality of leg structures are provided, a plurality of housing coupling portions 33 may also be provided. In this case, although not shown, the plurality of housing coupling portions 33 may be connected to one another and may be integrally formed. The leg structures may be arranged in a radial shape,

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a cross shape, or a combined shape about the central portion 31.

The central portion 31 and at least one tab coupling portion 32 may be located over the electrode assembly 10, and when the beading portion 21 is formed on the battery housing 20, the central portion 31 and the at least one tab coupling portion 32 may be located under the beading portion 21. One or more holes for injecting an electrolytic solution may be formed in the tab coupling portion 32.

When a total radial length of the tab coupling portion 32 is T, an outer diameter of the electrode assembly 10 is JR, and a height of an outermost segment 11a of the electrode assembly is F, the following relation may be satisfied.

$$JR - 2 * F \leq T < JR$$

Preferably, the total radial length T of the tab coupling portion 32 may be equal to or greater than a length obtained by subtracting the height of the segment 11a located at the outermost side from the outer diameter JR of the electrode assembly 10 twice. When the relation is satisfied, the tab coupling portion 32 covers an end portion of the segment 11a located at the outermost side. That is, the current collector 30 may have an outer diameter covering an end portion of the segment 11a that is bent at a last winding turn of the first electrode. In this case, welding may be performed in a state where the segments 11a that form a bent surface 102 coupled to the tab coupling portion 32 are uniformly pressed by the current collector 30, and even after the welding, a close stacked state of the segments 11a may be maintained well. The close stacked state refers to a state where there is substantially no gap between the segments as shown in FIG. 1c. The close stacked state contributes to lower the resistance of the secondary battery 1 to a level suitable for rapid



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charging (e.g., 0.5 milliohm (mohm) to 4 milliohm (mohm), preferably 1.0 milliohm (mohm) to 4 milliohm (mohm)) or less.

In another aspect, the total radial length T of the tab coupling portion 32 may be less than an outer diameter JR of the electrode assembly 10. When the total radial length T of the tab coupling portion 32 is greater than the outer diameter JR of the electrode assembly 10, a dead space in the battery housing 20 may be increased, thereby adversely affecting the energy density of the battery 1. Accordingly, it is preferable that the total radial length T is less than the outer diameter JR of the electrode assembly 10.

The central portion 31 includes a circular current collector hole H2 formed at a position corresponding to a winding central hole H1 formed at a central portion of the electrode assembly 10. The winding central hole H1 and the current collector hole H2 communicating with each other may function as paths for irradiating a laser welding beam or inserting a welding rod for welding between the terminal 50 and the current collector (second current collector) P or welding between the terminal 50 and a lead tab (not shown), or paths for irradiating a laser welding beam.

FIG. 7 is a view for describing a relationship between a current collector hole and a winding hole.

Referring to FIG. 7, a diameter of the current collector hole H2 may be equal to or greater than a diameter of the winding central hole H1 formed in a core of the electrode assembly 10. For example, the reason why the diameter of the current collector hole H2 is set to be greater than the diameter of the winding central hole H1 formed in the core of the electrode assembly 10 is that it is necessary to secure a space according to the insertion of a

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welding guide, when the laser welding beam is irradiated or the welding rod is inserted for welding between the terminal 50 and the current collector (second current collector) P or welding between the terminal 50 and the lead tab (not shown). When the diameter of the current collector hole H2 is excessively less than the diameter of the winding central hole H1, the winding central hole H1 may be covered and may act as an interference factor during continuous resistance welding (CRW).

Unlike the embodiment, according to another embodiment of the present disclosure, the diameter of the current collector H2 may be less than the diameter of the winding central hole H1 formed in the core of the electrode assembly 10. For example, when the diameter of the winding central hole H1 is R3, the diameter of the current collector hole H2 may be equal to or greater than  $0.5 \cdot R3$  and less than R3, and preferably, may be equal to or greater than  $0.7 \cdot R3$  and less than R3.

In general, when gas is discharged from a winding central portion during venting, due to strong pressure, a separator or an uncoated portion at the center of winding may be separated from a top surface of the electrode assembly 10. In this case, when the diameter of the current collector hole H2 is less than the diameter of the winding central hole H1 formed in the core of the electrode assembly 10, the separator or the uncoated portion at the center of winding may be prevented from being separated from the top surface of the electrode assembly 10. However, when the diameter of the current collector hole H2 is excessively small, the injection of an electrolytic solution may be degraded, and a space for welding between the second current collector P and the terminal 50 is required, and thus, it is preferable that the diameter of the current collector hole H2 is equal to or greater than

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0.5\*R3 and it is more preferable that the diameter of the current collector hole H2 is equal to or greater than 0.7\*R3.

In another aspect, the central portion 31 may have a substantially circular plate shape. For example, referring to FIG. 4a, the central portion 31 may have an annular plate shape at the center of which the current collector hole H2 is formed.

The at least one tab coupling portion 32 may extend substantially radially from the central portion 31 of the current collector 30 to a sidewall of the battery housing 20. For example, a plurality of tab coupling portions 32 may be provided. For example, referring to FIG. 4a, the plurality of tab coupling portions 32 may be spaced apart from one another along a circumference of the central portion 31. As such, because the battery 1 of the present disclosure includes the plurality of tab coupling portions 32, a coupling area with the first uncoated portion 11 may be increased. Accordingly, a coupling force between the first uncoated portion 11 and the tab coupling portion 32 may be secured and electrical resistance may be reduced.

The tab coupling portion 32 may be welded to the first uncoated portion 11. Examples of a welding method include, but are not limited to, laser welding, resistance welding, and ultrasonic welding. The tab coupling portion 32 may be welded to the first uncoated portion 11 while being parallel to the bottom surface of the battery housing 20. The first uncoated portion 11 and the tab coupling portion 32 may be welded in the radial direction of the electrode assembly 10.

FIG. 1b is a longitudinal sectional view illustrating a part of a battery, according to another embodiment of the present disclosure. FIG. 1c is an enlarged view illustrating an

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upper portion of the electrode assembly 10 of FIG. 1b. FIG. 1d is an enlarged view illustrating an upper portion of the first uncoated portion 11 of FIG. 1c.

Referring to FIG. 1b, in a state where the tab coupling portion 32 is mounted on an end portion of the first uncoated portion 11, welding may be performed on a certain region.

5 Alternatively, at least a part of the first uncoated portion 11 may include a plurality of segments 11a in a winding direction of the electrode assembly 10. The plurality of segments 11a may be bent in a radial direction of the electrode assembly 10 to form the bent surface 102. The radial direction of the electrode assembly refers to a direction toward a core or an outer circumference. For example, as shown in FIG. 1b, at least part of the first  
10 uncoated portion 11 may include a plurality of segments 11a divided in the winding direction of the electrode assembly 10. The plurality of segments 11a may be bent toward the core of the electrode assembly 10. Referring to FIGS. 1c and 1d, the plurality of segments 11a may overlap in multiple layers in the radial direction of the electrode assembly 10. The bent surface 102 may include a stack number increasing section in which the number of  
15 overlapping layers of the segments 11a is sequentially increased to a maximum value from the outer circumference of the electrode assembly 10 to the core and a stack number uniform section from a radius point at which the number of overlapping layers is the maximum value to a radius point at which an innermost segment exists.

In this case, in a state where the tab coupling portion 32 is mounted on the bent  
20 surface 102 of the first uncoated portion 11, welding may be performed on a certain region. That is, the tab coupling portion 32 may be coupled to a region where the plurality of segments 11a overlap in multiple layers. For example, the tab coupling portion 32 may be

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coupled to the bent surface to overlap the stack number uniform section. Referring to FIG.

1d, welding between the tab coupling portion 32 and the first uncoated portion 11 may be performed on a region of the bent surface 102 of the first uncoated portion 11 where the number of overlapping layers of the first uncoated portion 11 is 10 or more. A radial ratio of a section in which the number of overlapping layers is 10 or more may be designed to be 25% or more based on a radius of the electrode assembly excluding the core, by adjusting a length of the first uncoated portion 11.

When the current collector 30 is welded to the bent surface 102 of the first uncoated portion 11, it is preferable to increase an output of a laser in order to sufficiently secure welding strength. When the output of the laser is increased, the laser may pass through a region where the first uncoated portion 11 overlaps and may penetrate into the electrode assembly 10, thereby damaging the separator or the active material layer. Accordingly, in order to prevent penetration of the laser, it is preferable to increase the number of overlapping layers of the first uncoated portion 11 to a certain level or more. In order to increase the number of overlapping layers of the first uncoated portion 11, a height of the segment 11a should be increased. However, when the height of the segment 11a is increased, a swell may occur in the first uncoated portion 11 in a process of manufacturing the first electrode current collector. Accordingly, it is preferable that the height of the segment 11a is adjusted to an appropriate level.

As described above, when a radial length ratio of the segment of the uncoated portion in which the number of overlapping layers is 10 or more is designed to be 25% or more based on a radius of the electrode assembly and the current collector 30 and a region

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where the segment of the uncoated portion overlaps in 10 or more layers are laser welded, even when an output of a laser is increased, the overlapping portion of the uncoated portion may sufficiently mask the laser, thereby preventing damage to the separator and the active material layer due to the laser.

5 Preferably, the output of the laser may be appropriately adjusted in a range of about 250 W to about 320 W or in a range of about 40% to about 90% of a maximum laser output specification, but the present disclosure is not limited thereto. When the output of the laser satisfies the numerical range, welding strength may be sufficiently increased. In an embodiment, welding strength may be increased to be 2 kgf/cm<sup>2</sup> or more, and more  
10 preferably, to 4 kgf/cm<sup>2</sup> or more. The welding strength may be preferably set to 8 kgf/cm<sup>2</sup> or less, and more preferably, set to 6 kgf/cm<sup>2</sup> or less. The welding strength is defined as a tensile force (kgf/cm<sup>2</sup>) per unit area of the current collector 30 when the current collector begins to be separated from the bent surface region. In detail, a tensile force is applied to the current collector after welding of the current collector is completed, and a magnitude  
15 thereof is gradually increased. When the tensile force is increased, the uncoated portion begins to be separated from a welding interface. In this case, a value obtained by dividing the tensile force applied to the current collector by the area of the current collector is the welding strength.

FIG. 1d is a partial cross-sectional view illustrating a bent surface region where, in  
20 an electrode assembly having a radius of 22 mm and a core radius of 4 mm and included in a battery having a form factor of 4680, the first uncoated portion 11 of the first electrode current collector divided into a plurality of segments is bent from an outer circumference to

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a core to overlap in 10 or more layers. In FIG. 1d, an electrode assembly region and a core region with no segments are not shown. A height of the segments starts from 3 mm and is increased by 1 mm whenever a radius of the electrode assembly is increased by 1 mm. After reaching a length 6 mm, 7 mm, or 8 mm in FIG. 1d, the height of the segments remains  
5 substantially the same.

Referring to FIG. 1d it is found that the number of overlapping layers of the first uncoated portion 11 is gradually increased from the outer circumference to the core, and as the length of the first uncoated portion 11 is increased, a maximum value of the number of overlapping layers is increased.

10 For example, when the length of the first uncoated portion 11 is 8 mm, the number of overlapping layers of the first uncoated portion 11 divided into a plurality of segments is increased to 18 in an interval from the outer circumference to 7 mm, is maintained at the maximum value of 18 in an interval further 8 mm toward the core, and is reduced by 1 or 2 in a radius interval adjacent to the core. The height of the segment is increased stepwise  
15 from 3 mm to 8 mm in a radius interval from 7 mm to 12 mm. In the present disclosure, the stack number uniform section is defined as a radius interval from a radius point at which the number of overlapping layers reaches a maximum value to a point at which an innermost segment is located as shown in FIG. 1d. Accordingly, a ratio of the stack number uniform section in which the segments 11a of the first uncoated portion 11 overlap in 10 or more  
20 layers is 44.4% (8/18) with respect to the radius of the electrode assembly excluding the core (4 mm).

In another example, when the length of the first uncoated portion 11 is 7 mm, the

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number of overlapping layers of the first uncoated portion 11 divided into a plurality of segments is increased to 15 in an interval from the outer circumference of the electrode assembly to 6 mm, is maintained at the maximum value of 15 in an interval further 9 mm toward the core, and is reduced by 1 or 2 in a radius interval adjacent to the core. The  
5 height of the segment is increased stepwise from 3 mm to 7 mm in a radius interval from 7 mm to 11 mm. Accordingly, a ratio of the stack number uniform section in which the segments 11a of the first uncoated portion 11 overlap in 10 or more layers is 50% (9/18) with respect to the radius of the electrode assembly excluding the core (4 mm).

In another example, when the length of the first uncoated portion 11 is 6 mm, the  
10 number of overlapping layers of the first uncoated portion 11 divided into a plurality of segments is increased to 12 in an interval from the outer circumference of the electrode assembly to 5 mm, is maintained at the maximum value of 12 in an interval further 10 mm toward the core, and is reduced by 1 or 2 in a radius interval adjacent to the core. The height of the segment is increased from 3 mm to 6 mm in a radius interval from 7 mm to 10  
15 mm. Accordingly, a ratio of the stack number uniform section in which the segments 11a of the first uncoated portion 11 overlap in 10 or more layers is 55.6% (10/18) with respect to the radius of the electrode assembly excluding the core (4 mm).

According to an embodiment, it is found that a length of a section in which the number of overlapping layers is sequentially increased is increased from 5 mm to 7 mm as  
20 a length of the first uncoated portion 11 is increased, and in particular, a condition that a ratio of the stack number uniform section in which the number of overlapping layers is 10 or more is 25% or more based on a radius of an electrode assembly excluding a core is



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satisfied.

In the present disclosure, the stack number uniform section may be increased or decreased by a radius of the core, a minimum value and a maximum value of a height of the segment in a segment height variable interval, and a height increment of the segment in a radial direction of the electrode assembly. Accordingly, it is obvious to one of ordinary skill in the art that the ratio is designed to be 25% or more by adjusting factors affecting the ratio of the stack number uniform section. In an example, when both the minimum value and the maximum value of the height of the segment are increased in the segment height variable interval, the number of stacked layers may be increased and the ratio of the stack number uniform section may be reduced to about 25%.

The stack number uniform section is a region where a current collector may be welded. Accordingly, when the ratio of the stack number uniform section is adjusted to be 25% or more, the welding strength of the current collector may be secured within a desirable range and it may be advantageous in terms of the resistance of a welding interface.

In another aspect of the present disclosure, when the first uncoated portion 11 has such a bent shape, a space occupied by the first uncoated portion 11 may be reduced, thereby improving energy density. Also, because a coupling area between the first uncoated portion 11 and the current collector 30 is increased, a coupling force may be improved and resistance may be reduced.

FIGS. 8a through 10 are views for describing a welding region between the current collector 30 and the first uncoated portion 11.

Referring to FIGS. 8a through 10, a welding bead BD may be formed in a welding

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region between the first uncoated portion 11 and the tab coupling portion 32. The welding bead BD refers to a substantially circular welding portion formed when spot welding is performed at a specific point. For example, in FIG. 11, the welding bead BD having a substantially circular shape formed as a result of spot welding is illustrated. When a plurality of welding beads BD are connected, a specific welding pattern may be formed. For example, referring to FIG. 8a, the plurality of welding beads BD may be gathered to form a substantially linear welding pattern. In an embodiment, the plurality of welding beads BD formed between the first uncoated portion 11 and the tab coupling portion 32 may form a welding pattern extending in a radial direction of the electrode assembly 10. Preferably, the welding beads BD formed between the first uncoated portion 11 and the tab coupling portion 32 may form a linear welding pattern extending in the radial direction of the electrode assembly 10. For example, a welding pattern formed between the first uncoated portion 11 and the tab coupling portion 32 may have a linear shape in which spot welding is connected. A width of the welding bead BD formed between the first uncoated portion 11 and the tab coupling portion 32 may be equal to or greater than about 0.1 mm. This is because, when laser technology is considered, a minimum width of the welding bead BD is equal to or greater than about 0.1 mm.

A longitudinal end portion of the tab coupling portion 32 may be located more inside than an innermost point of the beading portion 21 formed on the battery housing 20. In more detail, a boundary region between the tab coupling portion 32 and the housing coupling portion 33 may be located more inside in a direction toward the winding central hole H1 than the innermost point of the beading portion 21 formed on the battery housing 20.

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According to this structure, damage to a coupling portion between components which may occur when the current collector 30 is excessively bent in order to locate an end portion of the housing coupling portion 33 on the beading portion 21 may be prevented. In other words, when viewed along a longitudinal axis of the battery housing 20, the at least one tab  
5 coupling portion 32 may not overlap the beading portion 21.

In order to secure a coupling force and reduce electrical resistance by increasing a coupling area between the current collector 30 and the electrode assembly 10, not only the tab coupling portion 32 but also the central portion 31 may be coupled to the first uncoated portion 11. An end portion of the first uncoated portion 11 may be bent to be parallel to  
10 the tab coupling portion 32. As such, when the end portion of the first uncoated portion 11 is bent and coupled to the tab coupling portion 32 to be parallel to the tab coupling portion 32, a coupling area may be increased, a coupling force may be improved, and electrical resistance may be reduced. Also, a total height of the electrode assembly 10 may be minimized and energy density may be improved.

15 The at least one housing coupling portion 33 may extend from an end portion of the tab coupling portion 32 and may be coupled to the beading portion 21 on an inner surface of the battery housing 20. For example, the at least one housing coupling portion 33 may extend from the end portion of the tab coupling portion 32 to a sidewall of the battery housing 20. A plurality of housing coupling portions 33 may be provided. For example, referring  
20 to FIG. 4a, the plurality of housing coupling portions 33 may be spaced apart from one another along a circumference of the central portion 31. Referring to FIG. 1a, the plurality of housing coupling portions 33 may be coupled to the beading portion 21 on the inner

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surface of the battery housing 20. As shown in FIGS. 2 and 3, when a top surface of the beading portion 21 extends in a direction substantially parallel to a bottom surface of the battery housing 20, that is, a direction substantially perpendicular to the sidewall of the battery housing 20, and the housing coupling portion 33 also extends in the same direction, the housing coupling portion 33 may stably contact the beading portion 21. Also, as such, when the housing coupling portion 33 stably contacts the beading portion 21, welding between two components may be smoothly performed, and thus, a coupling force between the two components may be improved and an increase in resistance at a coupling portion may be minimized. Also, due to such a structure in which the current collector 30 is coupled to the beading portion 21 of the battery housing 20, not an inner surface of a cylindrical portion of the battery housing 20, a distance between the current collector 30 and the beading portion 21 may be reduced. Accordingly, a dead space inside the battery housing 20 may be minimized and the energy density of the battery 1 may be improved.

Referring to FIGS. 3 and 4a, the housing coupling portion 33 includes a contact portion 33a that is coupled to the beading portion 21 on an inner surface of the battery housing 20 and a connecting portion 33b that connects the tab coupling portion 32 to the contact portion 33a.

The contact portion 33a is coupled to the inner surface of the battery housing 20. When the beading portion 21 is formed on the battery housing 20, the contact portion 33a may be coupled to the beading portion 21 as described above. In this case, as described above, for stable contact and coupling, the beading portion 21 and the contact portion 33a may extend in a direction substantially parallel to a bottom surface of the battery housing 20,

that is, a direction substantially perpendicular to a sidewall of the battery housing 20. The contact portion 33a may have a flat surface coupled to a top surface of the beading portion 21 facing the opening portion. That is, the contact portion 33a includes at least a flat portion substantially parallel to the bottom surface of the battery housing 20.

5           In an embodiment of the present disclosure, the connecting portion 33b may extend in a radial direction and a winding axis direction. Meanwhile, referring to FIG. 13f, the connecting portion 33b may have an upwardly convex structure. For example, the connecting portion 33b may have an upwardly convex curved shape. Alternatively, as shown in FIG. 13f, the connecting portion 33b may include at least one bent part C.  
10   Preferably, when viewed along a longitudinal axis of the battery housing, the at least one bent part C may be bent at an obtuse angle so as not to overlap. More preferably, a boundary point between the contact portion 33a and the connecting portion 33b may be bent at an obtuse angle. That is, as shown in FIG. 13f, an inclination of the connecting portion 33b may be reduced stepwise or gradually toward the beading portion.

15           In another embodiment of the present disclosure, referring to FIG. 4a, the connecting portion 33b may include at least one bending portion B whose extension direction is changed at least once between the central portion 31 and the contact portion 33a. That is, the connecting portion 33b may have a structure that may be contracted and extended within a certain range, for example, a spring-like structure or a bellows-like structure. The  
20   connecting portion 33b may be elastically biased upward by the bending portion B. According to this structure of the connecting portion 33b, even when there is a height distribution of the electrode assembly 10 within a certain range, the contact portion 33a may

be in close contact with the beading portion 21 in a process of accommodating the electrode assembly 10 to which the current collector 30 is coupled in the battery housing 20. Also, according to this structure of the connecting portion 33b, a shape may be more stably achieved during a sizing process.

5           In another embodiment of the present disclosure, as shown in FIGS. 2 and 3, a connected portion between the contact portion 33a and the connecting portion 33b may be bent. Alternatively, as shown in FIG. 1a, a connected portion between the contact portion 33a and the connecting portion 33b may have a complementary shape corresponding to an inner surface of the beading portion 21. In particular, the connected portion between the  
10   contact portion 33a and the connecting portion 33b may be coupled to the beading portion 21 with no gap while having a shape matching the inner surface of the beading portion 21. According to this structure, the beading portion 21 may effectively support the current collector 30. Also, according to this structure, unnecessary interference between the beading portion 21 and the connecting portion 33b may be prevented. Accordingly, stable  
15   coupling between the contact portion 33a and the beading portion 21 may be effectively maintained.

          According to another aspect of the present disclosure, a protruding outermost point of the bending portion B may be spaced by a certain interval from an innermost point of the beading portion 21. For example, referring to FIG. 3, the bending portion B may not  
20   contact the beading portion 21. According to this structure, unnecessary interference between the beading portion 21 and the connecting portion 33b may be prevented. Accordingly, stable coupling between the contact portion 33a and the beading portion 21

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may be effectively maintained.

According to another aspect of the present disclosure, due to the bending portion B, an angle between the contact portion 33a and the connecting portion 33b may be an acute angle. For example, referring to FIGS. 2, 4b, and 8b, the connecting portion 33b does not include a bending portion. Accordingly, an angle between the contact portion 33a and the connecting portion 33b may be an obtuse angle. In contrast, referring to FIGS. 3 and 4a, the connecting portion 33b includes a bending portion. Accordingly, an angle between the contact portion 33a and the connecting portion 33b may be an acute angle. According to this structure, because an angle between the contact portion 33a and the connecting portion 33b is an acute angle, interference between the beading portion 21 and the connecting portion 33b may be prevented. Accordingly, stable coupling between the contact portion 33a and the beading portion 21 may be maintained. Although one bending portion B is provided in the drawings of the present disclosure, the present disclosure is not limited thereto and a plurality of bending portions B may be provided.

It is preferable that a vertical distance between the contact portion 33a and the central portion 31 in a state where an external force is not applied to the current collector 30 and thus there is no deformation is equal to a vertical distance between a top surface of the beading portion 21 and the central portion 31 when the electrode assembly 10 to which the current collector 30 is coupled is mounted in the battery housing 20 or is smaller within a range in which the connecting portion 33b is stretchable. In a case where the connecting portion 33b is configured to satisfy the above condition, when the electrode assembly 10 to which the current collector 30 is coupled is mounted in the battery housing 20, the contact

portion 33a may naturally be in close contact with the beading portion 21.

In addition, according to such a contractible and stretchable structure of the connecting portion 33b, even when vibration and/or impact occurs during the use of the battery 1 and thus the electrode assembly 10 vertically moves, impact according to the movement of the electrode assembly 10 may be reduced, within a certain range.

In another aspect of the present disclosure, the connecting portion 33b may have an upwardly convex curved shape. For example, the connecting portion 33b may protrude toward a winding center of the electrode assembly 10. A shape of the connecting portion 33b is determined to prevent damage to a coupling portion between the current collector (first current collector) 30 and the electrode assembly 10 and/or a coupling portion between the current collector (first current collector) 30 and the battery housing 20 during a sizing process.

FIGS. 13a through 13d are views for describing a process of manufacturing the battery 1 of the present disclosure.

FIG. 13a is a view for describing a welding process of the current collector 30. After the current collector 30 is placed on the electrode assembly 10 that is accommodated in the battery housing 20, a process of welding the current collector 30 and the first uncoated portion 11 of the electrode assembly 10 which protrudes upward is illustrated. In this case, the tab coupling portion 32 of the current collector 30 is welded to a bent surface formed by the plurality of segments 11a of the first uncoated portion 11.

Next, FIG. 13b is a view for describing a beading process of the battery housing 20. In a state where the current collector 30 is welded to the electrode assembly 10, a beading



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knife may move toward the inside of the battery housing 20. Accordingly, the beading portion 21 formed by press-fitting a part of the battery housing 20 into the battery housing 20 is provided on a side surface of the battery housing 20. Because the beading portion 21 is located under than the contact portion 33a of the current collector 30, an inner surface of the beading portion 21 and the contact portion 33a may be welded to each other.

Next, FIG. 13c is a view for describing a crimping process of the battery housing 20. The contact portion 33a of the current collector 30 may be placed on a top surface of the beading portion 21. The cap 40 whose end portion is surrounded by the sealing gasket G1 may be placed on a top surface of the contact portion 33a. Next, the battery housing 20 is bent to surround a circumferential edge of the cap 40, and fixes the cap 40 and the current collector 30. Due to this bent shape of the crimping portion 22, the cap 40 and the current collector 30 are fixed to the beading portion 21.

Next, FIG. 13d is a view for describing a sizing process of the battery housing 20. A sizing process is a compression process for reducing a height of the beading portion 21 of the battery housing 20 in order to reduce a total height of the battery 1, when the battery 1 is manufactured. According to the sizing process, because the battery housing 20 is compressed in a longitudinal direction, a part of the electrode assembly 10 may be compressed by the beading portion 21. In another aspect, according to the sizing process, because the battery housing 20 is compressed in the longitudinal direction (vertical direction), the current collector 30 may be vertically bent under pressure. That is, the tab coupling portion 32 may be bent upward, and thus, welding between the tab coupling portion 32 and the first uncoated portion 11 may be likely to be damaged. Accordingly, there is a demand

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for a shape of the current collector 30 in which a welding region between the tab coupling portion 32 and the first uncoated portion 11 is not damaged even after the sizing process.

For example, when the connecting portion 33b has an upwardly convex shape as shown in FIG. 13f, upward lifting of the tab coupling portion 32 may be suppressed as much as possible as shown in FIG. 13d. That is, when the battery housing 20 of FIG. 13c is vertically compressed, the current collector 30 of the present disclosure vertically receives stress. However, because the connecting portion 33b of the current collector 30 of the present disclosure has an upwardly convex shape, stress applied to the tab coupling portion 32 may be minimized. Accordingly, the tab coupling portion 32 may not be bent upward, and good welding with the first uncoated portion 11 may be maintained.

In more detail, referring to FIGS. 13f and 13g, the connecting portion 33b before a sizing process may have an upwardly convex shape based on an imaginary straight line that connects an end portion of the contact portion 33a to an end portion of the tab coupling portion 32. For example, at least one bent part C having an obtuse angle may be provided on the connecting portion 33b. The bent part C may be located over an imaginary plane that passes through the center of the imaginary straight line that connects the end portion of the contact portion 33a to the end portion of the tab coupling portion 32, and is parallel to a bottom surface of the battery housing 20. Preferably, a length of the connecting portion 33b between the tab coupling portion 32 and the bent part C may be greater than a length of the connecting portion 33b between the contact portion 33a and the bent part C.

According to this structure, during the sizing process of receiving pressure in a vertical direction, the contact portion 33a moves downward in an arrow direction and the

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connecting portion 33b moves upward in an arrow direction (see dashed line). In more detail, the connecting portion 33b moves upward to be over the beading portion 21. That is, a profile of the housing coupling portion 33 is changed before and after the sizing process as shown in FIG. 13f. A degree to which the connecting portion 33b moves upward varies  
5 according to a change in a height of the battery housing 20 during the sizing process. Unlike in the drawing, a position of the bent part C may move upward only up to a height of the contact portion 33a. As such, because the connecting portion 33b may absorb most of stress due to the upward movement of the connecting portion 33b, stress applied to a welding region between the tab coupling portion 32 and the first uncoated portion 11 is relatively  
10 small. Accordingly, according to the present disclosure, a phenomenon where the tab coupling portion 32 is lifted upward may be prevented. Also, according to the above structure, because a length of the connecting portion 33b between the tab coupling portion 32 and the bent part C is greater than a length of the connecting portion 33b between the contact portion 33a and the bent part C, the insertion of the current collector 30 into the  
15 battery housing 20 may be facilitated and stress distribution may be effectively achieved.

In another embodiment of the present disclosure, referring to FIG. 13g, a profile of the battery collector plate 30 after a sizing process may be deformed to be different from that in FIG. 13f. For example, in FIG. 13f, the connecting portion 33b may be deformed into an upwardly convex curved shape after the sizing process, whereas in FIG. 13g, the  
20 connecting portion 33b may be deformed into a straight line shape that is bent at the bent part C. In more detail, in FIG. 13g, after the sizing process, the connecting portion 33b may be deformed to be upwardly convex while each of a part of the connecting portion 33b

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between the tab coupling portion 32 and the bent part C and a part of the connecting portion 33b between the contact portion 33a and the bent part C maintains a straight line shape.

As a result of examining a shape of the current collector 30 capable of preventing distortion and/or lifting of the current collector 30, the present inventors have found that, when the connecting portion 33b has an upwardly convex structure, damage to welding between the tab coupling portion 32 and the first uncoated portion 11 is significantly reduced.

FIG. 13e is a view illustrating a degree of damage to a welding region of the current collector 30 after a sizing process according to a shape of the current collector 30 before a sizing process.

Referring to FIG. 13e, Experimental Example 1 is an experimental example in which the connecting portion 33b before sizing had a straight line shape. Experimental Example 2 is an experimental example in which the connecting portion 33b before sizing was convex downward. Experimental Example 3 is an experimental example in which the connecting portion 33b before sizing was convex upward. As a result of performing a 1 mm-sizing process for Experimental Examples 1 through 3, in Experimental Example 1 in which the connecting portion 33b had a straight line shape, a welding region with the tab coupling portion 32 was lifted by about 0.72 mm. In Experimental Example 2 in which the connecting portion 33b was convex downward, a welding region with the tab coupling portion was lifted by about 0.99 mm. That is, it was found that when the connecting portion 33b was convex downward, a lifting phenomenon was increased compared to when the connecting portion 33b had a straight line shape. In Experimental Example 3 in which the connecting portion 33b was convex upward, a welding region with the tab coupling portion

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32 was lifted by about 0.02 mm. It means that a lifting phenomenon was significantly reduced compared to Experimental Examples 1 and 2. That is, in Experimental Example 3 in which the connecting portion 33b was convex upward, it was found that damage to a welding region between the tab coupling portion and the first uncoated portion was minimized. This is because a degree of lifting of the current collector 30 is affected by stress applied by the current collector 30 to the electrode assembly 10. That is, in Experimental Example 1 in which the connecting portion 33b had a straight line shape and Experimental Example 2 in which the connecting portion 33b was convex downward, because stress applied to a welding portion between the current collector 30 and the electrode assembly 10 in a sizing process was about 4.5 MPa and about 3.7 MPa which were very large, it was found that a lifting phenomenon of the current collector 30 was severe. In contrast, in Experimental Example 3 in which the connecting portion 33b was convex upward, because stress applied to a welding portion between the current collector 30 and the electrode assembly 10 in a sizing process was about 2.0 MPa which was lower than those in Experimental Examples 1 and 2, it was found that a lifting phenomenon of the current collector 30 was relatively small.

Accordingly, preferably, as shown in FIG. 13f, a gradient of the connecting portion 33b may not be constant and a gradient of an upper portion may be less than a gradient of a lower portion based on a certain point (e.g., the bent part C). The certain point may be located above a middle point of the connecting portion 33b. Alternatively, the connecting portion 33b may have an upwardly convex shape based on an imaginary straight line that connects the tab coupling portion 32 to the contact portion 33a. The convex shape may be

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a shape in which a straight line and a straight line are connected, a curved shape, or a combined shape thereof. In an example, as shown in FIG. 13f, the connecting portion 33b may include at least one bent part C based on the certain point. Preferably, the at least one bent part C may be bent at an obtuse angle so as not to overlap, when viewed along a longitudinal axis of the battery housing 20. In another modified example, an inclination of the connecting portion 33b may be reduced stepwise or gradually toward the beading portion 21.

In another aspect of the present disclosure, referring to FIG. 13d, an angle  $\theta$  between the tab coupling portion 32 and the connecting portion 33b may range from, for example,  $0^\circ$  to  $90^\circ$ . For example, when a height of an upper end of the electrode assembly 10 is increased to correspond to a height of the beading portion 21 in a sizing process, the tab coupling portion 32 and the contact portion 33a may be located at the same height. That is, in this case, the angle  $\theta$  between the tab coupling portion 32 and the connecting portion 33b is  $0^\circ$ . Even when the sizing process is performed, it is not preferable that the contact portion 33a is located under the tab coupling portion 32. This is because, in this case, the first uncoated portion 11 may be excessively pressed by the beading portion 21 to be damaged. Accordingly, it is preferable that the angle  $\theta$  between the tab coupling portion 32 and the connecting portion 33b is equal to or greater than  $0^\circ$ . In another aspect, the angle  $\theta$  between the tab coupling portion 32 and the connecting portion 33b may be increased up to  $90^\circ$  according to a shape in which a length, a thickness, or a gradient of the connecting portion 33b is changed stepwise or gradually. However, in order to avoid contact with the cap 40, it is not preferable that the angle  $\theta$  exceeds  $90^\circ$ .

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In another aspect of the present disclosure, the connecting portion 33b may support the cap 40. For example, the connecting portion 33b may be bent upward due to a sizing process. In this case, the connecting portion 33b that is bent upward may contact the cap 40. In this case, the connecting portion 33b may support the cap 40 upward. Accordingly, 5 the current collector 30 may be firmly fixed in a vertical direction due to the sizing process. Accordingly, even when vibration and/or impact occurs during the use of the battery 1, because the current collector 30 fixes the electrode assembly 10 in the vertical direction, unnecessary vertical movement of the electrode assembly 10 inside the battery housing 20 may be prevented.

10 In another aspect of the present disclosure, a beading portion top surface and a beading portion bottom surface may be asymmetric with respect to an imaginary reference plane that passes through an innermost point of the beading portion 21 to be parallel to a bottom surface of the battery housing. For example, referring to FIG. 13d, because the battery housing 20 is compressed in the vertical direction due to the sizing process, the 15 beading portion 21 is also compressed in the vertical direction. Accordingly, the beading portion top surface and the beading portion bottom surface may be asymmetric with respect to the imaginary reference plane that passes through the innermost point of the beading portion 21.

In another aspect of the present disclosure, a press-fitting depth of the beading 20 portion 21 may be defined as PD. For example, referring to FIG. 11, a distance from an inner surface of the battery housing 20 to an innermost point of the beading portion 21 may be defined as the press-fitting depth PD. Meanwhile, a shortest distance from an end

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portion of the contact portion 33a to a vertical line that passes through the innermost point of the beading portion 21 may be defined as an overlap length OV. That is, referring to FIG. 11, when the beading portion 21 is projected in a vertical direction, the overlap length OV refers to a radial length of a region where the projection and the current collector 30 overlap each other. In this case, the battery 1 of the present disclosure may satisfy the following relation.

$$(R_{1,\min} + W_{\text{bead},\min}) / PD_{\max} \leq OV / PD \leq (PD_{\max} - R_{2,\min}) / PD_{\max}$$

In order for the contact portion 33a of the current collector 30 to be weldably placed on the beading portion 21, it is preferable that the ratio is equal to or greater than  $(R_{1,\min} + W_{\text{bead},\min}) / PD_{\max}$ . Referring to FIG. 11, in order for the contact portion 33a of the current collector 30 to be weldably placed on the beading portion 21, a region that is overlapped more than the radius of curvature R1 of the beading portion 21 is required. For example, when the contact portion 33a overlaps only by the radius of curvature R1 of the beading portion 21, the flat section F does not exist, and thus, the contact portion 33a may contact the beading portion 21 at only one contact point. That is, the contact portion 33a may not be stably placed on the beading portion 21. Accordingly, the contact portion 33a requires a region that is additionally overlapped in addition to the radius of curvature R1 of the beading portion 21. In this case, it is preferable that a length of the region that is additionally overlapped is equal to or greater than the welding bead width  $W_{\text{bead}}$ . That is, the contact portion 33a and the beading portion 21 may substantially overlap in the region that is additionally overlapped, and welding may be performed in this region. Accordingly, when the length of the region that is additionally overlapped is equal to or greater than the



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welding bead width  $W_{\text{bead}}$ , stable welding may be performed without departing from the overlapped region. That is, a minimum overlap length required for the contact portion 33a to be weldably placed on the beading portion 21 is  $R_{1,\text{min}} + W_{\text{bead},\text{min}}$ .

In another aspect, in order for the contact portion 33a of the current collector 30 to be weldably placed on the beading portion 21, it is preferable that the ratio is equal to or less than  $(PD_{\text{max}} - R_{2,\text{min}}) / PD_{\text{max}}$ . Referring to FIG. 11, there is the radius of curvature R2 at a boundary region between the beading portion 21 and an inner surface of the battery housing 20. Accordingly, when the contact portion 33a of the current collector 30 moves to the boundary region between the inner surface of the battery housing 20 and the beading portion 21 at which the radius of curvature R2 is formed, the contact portion 33a is lifted without being closely attached to the beading portion 21 due to the radius of curvature R2. Accordingly, a maximum overlap length required for the contact portion 33a to be closely placed on the beading portion 21 is  $PD_{\text{max}} - R_{2,\text{min}}$ .

In an example, a maximum value  $PD_{\text{max}}$  of the press-fitting depth PD of the beading portion 21 may be about 10 mm, minimum values  $R_{1,\text{min}}$  and  $R_{2,\text{min}}$  may each be about 0.05 mm, and  $W_{\text{bead},\text{min}}$  may be about 0.1 mm. In this case, a ratio of the overlap length OV to the press-fitting depth PD of the beading portion 21 may range from about 1.5% to about 99.5%. In order for the contact portion 33a of the current collector 30 to be weldably placed on the beading portion 21, it is preferable that the ratio is equal to or greater than about 1.5%. A lower limit of the OV/PD ratio may be determined from the maximum value  $PD_{\text{max}}$  of the press-fitting depth of the beading portion, the minimum value  $R_{1,\text{min}}$  of the radius of curvature R1, and a minimum width of the contact portion 33a that should contact a top

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surface of the beading portion 21 for welding of the contact portion 33a, that is, a length of the minimum width  $W_{\text{bead,min}}$  of the welding bead BD. In detail, in an example, the maximum value  $PD_{\text{max}}$  of the press-fitting depth may be 10 mm, the minimum contact width of the contact portion 33a required for welding of the contact portion 33a, that is, a length of the minimum width  $W_{\text{bead,min}}$  of the welding bead BD may be 0.1 mm, and the minimum value  $R_{1,\text{min}}$  of the radius of curvature R1 may be 0.05 mm. In this condition, because a minimum value of the overlap length OV is 0.15 mm (= 0.1 mm + 0.05 mm) and  $PD_{\text{max}}$  is 10 mm, a lower limit of the OV/PD ratio is 1.5%. Meanwhile, a point at which the contact portion 33a of the current collector 30 may contact with a maximum width on a flat portion of the beading portion top surface is a point spaced by the radius of curvature R2 from an inner surface of the battery housing. Accordingly, when an end portion of the contact portion 33a is located at the point, the overlap length OV is maximized. An upper limit of the OV/PD ratio may be determined from the maximum value of the press-fitting depth and the minimum value  $R_{2,\text{min}}$  of the radius of curvature R2. In detail, the maximum value of the press-fitting depth may be 10 mm, and the minimum value of the radius of curvature R2 may be 0.05 mm. In this condition, because the maximum value of the overlap length OV is 9.95 mm (= 10 mm - 0.05 mm) and  $PD_{\text{max}}$  is 10 mm, an upper limit of the OV/PD ratio is 99.5%.

In another aspect of the present disclosure, a welding position where the beading portion 21 and the contact portion 33a are welded may be defined as W. In more detail, the welding position W may refer to a distance from an innermost point of the beading portion 21 to a central point of an outermost welding bead BD in a radial direction. In this

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case, the welding position  $W$  and the press-fitting depth  $PD$  may satisfy the following relation.

$$(OV_{\min}-0.5*W_{\text{bead},\min})/PD_{\max} \leq W/PD \leq (OV_{\max}-0.5*W_{\text{bead},\min})/PD_{\max}$$

The welding position  $W$  of the beading portion 21 and the contact portion 33a may be determined from an overlap length of the contact portion 33a and the beading portion 21 and the minimum width  $W_{\text{bead},\min}$  of the welding bead  $BD$ . The welding position  $W$  is a central point of the welding bead  $BD$ .

Referring to FIG. 11, a welding position when the contact portion 33a is minimally placed on the beading portion 21 may be defined as  $W1$ . An overlap length in this case is  $OV_{\min}$  as described above. Because welding may be stably performed when the welding bead  $BD$  is formed within an overlapped region, the welding bead  $BD$  should be completely included in the overlapped region. Accordingly, the welding position  $W1$  should be a point spaced apart by at least  $0.5*W_{\text{bead},\min}$  from  $OV_{\min}$  toward the inside of the beading portion 21. Accordingly,  $W1$  may satisfy the following relation.

$$\begin{aligned} W1 &= OV_{\min}-0.5*W_{\text{bead},\min} \\ &= R_{1,\min}+W_{\text{bead},\min}-0.5*W_{\text{bead},\min} \\ &= R_{1,\min}+0.5*W_{\text{bead},\min} \end{aligned}$$

Because a  $PD$  value should be maximized in order to minimize  $W1/PD$ , a minimum value of  $W/PD$  is  $(OV_{\min}-0.5*W_{\text{bead},\min})/PD_{\max}$ .

In another aspect, referring to FIG. 11, a welding position when the contact portion 33a is maximally placed on the beading portion 21 may be defined as  $W2$ . An overlap length in this case is  $OV_{\max}$  as described above. Because welding may be stably performed

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when the welding bead is formed within an overlapped region, the welding bead BD should be completely included in the overlapped region. Accordingly, the welding position W2 should be a point spaced apart by at least  $0.5 \cdot W_{\text{bead,min}}$  from  $OV_{\text{max}}$  toward the inside of the beading portion 21. Accordingly, W2 may satisfy the following relation.

$$\begin{aligned} 5 \quad W2 &= OV_{\text{max}} - 0.5 \cdot W_{\text{bead,min}} \\ &= PD_{\text{max}} - R_{2,\text{min}} - 0.5 \cdot W_{\text{bead,min}} \end{aligned}$$

In order maximize  $W2/PD$ ,  $\{1 - (R_{2,\text{min}} + 0.5 \cdot W_{\text{bead,min}})/PD\}$  that is a value obtained by dividing  $(PD_{\text{max}} - R_{2,\text{min}} - 0.5 \cdot W_{\text{bead,min}})$  by  $PD$  should be maximized. That is, when a  $PD$  value is maximized, a  $W2/PD$  value is also maximized. Accordingly, a maximum value of

10  $W/PD$  is  $(OV_{\text{min}} - 0.5 \cdot W_{\text{bead,min}})/PD_{\text{max}}$ .

In an example, a minimum width required to weld the contact portion 33a to the beading portion 21 may be 0.1 mm. That is, 0.1 mm corresponds to a minimum width of the welding bead BD that may be formed by using laser welding. Accordingly, the welding position W1 when the contact portion 33a minimally contacts a top surface of the beading

15 portion 21 corresponds to a point spaced apart by  $(R_{1,\text{min}} + 0.5 \cdot 0.1 \text{ mm})$  from an innermost point of the beading portion 21.  $R_{1,\text{min}}$  that is a minimum value of the radius of curvature  $R1$  is, for example, 0.05 mm. When a laser is irradiated to the point, the welding bead BD having a width of 0.1 mm is formed on a contact surface between the contact portion 33a and the beading portion 21. A width of the welding bead BD corresponds to a minimum

20 contact width of the contact portion 33a. The welding position W1 based on the press-fitting depth  $PD$  of the beading portion 21 is a point spaced apart by 0.1 mm from the innermost point of the beading portion 21.

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When the contact portion 33a maximally contacts the top surface of the beading portion 21, an end portion of the contact portion 33a is located at a point spaced apart by a radius of curvature  $R_{2,\min}$  from an inner surface of the battery housing.  $R_{2,\min}$  that is a minimum value of the radius of curvature  $R_2$  is, for example, 0.05 mm. In this case, the welding position W2 which may be closest to an end of the contact portion 33a is a point spaced apart by 0.05 mm from the end of the contact portion 33a. When a laser is irradiated to the point, the welding bead having a minimum width of 0.1 mm may be formed to contact the end of the contact portion 33a. The welding position W2 when the contact portion 33a maximally contacts the top surface of the beading portion 21 is a point spaced apart by ( $PD - R_{2,\min} - 0.05$  mm) from the innermost point of the beading portion 21. In an example, when  $R_{2,\min}$  is 0.05 mm, a maximum value of the welding position W2 is a point spaced apart by  $PD - 0.1$  mm from the innermost point of the beading portion 21.

As described above, when  $R_{1,\min}$  and  $R_{2,\min}$  are each 0.05 mm, the welding position W of the contact portion 33a based on the press-fitting depth PD may be set within a range of (0.1 mm) to ( $PD - 0.1$  mm) based on the innermost point of the beading portion 21. Because a ratio of the welding position W1 based on the press-fitting depth PD is a value when the press-fitting depth PD is maximized, a minimum value (%) of  $W1/PD$  is 1% ( $=100 \cdot 0.1 \text{ mm} / 10 \text{ mm}$ ). Also, because a maximum value of  $W1/PD$  of the welding position W2 based on the press-fitting depth PD is a value when the press-fitting depth PD is maximized, a maximum value (%) of  $W2/PD$  is 99% ( $=100 \cdot (10 \text{ mm} - 0.1 \text{ mm}) / 10 \text{ mm}$ ). For short, a welding position region based on the press-fitting depth PD may be a region that is equal to or greater than 1% and equal to or less than 99% based on the press-fitting depth

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PD.

Referring to FIG. 11, a distance from an innermost point of the beading portion 21 when the overlap length is OV to a central point of the outermost welding bead BD in a radial direction may be defined as W. In this case, the battery 1 may satisfy the following  
5 relation.

$$W = OV - 0.5 * W_{\text{bead,min}}$$

In another aspect, the beading portion 21 may include the flat section F parallel to a bottom surface of the battery housing 20 in at least a region, and a length of the flat section F of the beading portion 21 contacting the current collector 30 may be  $OV - R1$ . That is,  
10 referring to FIG. 11, the flat section F corresponds to a length obtained by subtracting the radius of curvature R1 of the beading portion 21 from the overlap length OV.

In another aspect of the present disclosure, when the overlap length is OV, a radial width length of a welding pattern which is a set of the welding beads BD formed between the beading portion 21 and the contact portion 33a may be equal to or greater than  $W_{\text{bead,min}}$   
15 and equal to or less than  $OV - R1$ .

Referring to FIG. 11, because a minimum width of the welding bead BD is  $W_{\text{bead,min}}$ , a minimum value of a radial width length of the welding pattern which is formed between the beading portion 21 and the contact portion 33a should be at least  $W_{\text{bead,min}}$ . A plurality of welding beads BD may be formed over the entire flat section F of the beading portion 21.  
20 In this case, the plurality of welding beads BD may form a certain welding pattern. Referring to FIG. 11, a maximum value of the radial width length of the welding pattern which is formed between the beading portion 21 and the contact portion 33a may satisfy the

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following relation.

Maximum value of the radial width length of the welding which is formed between the beading portion 21 and the contact portion 33a

$$\begin{aligned} &= W - W1 + \text{minimum width of the welding bead BD} \\ 5 \quad &= [(OV - 0.5 \cdot W_{\text{bead,min}}) - (R1 + 0.5 \cdot W_{\text{bead,min}})] + W_{\text{bead,min}} \\ &= OV - R1 \end{aligned}$$

In another aspect of the present disclosure, a ratio of the radial width length of the welding pattern to a length of the flat section F may range from about 10% to about 40%. Preferably, the ratio may range from about 20% to about 30%. When the ratio satisfies the  
10 range, welding strength may be increased as a welding area is increased. Accordingly, the battery 1 according to the present disclosure may secure high impact resistance.

In another aspect of the present disclosure, a ratio of the area where the current collector 30 does not contact a top surface of the electrode assembly 10 to the area of a circle having an outer diameter of the electrode assembly 10 as a diameter may be defined as an  
15 aperture ratio of the current collector 30. The aperture ratio may be calculated as follows.

$$\begin{aligned} &\text{Aperture ratio (\%)} \\ &= 1 - (\text{area where the current collector contacts the top surface of the electrode} \\ &\quad \text{assembly}) / (\text{area of the circle having the outer diameter of the electrode assembly as the} \\ &\quad \text{diameter}) \\ 20 \quad &= (\text{area where the current collector does not contact the top surface of the electrode} \\ &\quad \text{assembly}) / (\text{area of the circle having the outer diameter of the electrode assembly as the} \\ &\quad \text{diameter}) \end{aligned}$$

The aperture ratio of the current collector 30 may be, for example, equal to or greater than about 30% and less than 10%, and preferably, may be equal to or greater than about 60% and less than 100%. Assuming that the current collector 30 of FIG. 8a is placed on and coupled to the electrode assembly 10, a region where the current collector 30 contacts the electrode assembly 10 may be the central portion 31 and the tab coupling portion 32. That is, a ratio of the area where the current collector 30 contacts the electrode assembly 10 to the area of a circle having an outer diameter of the electrode assembly 10 as a diameter may be equal to or less than about 70%, and preferably, may be equal to or less than about 40%. When an aperture ratio of the current collector 30 is within the range, an electrolytic solution may be smoothly penetrated into the electrode assembly 10 through an opening region of the current collector 30 having the current collector hole H2 during injection of the electrolytic solution. That is, when the aperture ratio of the current collector 30 is within the range, the electrolytic solution may be penetrated into the electrode assembly 10 through the opening region of the current collector 30 and the winding central hole H1 formed in the electrode assembly 10, and in particular, because there is a fine gap between overlapped surfaces of the segments 11a and between adjacent segments 11a, the electrolytic solution may be smoothly penetrated into the electrode assembly 10 due to capillary action through the gap.

Next, referring to FIG. 5, the current collector 30 according to another embodiment of the present disclosure is illustrated. The current collector 30 according to another embodiment of the present disclosure is only different in a shape of the contact portion 33a from the current collector 30 of FIG. 4a, and thus, other structures of the current collector 30 described above may be substantially the same.



Referring to FIG. 5, as an example, the contact portion 33a may have a greater width than the connecting portion 33b. For example, at least a part of the contact portion 33a may extend along an inner circumferential surface of the battery housing 20. Preferably, the contact portion 33a may have an arc shape that extends along the beading portion of the battery housing 20. Also, although not shown in FIG. 5, in order to maximize a contact area, the current collector 30 may be configured so that a sum of an extending length of the contact portion 33a of at least one housing coupling portion 33 is substantially the same as an inner circumference of the battery housing 20. In this embodiment, a coupling area is maximized, and thus, a coupling force may be improved and electrical resistance may be reduced.

Next, referring to FIG. 6, the current collector 30 according to another embodiment of the present disclosure is illustrated. The current collector 30 according to another embodiment of the present disclosure is only different in shapes of the contact portion 33a and the connecting portion 33b from the current collector 30 of FIG. 5, and thus, other structures of the current collector 30 described above may be substantially the same. That is, the connecting portion 33b may have a greater width than the tab coupling portion 32. Alternatively, as another embodiment, the connecting portion 33b may also have a smaller width than the tab coupling portion 32.

Referring to FIG. 6, at least a part of the connecting portion 33b may extend along an inner circumferential surface of the battery housing 20. In detail, the contact portion 33a may have an arc shape that extends along the beading portion of the battery housing 20,

and the connecting portion 33b may have an arc shape that extends along the contact portion 33a. According to this structure, because the area of the current collector 30 is additionally increased when compared to the current collector 30 of FIG. 5, the effect of reducing electrical resistance may be maximized.

5 Referring to FIG. 6, the current collector 30 may not include the bending portion B, unlike the current collector 30 of FIGS. 4a and 5. When the current collector 30 does not include the bending portion B, raw materials required to manufacture the current collector 30 may be reduced. Accordingly, manufacturing costs of the current collector 30 may be reduced.

10 Referring to FIG. 1a, the cap 40 covers the opening portion formed on a side of the battery housing 20. The cap 40 may be fixed by the crimping portion 22 formed on an upper end of the battery housing 20. In this case, in order to improve a fixing force and improve the sealing property of the battery housing 20, the sealing gasket G1 may be located between the battery housing 20 and the cap 40. However, in the present disclosure, the cap  
15 40 is not a component that should function as a passage of current. Accordingly, as long as the battery housing 20 and the cap 40 may be firmly fixed and the sealing property of the opening portion of the battery housing 20 may be secured through the application of another structure well known in the related art, the application of the sealing gasket G1 is not essential.

20 Assuming that the sealing gasket G1 is applied, the sealing gasket G1 that is located between the opening portion of the battery housing 20 and the current collector 30 may be configured so that a portion of the current collector 30 contacting the beading portion 21 is

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located between the beading portion 21 and the sealing gasket G1. The sealing gasket G1 may have a substantially annular shape surrounding the cap 40. The sealing gasket G1 may simultaneously cover a top surface, a bottom surface, and a side surface of the cap 40. A radial length of a portion of the sealing gasket G1 covering the bottom surface of the cap 40 may be equal to or less than a radial length of a portion of the sealing gasket G1 covering the top surface of the cap 40. When a radial length of a portion of the sealing gasket G1 covering the bottom surface of the cap 40 is excessively large, the sealing gasket G1 may press the current collector 30 in a process of vertically compressing the battery housing 20 during a sizing process, thereby damaging the current collector 30 or the battery housing 20. In particular, when a radial length of a portion of the sealing gasket G1 covering the bottom surface of the cap 40 is excessively large, the sealing gasket G1 may excessively press the connecting portion 33b in a process of vertically compressing the battery housing 20 during a sizing process, thereby deforming the connecting portion 33b or damaging a part of the connecting portion 33b. Accordingly, it is necessary to keep a radial length of a portion of the sealing gasket G1 covering the bottom surface of the cap 40 to a certain level.

In contrast, a portion of the sealing gasket G1 covering the top surface of the cap 40 does not interfere with the current collector 30 due to its structural and positional characteristics. In another aspect, the battery housing 20 and the cap 40 do not necessarily need to be insulated from each other. That is, because a portion of the sealing gasket G1 covering the top surface of the cap 40 needs only a sealing function and does not need insulation or other separate functions, there are relatively few restrictions on its length.

For example, as shown in FIG. 1a, a radial length of a portion of the sealing gasket

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G1 covering the bottom surface of the cap 40 may be the same as a radial length of a portion of the sealing gasket G1 covering the top surface of the cap 40. Alternatively, as shown in FIGS. 2 and 3, a radial length of a portion of the sealing gasket G1 covering the bottom surface of the cap 40 may be less than a radial length of a portion of the sealing gasket G1 covering the top surface of the cap 40.

The contact portion 33a may be located and fixed between the beading portion 21 of the battery housing 20 and the sealing gasket G1. That is, the contact portion 33a may be fixed due to a crimping force of the crimping portion 22 in a state where the contact portion 33a is located between the beading portion 21 of the battery housing 20 and the sealing gasket G1.

In this case, a thickness of the sealing gasket G1 may vary according to a circumferential direction. For example, a thickness of the sealing gasket G1 may be alternately increased and decreased in the circumferential direction.

In an example, the sealing gasket G1 may have the same compressibility in a region where the sealing gasket G1 contacts the contact portion 33a and in a region where the sealing gasket G1 does not contact the contact portion 33a. That is, in an uncompressed state, the sealing gasket G1 may be configured so that a thickness of the sealing gasket G1 varies in the circumferential direction.

In another example, the sealing gasket G1 may be configured so that a compressibility in a region where the sealing gasket G1 does not contact the contact portion 33a is less than that in a region where the sealing gasket G1 contacts the contact portion 33a. That is, in an uncompressed state, the sealing gasket G1 may be configured to have a constant

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thickness in the circumferential direction, and may be configured so that a thickness varies only in a certain region when compressed due to a crimping force later.

In another example, the sealing gasket G1 may be configured so that a thickness in a region where the sealing gasket G1 does not contact the contact portion 33a is greater than  
5 that in a region where the sealing gasket G1 contacts the contact portion 33a. That is, although not shown, the sealing gasket G1 may have a relatively high compressibility in a region where the sealing gasket G1 contacts the contact portion 33a.

In another aspect, a welding portion may be formed between the beading portion 21 of the battery housing 20 and the contact portion 33a of the current collector. For example,  
10 the fixing of the contact portion 33a may not be reliable only with a crimping force. In addition, when the sealing gasket G1 is contracted by heat or the crimping portion 22 is deformed by external impact, a coupling force between the current collector and the battery housing 20 is likely to be reduced. Accordingly, the current collector 30 may be fixed to the battery housing 20 through welding in a state where the contact portion 33a is placed on  
15 the beading portion 21 of the battery housing 20. Next, the cap 40 surrounded by the sealing gasket G1 may be placed on an upper end of the contact portion 33a and the crimping portion 22 may be formed, to complete a manufacturing process of the battery 1. In this case, examples of the welding method may include, but are not limited to, laser welding, resistance welding, and ultrasonic welding. As such, according to a structure in which the  
20 contact portion 33a is located between the beading portion 21 and the sealing gasket G1 and the contact portion 33a is coupled to the beading portion 21 through welding, a coupling force of a welding portion may be increased and surface adhesion may be ensured even with

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cell behavior for a long time. Accordingly, safety problems such as cycle fading may be minimized.

FIGS. 8a through 10 are views for describing a welding region between the contact portion 33a and the beading portion 21.

5 Referring to FIGS. 8a through 10, the welding bead BD may be formed in a welding region between the contact portion 33a and the beading portion 21. For example, when a beading portion top surface and a beading portion bottom surface are inclined at a certain angle with respect to a bottom surface of the battery housing 20 as shown in FIG. 1a, the contact portion 33a may be mounted on an inclined top surface of the beading portion 21.

10 Alternatively, as shown in FIGS. 2 and 3, when each of the beading portion top surface and the beading portion bottom surface includes the flat section F parallel to the bottom surface of the battery housing 20 in at least a region, the contact portion 33a may be mounted on a flat top surface of the beading portion 21. Next, the contact portion 33a may be welded to the beading portion 21.

15 FIG. 11 is a view for describing a position, a length, and a width of the welding bead BD formed in a welding region between the contact portion 33a and the beading portion 21.

Referring to FIG. 11, the contact portion 33a may be welded to a flat top surface of the beading portion 21.

20 Referring to 8a through 10, when a plurality of welding beads BD may be gathered, a certain welding pattern may be formed. For example, referring to FIG. 8a, a plurality of welding beads BD may be gathered to form a welding pattern having a substantially straight line shape. For example, a welding pattern formed between the beading portion 21 and the

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contact portion 33a may have a linear shape in which spot welding is connected. A width of the welding bead BD formed between the beading portion 21 and the contact portion 33a may be equal to or greater than about 0.1 mm. This is because, when laser technology is considered, a minimum width of the welding bead BD is equal to or greater than about 0.1  
5 mm.

At least one welding bead BD may be formed between the beading portion 21 and the contact portion 33a. For example, a plurality of welding beads BD may be formed in a circumferential direction between the beading portion 21 and the contact portion 33a. In particular, a plurality of welding beads BD formed between the beading portion 21 and the  
10 contact portion 33a may be formed in the same contact portion 33a. For example, the plurality of welding beads BD formed in the same contact portion 33a may be symmetrically formed in the same contact portion 33a. The plurality of welding beads BD formed in the same contact portion 33a may be formed at an interval of a certain angle, for example, 30°. In detail, the plurality of welding beads BD formed in the same contact portion 33a may be  
15 located within a circumferential angle range of 30° or less based on the center of a circle formed by the beading portion 21 in the same contact portion 33a.

The welding beads BD formed between the beading portion 21 and the contact portion 33a may form a welding pattern having a straight line shape extending in the circumferential direction. Alternatively, the welding beads BD formed between the  
20 beading portion 21 and the contact portion 33a may form a welding pattern having an arc shape extending in the circumferential direction. According to an embodiment of the present disclosure, a circumferential length of the contact portion 33a may be the same as a

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circumferential length of the tab coupling portion 32. Also, a circumferential length of the contact portion 33a may be the same as a circumferential length of the connecting portion 33b. For example, as shown in FIG. 4a, the tab coupling portion 32, the connecting portion 33b, and the contact portion 33a may extend to have the same width. Preferably, the tab  
5 coupling portion 32, the connecting portion 33b, and the contact portion 33a may have the same width along the extending direction.

In another aspect, an extension direction of a welding pattern formed between the first uncoated portion 11 and the tab coupling portion 32 and an extension direction of a welding pattern formed between the beading portion 21 and the contact portion 33a may be  
10 different from each other. Preferably, an extension direction of a welding pattern formed between the first uncoated portion 11 and the tab coupling portion 32 and an extension direction of a welding pattern formed between the beading portion 21 and the contact portion 33a may be substantially perpendicular to each other. Referring to FIGS. 8a and 8b, a welding pattern formed between the first uncoated portion 11 and the tab coupling portion  
15 32 may be formed in a radial direction. A welding pattern formed between the beading portion 21 and the contact portion 33a may be formed in a circumferential direction of the battery housing 20. That is, an extension direction of the welding pattern formed between the first uncoated portion 11 and the tab coupling portion 32 and an extension direction of the welding pattern formed between the beading portion 21 and the contact portion 33a may  
20 be substantially perpendicular to each other. According to this structure, coupling strength between the current collector 30 and the electrode assembly 10 may be increased. That is, according to this structure, because the current collector 30 is fixed by welding performed



in various directions, even when the current collector 30 receives vibration or impact in a specific direction, the current collector 30 may be firmly fixed.

According to another embodiment of the present disclosure, a circumferential length of the contact portion 33a may be greater than a circumferential length of the tab coupling portion 32. Also, preferably, a circumferential length of the contact portion 33a may be greater than a circumferential length of the connecting portion 33b. For example, referring to FIGS. 5 and 6, it may be found that a circumferential length of the contact portion 33a is greater than a circumferential length of the tab coupling portion 32. Also, referring to FIG. 5, it may be found that a circumferential length of the contact portion 33a is greater than a circumferential length of the connecting portion 33b. As such, when a circumferential length of the contact portion 33a is large, a coupling force between the beading portion 21 and the current collector 30 may be improved. Furthermore, when a circumferential length of the contact portion 33a and/or the connecting portion 33b is large, the internal resistance of a battery may be reduced.

Referring to FIGS. 5 and 6, the contact portion 33a may have an arc shape extending in a circumferential direction along the beading portion 21 of the battery housing. In more detail, the contact portion 33a may have an arc shape extending in opposite directions along the circumferential direction, from an intersection between the connecting portion 33b and the contact portion 33a.

Referring to FIG. 6, the connecting portion 33b may have an arc shape extending in the circumferential direction along the contact portion 33a. Because the contact portion 33a has an arc shape extending in the circumferential direction along the beading portion 21

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of the battery housing, a coupling force between the beading portion 21 and the current collector may be improved. More preferably, a sum of lengths of the contact portions 33a extending in the circumferential direction may correspond to a length of an inner circumference of the battery housing. That is, although not shown, the current collector 30  
5 may have an annular shape in which the contact portions 33a are connected to one another. According to this shape, a coupling force between the beading portion 21 and the current collector 30 may be further improved.

FIG. 12 is a view for describing a relationship between a diameter of an inner surface of a battery housing and a total diameter of a current collector.

10 Referring to FIG. 12, when a diameter of an outer surface of the battery housing is  $D_e$ , a diameter of an inner surface of the battery housing 20 is  $D_i$ , and a total diameter of the current collector 30 is  $d$ , a relationship of  $D_e > D_i > d$  may be satisfied.

The cap 40 may include a venting portion 41 formed to prevent an increase in internal pressure due to gas generated inside the battery housing 20. The venting portion  
15 41 is formed in a part of the cap 40, and corresponds to a region that is structurally weaker than a peripheral region to be easily ruptured when internal pressure is applied. The venting portion 41 may be a region having a smaller thickness than the peripheral region.

The terminal 50 passes through the battery housing 20 from the opposite side to the opening portion of the battery housing 20 and is electrically connected to the second  
20 uncoated portion 12 of the electrode assembly 10. The terminal 50 may pass through a substantially central portion of a bottom surface of the battery housing 20. The terminal 50 may be coupled to the current collector (second current collector) P coupled to the second

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uncoated portion 12 or may be coupled to a lead tab (not shown) coupled to the second uncoated portion 12, to be electrically connected to the electrode assembly 10. Accordingly, the terminal 50 may have the same polarity as a second electrode of the electrode assembly 10, and may function as a second electrode terminal T2. When the  
5 second uncoated portion 12 is a positive electrode tab, the terminal 50 may function as a positive electrode terminal. Preferably, the terminal 50 has a riveted structure. A battery to which a riveting structure of the terminal 50 is applied may perform electrical wiring in one direction. Also, because the terminal 50 having the riveting structure has a large cross-sectional area and thus has low resistance, the terminal 50 is very suitable for rapid charging.

10 FIGS. 18a and 18b are views for describing the second current collector P, according to an embodiment of the present disclosure.

In another aspect of the present disclosure, referring to FIGS. 2 and 3, the second current collector P may be located between the second uncoated portion 12 and the terminal 50. Referring to FIGS. 18a and 18b, the second current collector P includes: a tab coupling  
15 portion P1 coupled to the second uncoated portion 12; and a terminal coupling portion P2 coupled to the terminal 50. The second current collector P may further include a connecting portion P3 and/or an edge portion P4.

In an aspect of the present disclosure, a plurality of tab coupling portions P1 may be provided. Preferably, the plurality of tab coupling portions P1 may be arranged at the same  
20 interval. Extending lengths of the plurality of tab coupling portions P1 may be the same. The terminal coupling portion P2 may be surrounded by the plurality of tab coupling portions P1.

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Preferably, the terminal coupling portion P2 may be located at a position corresponding to the winding central hole H1 formed at a winding center of the electrode assembly 10. More preferably, the terminal coupling portion P2 may cover the winding central hole H1 of the electrode assembly 10. According to this structure, the terminal 50 and the terminal coupling portion P2 located over the winding central hole H1 of the electrode assembly 10 may be welded.

The tab coupling portion P1 and the terminal coupling portion P2 may be spaced apart from each other without being directly connected to each other. For example, the tab coupling portion P1 and the terminal coupling portion P2 may be indirectly connected by the edge portion P4. As such, in the second current collector P according to an embodiment of the present disclosure, because the tab coupling portion P1 and the terminal coupling portion P2 are connected through the edge portion P4 without being directly connected to each other, when impact and/or vibration occurs in the battery 1, impact applied to a coupling portion between the tab coupling portion P1 and the second uncoated portion 12 and a coupling portion between the terminal coupling portion P2 and the terminal 50 may be distributed. Accordingly, the second current collector P may minimize or prevent damage to a welding portion due to external impact. The second current collector P of the present disclosure has a structure in which stress may be concentrated on a connected portion between the edge portion P4 and the terminal coupling portion P2 when external impact is applied. Because the connected portion is not a region where a welding portion for coupling components is formed, product defects due to damage to the welding portion caused by external impact may be prevented.

The second current collector P may further include the connecting portion P3 connected to the terminal coupling portion P2. The connecting portion P3 may be narrower than the tab coupling portion P1. In this case, electrical resistance in the connecting portion P3 is increased and larger resistance is generated than in another portion when current flows through the connecting portion P3, and thus, when overcurrent occurs, a part of the connecting portion P3 is broken, thereby blocking the overcurrent. A width of the connecting portion P3 may be adjusted to an appropriate level by considering an overcurrent blocking function.

The second current collector P may further include the edge portion P4 having a substantially rim shape in which an empty space is formed. In this case, the tab coupling portion P1 may extend inward from the edge portion P4, and may be coupled to the second uncoated portion 12. Although the edge portion P4 has a substantially circular rim shape in FIG. 18a, the present disclosure is not limited thereto. The edge portion P4 may have a substantially quadrangular rim shape or another shape, unlike in FIG. 18a.

In another aspect of the present disclosure, referring to FIG. 18b, the connecting portion P3 may include a notch portion N formed to partially reduce a width of the connecting portion P3. When the notch portion N is provided, electrical resistance in a region where the notch portion N is formed is increased, and thus, when overcurrent occurs, the overcurrent may be rapidly blocked. Preferably, a position of the notch portion N may be included in a stack number uniform section (FIG. 1d). More preferably, a position of the notch portion N may be included in a portion of the stack number uniform section in which the number of overlapping layers is maintained at a maximum. Accordingly, a

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byproduct generated when the notch portion N is broken may be reliably prevented from being penetrated into the electrode assembly.

Referring to FIGS. 2 and 3 together with FIGS. 18a and 18b, in an aspect of the present disclosure, a longest radius from the center of the terminal coupling portion P2 of the second current collector P to an end of the tab coupling portion P1 may be greater than a longest radius from a central portion of the current collector 30 to an end of the tab coupling portion 32. For example, a radius of the edge portion P4 having a substantially rim shape may be greater than a longest radius from a central portion of the current collector 30 to an end of the tab coupling portion 32. This is because, when the beading portion 21 is press-fitted into the battery housing 20, a welding area between the tab coupling portion 32 of the current collector 30 and the first uncoated portion 11 is limited.

In another aspect of the present disclosure, the tab coupling portion P1 of the second current collector P may be coupled to a bent end portion of the second uncoated portion 12. That is, the tab coupling portion P1 of the second current collector P may be welded to a bent surface formed by a plurality of segments of the second uncoated portion 12. Preferably, a welding region may overlap a stack number uniform section (FIG. 1d) by at least 50% in a radial direction, and the larger the overlap ratio, the more preferable. More preferably, a welding region may overlap a portion of the stack number uniform section in which the number of overlapping layers is at a maximum in the radial direction by at least 50%, and the larger the overlap ratio, the more preferable. Substantially the same conditions as these welding conditions may be applied to the current collector 30.

In another aspect of the present disclosure, a welding region for coupling the tab

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coupling portion P1 of the second current collector P to the bent end portion of the second uncoated portion 12 may be further formed, and a distance from the center of the terminal coupling portion P2 of the second current collector P to the welding region may be the same as or may have a distance deviation of about 5% or less from a distance from a central portion  
5 of the current collector 30 to a welding region on the tab coupling portion 32. In another aspect of the present disclosure, the welding region of the second current collector P may have a length greater than that of the welding region on the tab coupling portion 32 of the current collector 30.

In an example, a flat portion (see FIG. 1a) of the terminal 50 and the second current  
10 collector P are welded by a laser and are welded in a continuous or discontinuous line to have an arc pattern, a diameter of the arc welding pattern may be equal to or greater than 2 mm, and preferably may be equal to or greater than 4 mm. When the diameter of the arc welding pattern satisfies the condition, a tensile force of a welding portion may be increased to 2 kgf or more and thus sufficient welding strength may be secured.

15 In another example, when the flat portion of the terminal 50 and the second current collector P are welded by ultrasound and are welded in a circular pattern, it is preferable that a diameter of the circular welding pattern is equal to or greater than 2 mm. When the diameter of the circular welding pattern satisfies the condition, a tensile force of a welding portion may be increased to 2 kgf or more and thus sufficient welding strength may be  
20 secured.

A diameter of the flat portion of the terminal 50 corresponding to a weldable region may be adjusted in a range of 3 mm to 14 mm. When a radius of the flat portion of the

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terminal 50 is less than 3 mm, it is difficult to form a welding pattern having a diameter of 2 mm or more by using a laser welding tool, an ultrasonic welding tool, or the like. Also, when a radius of the flat portion of the terminal 50 exceeds 14 mm, a size of the terminal 50 may be excessively increased and the area occupied by an outer surface of the bottom of the battery housing 20 may be reduced, and thus, it is difficult to connect an electrical connection component (bus bar) through the outer surface.

Preferably, because a diameter of a welding pattern is equal to or greater than 2 mm and a diameter of a weldable region ranges from 3 mm to 14 mm to secure a tensile force of a welding portion of 2 kgf or more, a ratio of the area of the welding pattern to the area of the weldable region may range from 2.04 ( $100 \cdot \pi 1^2 / \pi 7^2$ )% to 44.4 ( $100 \cdot \pi 1^2 / \pi 1.5^2$ )%.

When the polarity and function of the terminal 50 are considered, the terminal 50 should maintain an insulated state from the battery housing 20 having the opposite polarity. To this end, the insulating gasket G2 may be applied between the terminal 50 and the battery housing 20. Alternatively, insulation may be achieved by coating an insulating material on a part of a surface of the terminal 50.

For the same reason, the second uncoated portion 12 and/or the current collector (second current collector) P should maintain an insulated state from the battery housing 20. To this end, the insulator S may be located between the second uncoated portion 12 and the battery housing 20 and/or between the current collector (second current collector) P and the battery housing 20. When the insulator S is applied, the terminal 50 may pass through the insulator S for electrical connection with the second uncoated portion 12.

Preferably, the insulator S and an inner surface of the bottom of the battery housing



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20 may be in close contact with each other. 'close contact' means that there is no space (gap) identified visually. In order to remove a space (gap), a distance from the inner surface of the bottom of the battery housing 20 to the flat portion of the terminal 50 may be equal to or slightly less than a thickness of the insulator S.

5 In the present disclosure, the entire surface of the battery housing 20 may function as a first electrode terminal T1. For example, when the first uncoated portion 11 is a negative electrode tab, the first electrode terminal T1 may be a negative electrode terminal. The battery 1 according to the present disclosure has a structure in which the terminal 50 exposed on a bottom surface of the battery housing 20 located opposite to an opening portion  
10 and a portion of the bottom surface of the battery housing 20 other than a portion occupied by the terminal 50 may be respectively used as the second electrode terminal T2 and the first electrode terminal T1. Accordingly, in the battery 1 according to the present disclosure, when a plurality of cylindrical secondary batteries 1 are electrically connected, both a positive electrode and a negative electrode may be connected, thereby simplifying an  
15 electrical connection structure. Also, because the battery 1 has a structure in which most of a bottom surface of the battery housing 20 located opposite to an opening portion may be used as an electrode terminal, a sufficient area for welding components for electrical connection may be secured.

In another aspect, an electrode of the electrode assembly 10 may have a  
20 segmentation structure for ease of bending the uncoated portion 11.

Referring to FIG. 14, an electrode plate includes a first electrode current collector having a sheet shape and formed of a conductive foil, an active material layer formed on at

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least one surface of the first electrode current collector, and the first uncoated portion 11 in which an active material is not coated on a long side end of a first electrode.

Preferably, the first uncoated portion 11 may include a plurality of segments 11a that are notched. The plurality of segments 11a may be divided into a plurality of groups, and the segments 11a included in each group may have the same height (length in a Y direction) and/or the same width (length in an X direction) and/or the same separation pitch. The number of segments 11a included in each group may be more or less than that illustrated. The segment 11a has a geometric shape in which at least one straight line and/or at least one curved line are combined. Preferably, the segment 11a may have a trapezoidal shape, but may be modified into any of shapes such as a quadrangular shape, a parallelogram shape, a semicircular shape, or a semi-elliptical shape.

Preferably, a height of the segment 11a may be increased stepwise in one direction parallel to a winding direction of the electrode assembly, for example, from a core side to an outer circumference side. Also, a core side-uncoated portion 11' adjacent to the core side may not include the segment 11a, and a height of the core-side uncoated portion 11' may be less than that of other uncoated regions. Also, an outer circumference-side uncoated portion 11'' adjacent to the outer circumference side may not include the segment 11a, and a height of the outer circumference-side uncoated portion 11'' may be less than that of other uncoated regions.

Optionally, an electrode plate may include an insulating coating layer 11b covering a boundary between the active material layer and the first uncoated portion 11. The insulating coating layer 11b may include an insulating polymer resin, and may optionally

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further include an inorganic filler. The insulating coating layer 11b may prevent an end portion of the active material layer from contacting a facing active material layer having the opposite polarity through a separator, and may structurally support bending of the segment 11a. To this end, when the electrode plate is wound for the electrode assembly 10, it is preferable that at least a part of the insulating coating layer 11b is exposed to the outside from the separator.

FIG. 15 is a cross-sectional view illustrating the electrode assembly 10, in which an uncoated portion segmentation structure of an electrode plate is applied to a first electrode current collector and a second electrode current collector, taken along a longitudinal direction Y, according to an embodiment of the present disclosure.

Referring to FIG. 15, the electrode assembly 10 may be manufactured by using a winding method. The second uncoated portion 12 protruding downward extends from the second electrode current collector, and the first uncoated portion 11 protruding upward extends from the first electrode current collector.

A pattern in which heights of the first and second uncoated portions 11, 12 are changed is schematically illustrated. That is, heights of the uncoated portions 11, 12 may be irregularly changed according to cut positions. For example, when a side portion of the segment 11a having a trapezoidal shape is cut, a height of an uncoated portion in a cross-section is less than a height of the segment 11a. Accordingly, it should be understood that heights of the uncoated portions 11, 12 shown in a cross-sectional view of the electrode assembly 10 correspond to an average of uncoated portion heights included in each winding turn.

As shown in FIGS. 16a and 16b, the uncoated portions 11, 12 may be bent in a radial direction of the electrode assembly 10, for example, from an outer circumference side to a core side. In FIG. 15, a bent portion 101 is marked by a dashed line box. When the uncoated portions 11, 12 are bent, the segments 11a adjacent to one another in the radial direction overlap one another in multiple layers to form the bent surfaces 102 over and under the electrode assembly 10. In this case, the core-side uncoated portion 11' (see FIG. 14) has a low thickness and thus is not bent, and a height  $h$  of the segment 11a that is a bent innermost segment is equal to or less than a radial length  $r$  of a winding region formed by the core-side uncoated portion 11' with no segment structure. Accordingly, the winding central hole H1 at the core of the electrode assembly 10 is not closed by the bent segments 11a. When the winding central hole H1 is not closed, there is no difficulty in an electrolyte injection process, and electrolyte injection efficiency is improved. Also, the terminal 50 and the second current collector P may be easily welded by inserting a welding tool through the winding central hole H1.

FIG. 17 is a view illustrating a state where the cylindrical secondary batteries 1 are electrically connected by using a bus bar 150, according to an embodiment of the present disclosure.

Referring to FIG. 17, the plurality of cylindrical secondary batteries 1 may be connected in series and in parallel in an upper portion by using the bus bar 150. The number of cylindrical secondary batteries 1 may be increased or decreased by considering the capacity of a battery pack 3.

In each battery 1, the terminal 50 may have a positive polarity and an outer surface

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of the bottom of the battery housing 20 may have a negative polarity, or vice versa.

Preferably, the plurality of cylindrical secondary batteries 1 may be arranged in a plurality of columns and rows. Columns are provided in a vertical direction based on the ground, and rows are provided in a left and right direction based on the ground. Also, in order to maximize space efficiency, the cylindrical secondary batteries 1 may be arranged in a closest packing structure. The closest packing structure is formed when a regular triangle is formed by connecting the centers of the terminals 50.

Preferably, the bus bar 150 may be located on adjacent cylindrical secondary batteries 1, and preferably, between the terminals 50. In an example, the bus bar 150 may be located between adjacent columns. Alternatively, the bus bar 150 may be located between adjacent rows.

Preferably, the bus bar 150 connects batteries arranged in the same column in parallel, and connects batteries arranged in two adjacent columns in series.

Preferably, the bus bar 150 may include a body portion 151, a plurality of first bus bar terminals 152, and a plurality of second bus bar terminals 153 for serial and parallel connection.

The body portion 151 may extend along a column of the cylindrical secondary batteries 1. Alternatively, the body portion 151 may extend along a column of the cylindrical secondary batteries 1, and may be regularly bent like a zigzag shape.

The plurality of first bus bar terminals 152 may protrude from a side of the body portion 151 to the terminal 50 of each battery 1, and may be electrically coupled to the terminal 50. The electrical connection with the terminal 50 may be performed by using

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laser welding, ultrasonic welding, or the like. Also, the plurality of second bus bar terminals 153 may protrude from the other side of the body portion 151 to the outer surface of the bottom of the battery housing 20 of each battery 1, and may be electrically coupled to the outer surface. The electrical connection with the outer surface may be performed by  
5 using laser welding, ultrasonic welding, or the like.

Preferably, the body portion 151, the plurality of first bus bar terminals 152, and the plurality of second bus bar terminals 153 may be formed of one conductive metal plate. The metal plate may be, but is not limited to, an aluminum plate or a copper plate. In a modified example, the body portion 151, the plurality of first bus bar terminals 152, and the  
10 plurality of second bus bar terminals 153 may be manufactured as separate pieces and then may be coupled to one another through welding or the like.

In the battery 1, because the terminal 50 having a positive polarity and the outer surface of the bottom of the battery housing 20 having a negative polarity are located in the same direction, the cylindrical secondary batteries 1 may be easily electrically connected by  
15 using the bus bar 150.

Also, because the terminal 50 of the battery 1 and the outer surface have large areas, a sufficient coupling area of the bus bar 150 may be secured and the resistance of the battery pack including the battery 1 may be sufficiently reduced.

As described above, the battery 1 of the present disclosure has a structure in which  
20 resistance is minimized by increasing a contact area between components, multiplexing a current path, minimizing a current path length, and the like. After a product is finally manufactured, AC resistance of the battery 1 measured by using a resistance measuring

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instrument between a positive electrode and a negative electrode, that is, between a top surface of the terminal 50 and an outer surface of a closed portion of the battery housing 20, may be 0.5 milliohm (mohm) to 4 milliohm (mohm), preferably 1.0 milliohm (mohm) to 4 milliohm (mohm), suitable for rapid charging.

5           In the present disclosure, a battery may be, for example, a battery in which a form factor ratio (defined as a value obtained by dividing a diameter of the battery by a height, that is, a ratio between a height  $H$  and a diameter  $\Phi$ ) is greater than about 0.4. Here, the term “form factor” used herein refers to a value indicating a diameter and a height of a battery.

          Preferably, a cylindrical battery may have a diameter of 40 mm to 50 mm and a  
10 height of 60 mm to 130 mm. The cylindrical battery according to an embodiment of the present disclosure may be, for example, a 46110 battery, a 4875 battery, a 48110 battery, a 4880 battery, or a 4680 battery. In the numerical value indicating the form factor, first two numbers indicate a diameter of a battery, and next two numbers indicate a height of the battery.

15           When a battery has recently been applied to an electric vehicle, a form factor of a battery has increased to be larger than 1865, 2170, or the like. The increase in the form factor leads to increased energy density, enhanced safety against thermal runaway, and improved cooling efficiency.

          The energy density of a battery may be further increased when an unnecessary space  
20 inside a battery housing is minimized along with the increase of the form factor. A battery according to the present disclosure has an optimal structure in which a coupling force of a coupling portion between a current collector and a battery housing may be improved, the

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capacity of a battery may be increased, and resistance may be reduced.

A battery according to an embodiment of the present disclosure may be a battery having a substantially cylindrical shape, whose diameter is about 46 mm, height is about 110 mm, and form factor ratio is about 0.418.

5 A battery according to another embodiment may be a battery having a substantially cylindrical shape, whose diameter is about 48 mm, height is about 75 mm, and form factor ratio is about 0.640.

A battery according to another embodiment may be a battery having a substantially cylindrical shape, whose diameter is about 48 mm, height is about 110 mm, and form factor  
10 ratio is about 0.418.

A battery according to another embodiment may be a battery having a substantially cylindrical shape, whose diameter is about 48 mm, height is about 80 mm, and form factor ratio is about 0.600.

A battery according to another embodiment may be a battery having a substantially  
15 cylindrical shape, whose diameter is about 46 mm, height is about 80 mm, and form factor ratio is about 0.575.

In the related art, batteries having a form factor ratio of about 0.4 or less have been used. That is, in the related art, for example, a 1865 battery, a 2170 battery, etc. have been used. The 1865 battery has a diameter of about 18 mm, a height of about 65 mm, and a  
20 form factor ratio of about 0.277. The 2170 battery has a diameter of about 21 mm, a height of about 70 mm, and a form factor ratio of about 0.300.

A battery according to an embodiment of the present disclosure may be included in



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a battery pack, and the battery pack may be mounted in a vehicle. Referring to FIG. 19, a battery pack 3 according to an embodiment of the present disclosure includes a secondary battery assembly in which the plurality of cylindrical secondary batteries 1 according to an embodiment of the present disclosure are electrically connected, and a pack housing 2 in which the secondary battery assembly is accommodated. In FIG. 19 of the present disclosure, for convenience of explanation, components for electrical connection such as a bus bar, a cooling unit, and a power terminal are not shown.

Referring to FIG. 20, a vehicle 5 according to an embodiment of the present disclosure may be, for example, an electric vehicle, a hybrid vehicle, or a plug-in hybrid vehicle, and includes the battery pack 3 according to an embodiment of the present disclosure. The vehicle 5 operates by receiving power from the battery pack 3 according to an embodiment of the present disclosure.

Although the embodiments of the present disclosure have been illustrated and described above, the present disclosure is not limited to the above-described specific embodiments. Various modified embodiments may be made by one of ordinary skill in the art without departing from the scope of the present disclosure as claimed in the claims.

#### Reference Signs

- 5: vehicle
- 20 3: battery pack
- 2: pack housing
- 1: battery

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- 10: electrode assembly
- 11: first uncoated portion
- 11a: segment
- 12: second uncoated portion
- 5 101: bent portion
- 102: bent surface
- H1: winding central hole
- 20: battery housing
- 21: beading portion
- 10 22: crimping portion
- 30: current collector (first current collector)
- H2: current collector hole
- 31: central portion
- 32: tab coupling portion
- 15 33: housing coupling portion
- 33a: contact portion
- 33b: connecting portion
- 40: cap
- 41: venting portion
- 20 G1: sealing gasket
- 50: terminal
- G2: insulating gasket

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T1: first electrode terminal

T2: second electrode terminal

P: current collector (second current collector)

P1: tab coupling portion

5 P2: terminal coupling portion

P3: connecting portion

P4: edge portion

S: insulator

F: flat section

10 BD: welding bead

PD: press-fitting depth

OV: overlap length

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**WHAT IS CLAIMED IS:**

1. A battery comprising:

an electrode assembly having a structure in which a first electrode and a second  
5 electrode are wound around a winding axis, along with a separator interposed therebetween  
to define a core and an outer circumference, the first electrode comprising an active material  
portion coated with an active material and a first uncoated portion not coated with an active  
material along a winding direction, at least a part of the first uncoated portion being used as  
an electrode tab by itself;

10 a battery housing in which the electrode assembly is accommodated through an  
opening portion formed at a side thereof;

a current collector comprising a tab coupling portion coupled to the first uncoated  
portion and a housing coupling portion extending from the tab coupling portion and  
electrically coupled to an inner surface of the battery housing; and

15 a cap covering the opening portion.

2. The battery of claim 1, wherein the battery housing comprises a beading  
portion formed on an end portion adjacent to the opening portion and press-fitted inward.

20 3. The battery of claim 2, wherein the battery housing comprises a crimping  
portion formed at a position closer to the opening portion than the beading portion, and  
extending and bent toward the opening portion.

4. The battery of claim 3, wherein the housing coupling portion is press-fixed by the crimping portion.

5 5. The battery of claim 2, wherein the housing coupling portion comprises:  
a contact portion coupled to the beading portion of the battery housing; and  
a connecting portion configured to connect the tab coupling portion to the contact portion.

10 6. The battery of claim 5, wherein the connecting portion has a structure that is convex upward based on an imaginary straight line that connects an end portion of the contact portion to an end portion of the tab coupling portion.

15 7. The battery of claim 5, wherein the connecting portion has a structure that moves upward to be over the beading portion.

8. The battery of claim 6, wherein the connecting portion comprises at least one bent part.

20 9. The battery of claim 8, wherein the bent part is located over an imaginary plane that passes through a center of the imaginary straight line that connects the end portion of the contact portion to the end portion of the tab coupling portion, and is parallel to a

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bottom surface of the battery housing.

10. The battery of claim 8, wherein the at least one bent part is bent at an obtuse angle so as not to overlap, when viewed along a longitudinal axis of the battery housing.

5

11. The battery of claim 8, wherein a boundary point between the contact portion and the connecting portion is bent at an obtuse angle.

12. The battery of claim 10, wherein an inclination of the connecting portion is reduced stepwise or gradually toward the beading portion.

10

13. The battery of claim 5, wherein an angle between the tab coupling portion and the connecting portion ranges from 0° to 90°.

15

14. The battery of claim 5, wherein the connecting portion supports the cap.

15. The battery of claim 5, wherein the tab coupling portion and the contact portion are located at a same height.

20

16. The battery of claim 5, wherein the contact portion comprises a flat surface coupled to a top surface of the beading portion facing the opening portion.

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17. The battery of claim 5, wherein the beading portion comprises:  
a beading portion top surface located over an innermost point that is press-fitted inward; and  
a beading portion bottom surface located under the innermost point that is press-  
5 fitted inward.

18. The battery of claim 17, wherein at least one tab coupling portion of the current collector is located at a lower position than the beading portion bottom surface.

10 19. The battery of claim 17, wherein at least one of the beading portion top surface and the beading portion bottom surface is inclined at a certain angle with respect to a bottom surface of the battery housing.

20. The battery of claim 19, wherein the contact portion is mounted on an  
15 inclined top surface of the beading portion.

21. The battery of claim 17, wherein at least one of the beading portion top surface and the beading portion bottom surface is parallel to a bottom surface of the battery housing in at least a region.

20

22. The battery of claim 17, wherein the beading portion top surface and the beading portion bottom surface are asymmetric with respect to an imaginary reference plane

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that passes through the innermost point of the beading portion to be parallel to a bottom surface of the battery housing.

23. The battery of claim 21, wherein the contact portion is mounted on a flat top surface of the beading portion.

24. The battery of claim 2, wherein,  
when a press-fitting depth of the beading portion is PD,  
a minimum value of a radius of curvature of the beading portion is  $R_{1,min}$ ,  
a minimum value of a welding bead width is  $W_{bead,min}$ , and  
a minimum value of a radius of curvature at a boundary region between the beading portion and the inner surface of the battery housing is  $R_{2,min}$ ,

$$PD \geq R_{1,min} + R_{2,min} + W_{bead,min}.$$

25. The battery of claim 2, wherein a press-fitting depth of the beading portion ranges from 0.2 mm to 10 mm.

26. The battery of claim 5, wherein,  
when a press-fitting depth of the beading portion is PD, a maximum value of the press-fitting depth is  $PD_{max}$ ,  
an overlap length that is a shortest distance from an end portion of the contact portion to a vertical line that passes through an innermost point of the beading portion is OV,



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a minimum value of a radius of curvature of the beading portion is  $R_{1,\min}$ ,

a minimum value of a welding bead width is  $W_{\text{bead},\min}$ , and

a minimum value of a radius of curvature at a boundary region between the beading portion and the inner surface of the battery housing is  $R_{2,\min}$ ,

5 
$$(R_{1,\min} + W_{\text{bead},\min}) / PD_{\max} \leq OV / PD \leq (PD_{\max} - R_{2,\min}) / PD_{\max}.$$

27. The battery of claim 5, wherein the contact portion is welded to the beading portion.

10 28. The battery of claim 21, wherein the contact portion is welded to a flat top surface of the beading portion.

29. The battery of claim 28, wherein a welding region between the contact portion and the beading portion is narrower than the flat top surface of the beading portion.

15 30. The battery of claim 5, wherein,  
when a press-fitting depth of the beading portion is  $PD$ , a maximum value of the press-fitting depth is  $PD_{\max}$ ,

a distance from an innermost point of the beading portion to a central point of an  
20 outermost welding bead in a radial direction is  $W$ ,

an overlap length that is a shortest distance from an end portion of the contact portion to a vertical line that passes through the innermost point of the beading portion is

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OV, a minimum value of the overlap length OV is  $OV_{\min}$ , a maximum value of the overlap length OV is  $OV_{\max}$ , and

a minimum value of a welding bead width is  $W_{\text{bead},\min}$ ,

$$(OV_{\min}-0.5*W_{\text{bead},\min})/PD_{\max} \leq W/PD \leq (OV_{\max}-0.5*W_{\text{bead},\min})/PD_{\max}.$$

5

31. The battery of claim 28, wherein at least one welding bead is formed between the beading portion and the contact portion,

wherein the at least one welding bead forms a welding pattern having a straight line shape extending in a circumferential direction.

10

32. The battery of claim 28, wherein at least one welding bead is formed between the beading portion and the contact portion,

wherein the at least one welding bead forms a welding pattern having an arc shape extending in a circumferential direction.

15

33. The battery of claim 28, wherein a welding bead formed between the beading portion and the contact portion forms a welding pattern,

wherein the welding pattern has a linear shape in which spot welding is connected.

20

34. The battery of claim 28, wherein a plurality of welding beads formed between the beading portion and the contact portion are formed in a same contact portion.

35. The battery of claim 28, wherein a width of a welding bead formed between the beading portion and the contact portion is equal to or greater than 0.1 mm.

36. The battery of claim 31, wherein the first uncoated portion and the tab coupling portion are welded in a radial direction of the electrode assembly.

37. The battery of claim 1, wherein the tab coupling portion is welded to the first uncoated portion while being parallel to a bottom surface of the battery housing.

38. The battery of claim 36, wherein a plurality of welding beads formed between the first uncoated portion and the tab coupling portion form a welding pattern having a straight line shape extending in the radial direction of the electrode assembly.

39. The battery of claim 36, wherein a welding bead formed between the first uncoated portion and the tab coupling portion forms a welding pattern, wherein the welding pattern has a linear shape in which spot welding is connected.

40. The battery of claim 36, wherein a width of a welding bead formed between the first uncoated portion and the tab coupling portion is equal to or greater than 0.1 mm.

41. The battery of claim 1, wherein at least a part of the first uncoated portion

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comprises a plurality of segments divided in a winding direction of the electrode assembly,

wherein the plurality of segments are bent in a radial direction of the electrode assembly to form a bent surface.

5           42.     The battery of claim 41, wherein the plurality of segments overlap in multiple layers in the radial direction of the electrode assembly to form the bent surface,

wherein the bent surface comprises a stack number increasing section in which the number of overlapping layers of the segments is sequentially increased to a maximum value from an outer circumference to a core of the electrode assembly and a stack number uniform

10 section from a radius point at which the number of overlapping layers is the maximum value to a radius point at which an innermost segment exists.

43.     The battery of claim 42, wherein the tab coupling portion is coupled to the bent surface to overlap the stack number uniform section.

15

44.     The battery of claim 43, wherein the number of overlapping layers in the stack number uniform section is 10 or more.

45.     The battery of claim 44, wherein the tab coupling portion is welded to the bent surface, and a welding region of the tab coupling portion overlaps the stack number uniform section by at least 50% in the radial direction of the electrode assembly.

20

46. The battery of claim 1, wherein the current collector comprises a circular current collector hole at a central portion of the current collector.

47. The battery of claim 46, wherein a diameter of the current collector hole is  
5 equal to or greater than a diameter of a winding central hole formed in a core of the electrode assembly.

48. The battery of claim 5, wherein the battery comprises a sealing gasket provided between the battery housing and the cap.

10

49. The battery of claim 48, wherein the contact portion is located between the sealing gasket and the beading portion.

50. The battery of claim 48, wherein a thickness of the sealing gasket varies in  
15 a circumferential direction.

51. The battery of claim 48, wherein a thickness of the sealing gasket is alternately increased and decreased in a circumferential direction.

20 52. The battery of claim 50, wherein the sealing gasket has a same compressibility in a region where the sealing gasket contact the contact portion and in a region where the sealing gasket does not contact the contact portion.

53. The battery of claim 50, wherein a compressibility of the sealing gasket in a region where the sealing gasket does not contact the contact portion is less than a compressibility of the sealing gasket in a region where the sealing gasket contacts the contact  
5 portion.

54. The battery of claim 48, wherein a thickness of the sealing gasket in a region where the sealing gasket does not contact the contact portion is greater than a thickness of the sealing gasket in a region where the sealing gasket contacts the contact portion.  
10

55. The battery of claim 1, wherein the current collector has a leg structure extending in a radial direction in a state where the tab coupling portion and the housing coupling portion are connected to each other.

15 56. The battery of claim 55, wherein a plurality of leg structures are provided.

57. The battery of claim 55, wherein the leg structures are arranged in a radial shape, a cross shape, or a combined shape thereof about a central portion of the current collector.  
20

58. The battery of claim 56, wherein a plurality of housing coupling portions are provided,

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wherein the plurality of housing coupling portions are connected to one another and integrally formed.

59. The battery of claim 5, wherein the connecting portion comprises at least  
5 one bending portion whose extension direction is changed at least once.

60. The battery of claim 59, wherein a protruding outermost point of the  
bending portion is spaced apart by a certain interval from an innermost point of the beading  
portion.

10

61. The battery of claim 59, wherein, due to the bending portion, an angle  
between the contact portion and the connecting portion is an acute angle.

62. The battery of claim 59, wherein the connecting portion is elastically biased  
15 upward by the bending portion.

63. The battery of claim 5, wherein a circumferential length of the contact  
portion is same as a circumferential length of the tab coupling portion.

20 64. The battery of claim 5, wherein a circumferential length of the contact  
portion is same as a circumferential length of the connecting portion.

65. The battery of claim 5, wherein a circumferential length of the contact portion is greater than a circumferential length of the tab coupling portion.

66. The battery of claim 5, wherein a circumferential length of the contact  
5 portion is greater than a circumferential length of the connecting portion.

67. The battery of claim 5, wherein the contact portion has an arc shape extending in a circumferential direction along the beading portion of the battery housing.

10 68. The battery of claim 5, wherein the contact portion has an arc shape extending in opposite directions along a circumferential direction, from an intersection between the connecting portion and the contact portion.

69. The battery of claim 67, wherein a sum of lengths of the contact portions  
15 extending in the circumferential direction corresponds to a length of an inner circumference of the battery housing.

70. The battery of claim 67, wherein the connecting portion has an arc shape extending in the circumferential direction along the contact portion.

20

71. The battery of claim 2, wherein a boundary region between the tab coupling portion and the housing coupling portion is bent so that an end portion of the housing



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coupling portion faces the beading portion.

72. The battery of claim 5, wherein a connected portion between the contact portion and the connecting portion is bent.

5

73. The battery of claim 5, wherein a connected portion between the contact portion and the connecting portion has a complementary shape corresponding to an inner surface of the beading portion.

10 74. The battery of claim 5, wherein a connected portion between the contact portion and the connecting portion is coupled to the beading portion while having a shape matching an inner surface of the beading portion.

15 75. The battery of claim 1, wherein a boundary region between the tab coupling portion and the housing coupling portion is located more inside than an innermost point of the beading portion formed on the battery housing.

76. The battery of claim 2, wherein, when viewed along a longitudinal axis of the battery housing, the tab coupling portion does not overlap the beading portion.

20

77. The battery of claim 1, wherein the second electrode comprises a second uncoated portion that is not coated with an active material layer and is exposed to the outside

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of the separator at a long side end thereof, at least a part of the second uncoated portion being used as an electrode tab by itself,

wherein the battery further comprises a terminal provided opposite to the opening portion and electrically connected to the second uncoated portion.

5

78. The battery of claim 77, further comprising a second current collector formed between the second uncoated portion and the terminal and comprising a tab coupling portion coupled to the second uncoated portion and a terminal coupling portion coupled to the terminal.

10

79. The battery of claim 78, wherein the terminal coupling portion covers a winding central hole of the electrode assembly.

15

80. The battery of claim 79, wherein a longest radius from a center of the terminal coupling portion of the second current collector to an end of the tab coupling portion is greater than a longest radius from a central portion of the current collector to an end of the tab coupling portion.

20

81. The battery of claim 78, wherein the tab coupling portion of the second current collector is coupled to a bent end portion of the second uncoated portion.

82. The battery of claim 81, wherein a welding region for coupling the tab

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coupling portion of the second current collector to the bent end portion of the second uncoated portion is further formed,

wherein a distance from a center of the terminal coupling portion of the second current collector to the welding region is same as or has a distance deviation of 5% or less  
5 from a distance from a central portion of the current collector to a welding region on the tab coupling portion.

83. The battery of claim 82, wherein the welding region of the second current collector has a length greater than a length of the welding region on the tab coupling portion  
10 of the current collector.

84. The battery of claim 1, wherein one or more holes for injecting an electrolytic solution are formed in the tab coupling portion.

85. The battery of claim 1, wherein a form factor ratio obtained by dividing a diameter of the battery by a height is greater than 0.4.  
15

86. The battery of claim 1, wherein resistance measured between a positive electrode and a negative electrode is equal to or less than 4 mohm.  
20

87. A battery pack comprising the battery according to any one of claims 1 through 86.

88. The battery pack of claim 87, wherein a plurality of cylindrical secondary batteries are arranged in a certain number of columns,  
wherein a terminal and an outer surface of a bottom of a battery housing of each  
5 battery are located to face upward.

89. The battery pack of claim 88, further comprising a plurality of bus bars configured to connect the plurality of cylindrical secondary batteries in series and in parallel,  
wherein each of the plurality of bus bars is located over adjacent cylindrical  
10 secondary batteries,

wherein each of the plurality of bus bars comprises:  
a body portion extending between adjacent terminals;  
a plurality of first bus bar terminals extending from a side of the body portion and electrically coupled to an electrode terminal of a battery located at the side; and  
15 a plurality of second bus bar terminals extending from the other side of the body portion and electrically connected to an outer surface of a bottom of a battery housing of a battery located at the other side.

90. A vehicle comprising the battery pack according to claim 87.  
20

91. A current collector comprising:  
at least one tab coupling portion coupled to a first uncoated portion of an electrode

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assembly; and

at least one housing coupling portion extending from the tab coupling portion and electrically coupled to a beading portion of a battery housing.

5           92.     A battery comprising:

an electrode assembly having a structure in which a first electrode and a second electrode each having a sheet shape and a separator located between the first and second electrodes are wound in one direction, the first electrode comprising a first uncoated portion not coated with an active material layer and exposed to the outside of the separator at a long  
10 side end thereof, at least a part of the first uncoated portion being used as an electrode tab by itself;

a battery housing in which the electrode assembly is accommodated through an opening portion formed at a side thereof;

a current collector electrically connected to the first uncoated portion and an inner  
15 surface of the battery housing; and

a sealing gasket located between the opening portion of the battery housing and the current collector,

wherein a portion of the current collector contacting the inner surface of the battery housing is located between the inner surface of the battery housing and the sealing gasket.

20

93.     The battery of claim 92, wherein the battery housing comprises a beading portion formed on an end portion adjacent to the opening portion and press-fitted inward.

94. The battery of claim 38, wherein an extension direction of a welding pattern formed between the first uncoated portion and the tab coupling portion and an extension direction of a welding pattern formed between the beading portion and the contact portion  
5 are perpendicular to each other.

95. The battery of claim 3, wherein an innermost point of the beading portion is located more inside in a radial direction than a distal point of the crimping portion.

10 96. The battery of claim 48, wherein the sealing gasket surrounds the cap, wherein a radial length of a portion of the sealing gasket covering a bottom surface of the cap is less than a radial length of a portion of the sealing gasket covering a top surface of the cap.

15 97. The battery of claim 41, wherein,  
when a total radial length of the tab coupling portion is  $T$ ,  
an outer diameter of the electrode assembly is  $JR$ , and  
a height of an outermost segment of the electrode assembly is  $F$ ,  
 $JR - 2 * F \leq T < JR$ .

20

98. The battery of claim 30, wherein,  
when a minimum value of a distance from the innermost point of the beading portion

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to the central point of the outermost welding bead in the radial direction is  $W1$ , and

when a distance from the innermost point of the beading portion to the central point of an outermost welding bead in the radial direction when the overlap length is  $OV$  is  $W$ ,

$$W1 = R1 + 0.5 * W_{\text{bead,min}}, \text{ and}$$

5  $W = OV - 0.5 * W_{\text{bead,min}}.$

99. The battery of claim 30, wherein the beading portion has a flat section parallel to a bottom surface of the battery housing in at least a region, and

when the overlap length is  $OV$  and a radius of curvature of the beading portion is  
10  $R1$ , a length of the flat section of the beading portion contacting the current collector is  $OV - R1$ .

100. The battery of claim 99, wherein a radial width length of a welding pattern formed between the beading portion and the contact portion is equal to or greater than  
15  $W_{\text{bead,min}}$  and equal to or less than  $OV - R1$ .

101. The battery of claim 100, wherein a ratio of the radial width length of the welding pattern to a length of the flat section ranges from 10% to 40%.

20 102. The battery of claim 1, wherein a ratio of an area where the current collector does not contact a top surface of the electrode assembly to an area of a circle having an outer diameter of the electrode assembly as a diameter is equal to or greater than 30% and less

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than 100%.

103. The battery of claim 1, wherein a ratio of an area where the current collector does not contact the electrode assembly to an area of a circle having an outer diameter of the electrode assembly as a diameter is equal to or greater than 60% and less than 100%.

104. The battery of claim 46, wherein a diameter of the current collector hole is less than a diameter of a winding central hole formed in a core of the electrode assembly.

105. The battery of claim 104, wherein,  
when a diameter of the winding central hole is  $R_3$ ,  
a diameter of the current collector hole is equal to or greater than  $0.5 \cdot R_3$  and less than  $R_3$ .

106. The battery of claim 104, wherein,  
when a diameter of the winding central hole is  $R_3$ ,  
a diameter of the current collector hole is equal to or greater than  $0.7 \cdot R_3$  and less than  $R_3$ .

107. The battery of claim 5, wherein the connecting portion extends in a radial direction and a winding axis direction.



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108. The battery of claim 5, wherein the tab coupling portion, the connecting portion and the contact portion have the same width along an extending direction.

109. The battery of claim 5, wherein the contact portion has a greater width than  
5 the connecting portion.

110. The battery of claim 5, wherein the connecting portion has a smaller width than the tab coupling portion.

111. The battery of claim 5, wherein the connecting portion has a greater width  
10 than the tab coupling portion.

**DRAWINGS**

FIG. 1a

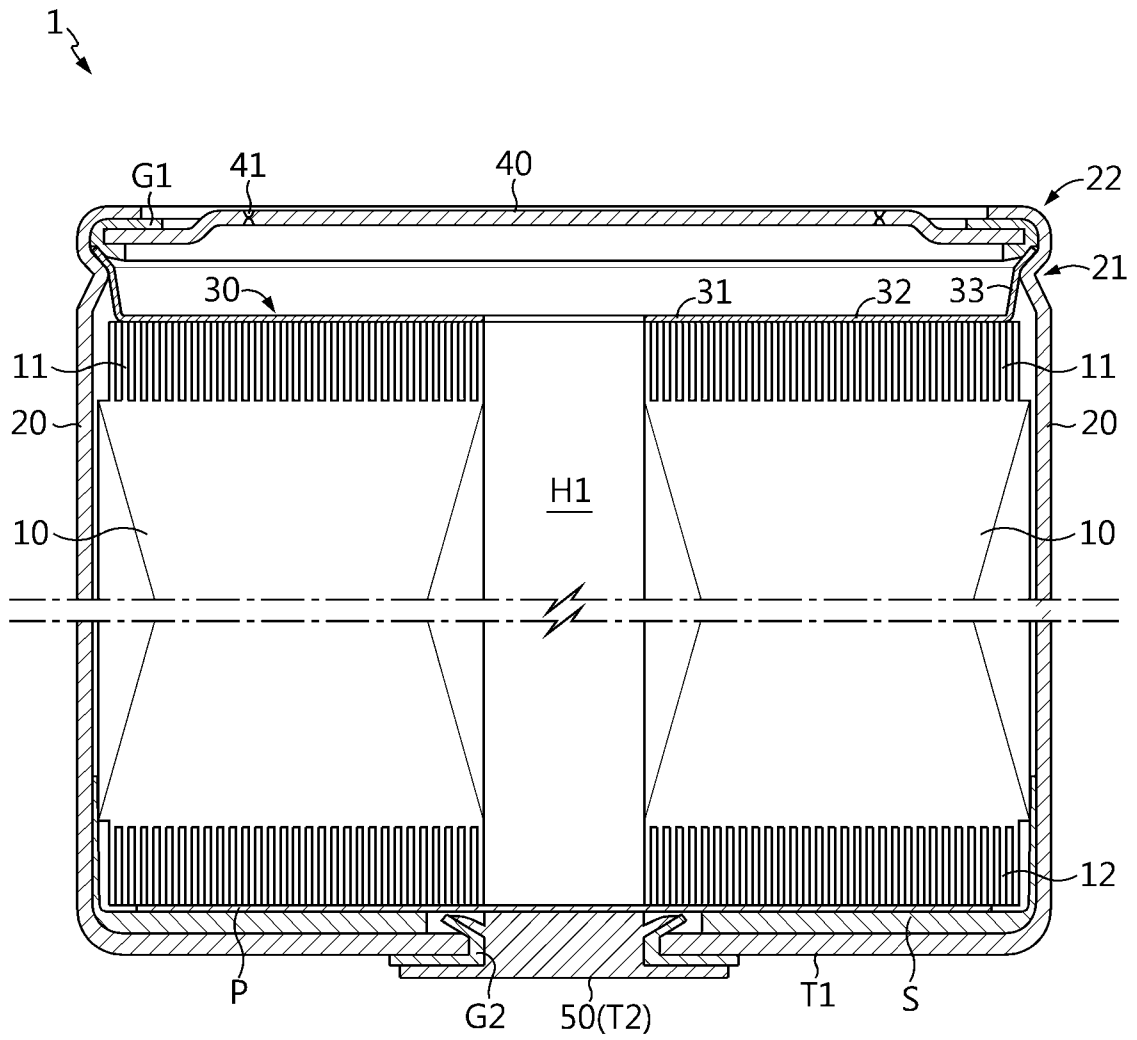


FIG. 1b

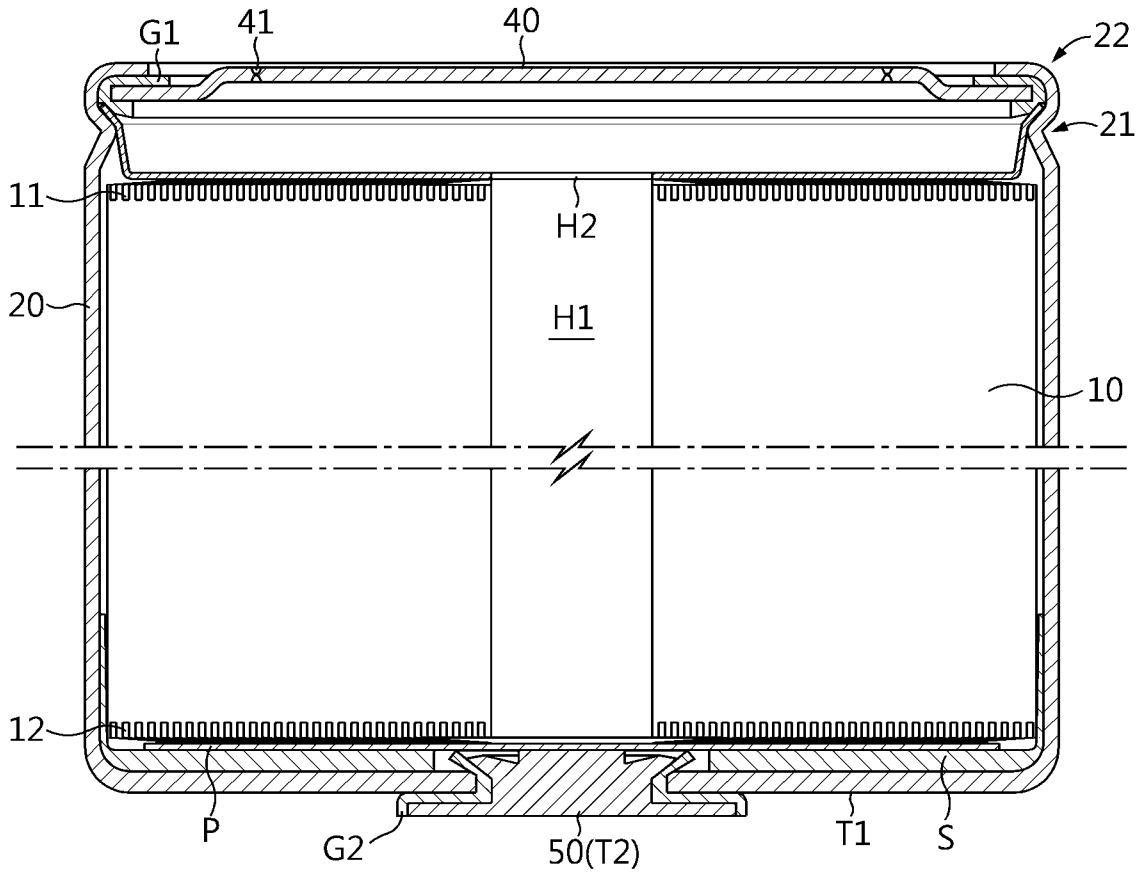


FIG. 1c



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FIG. 1d

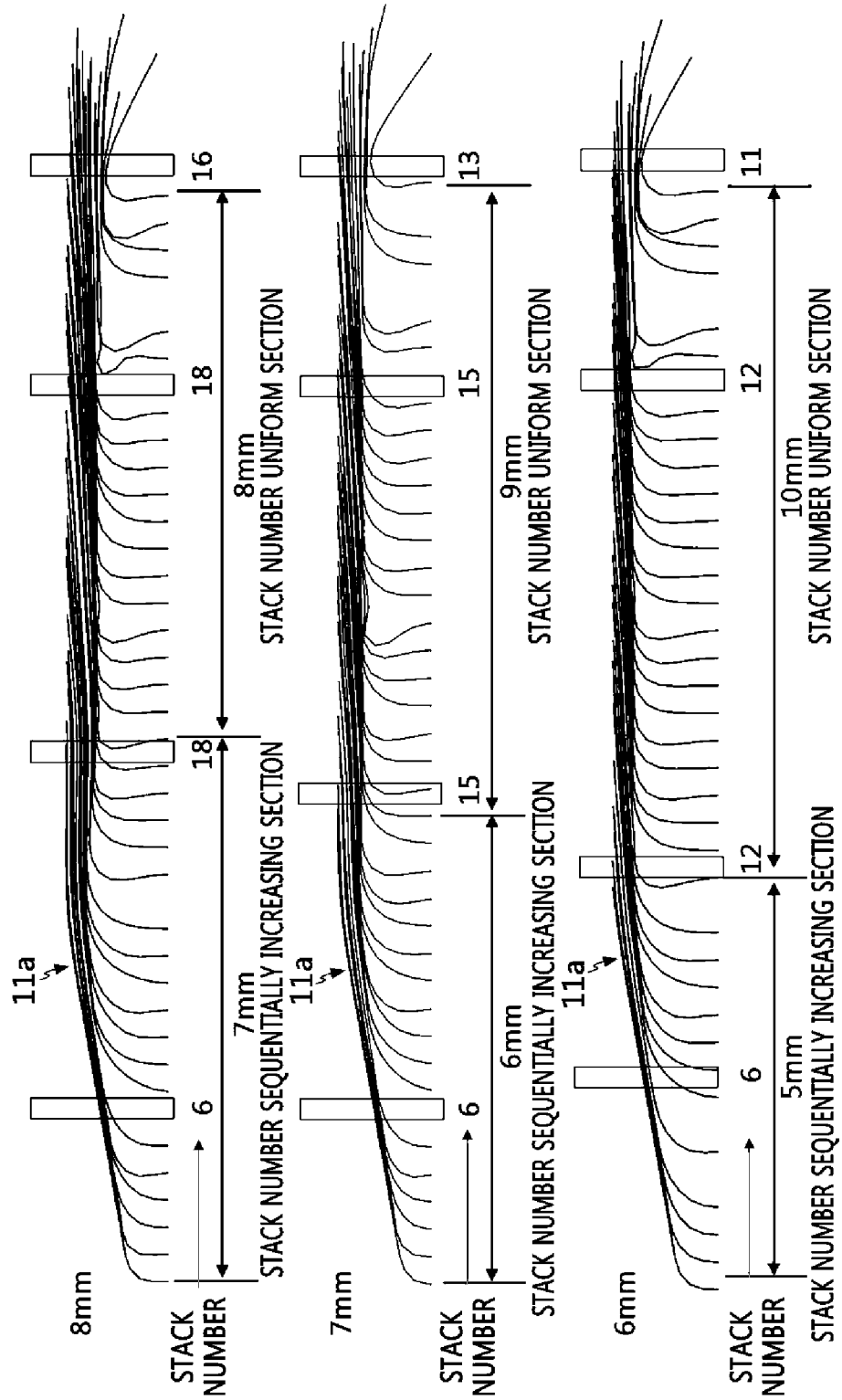


FIG. 2

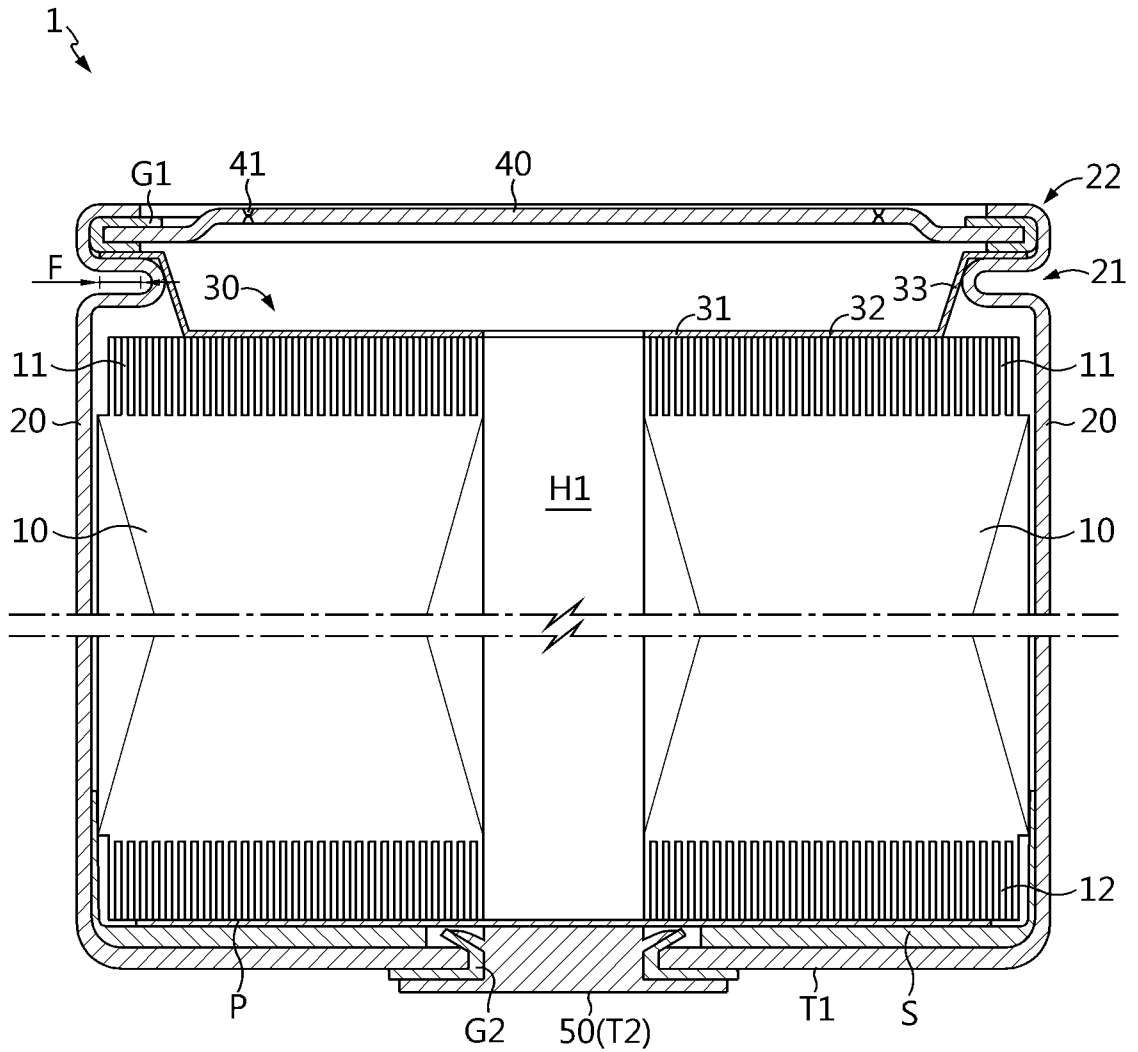


FIG. 3

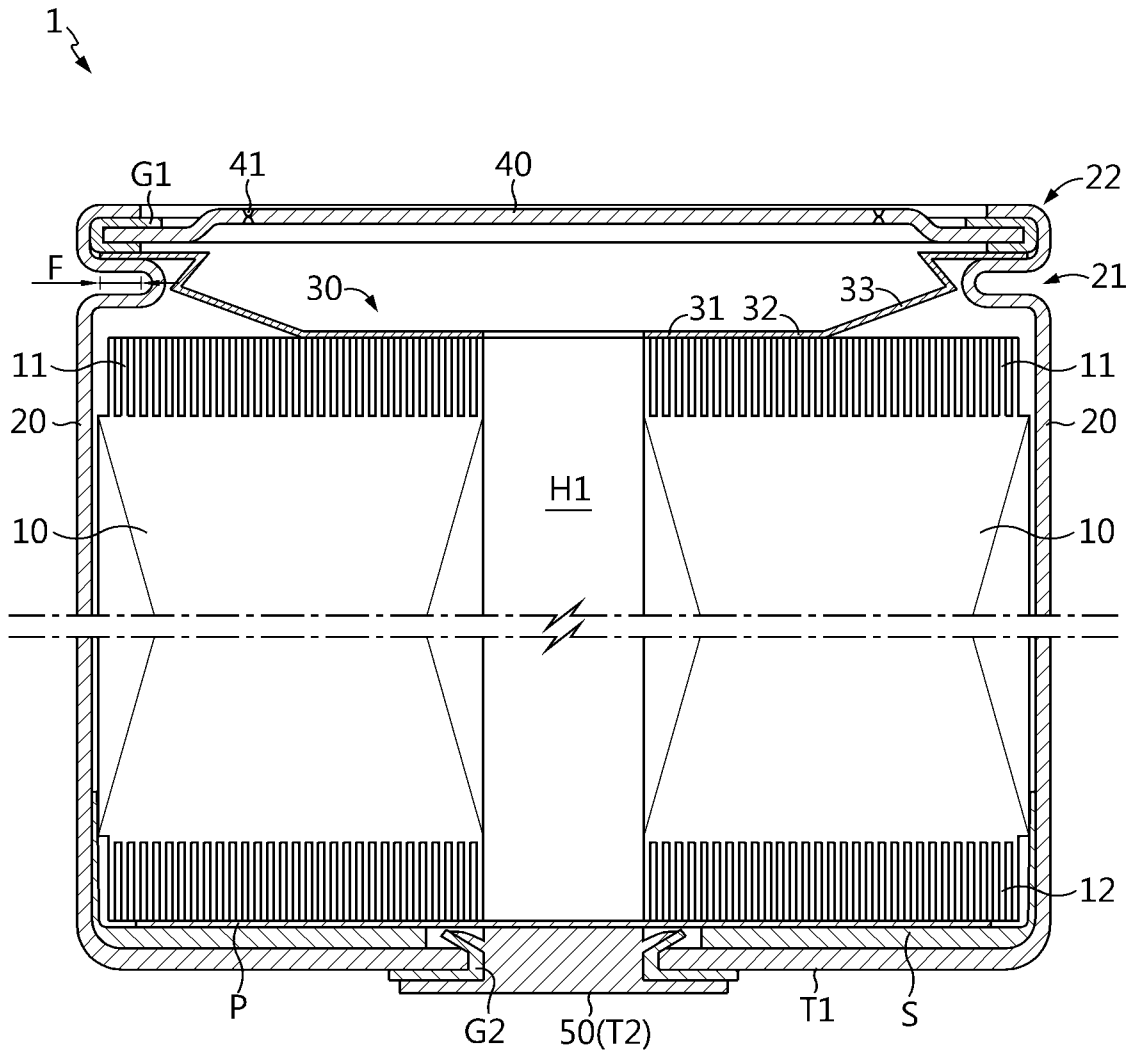


FIG. 4a

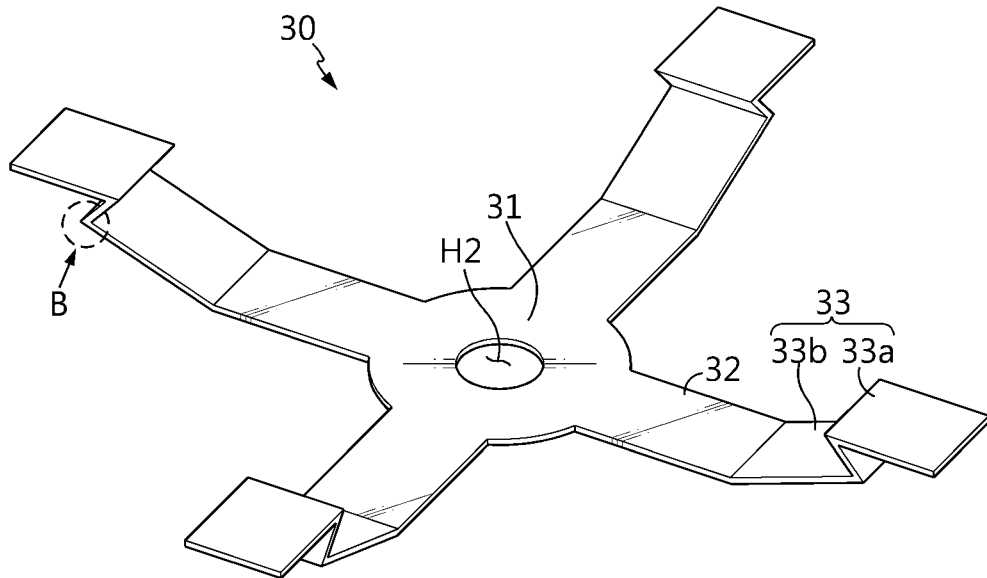


FIG. 4b

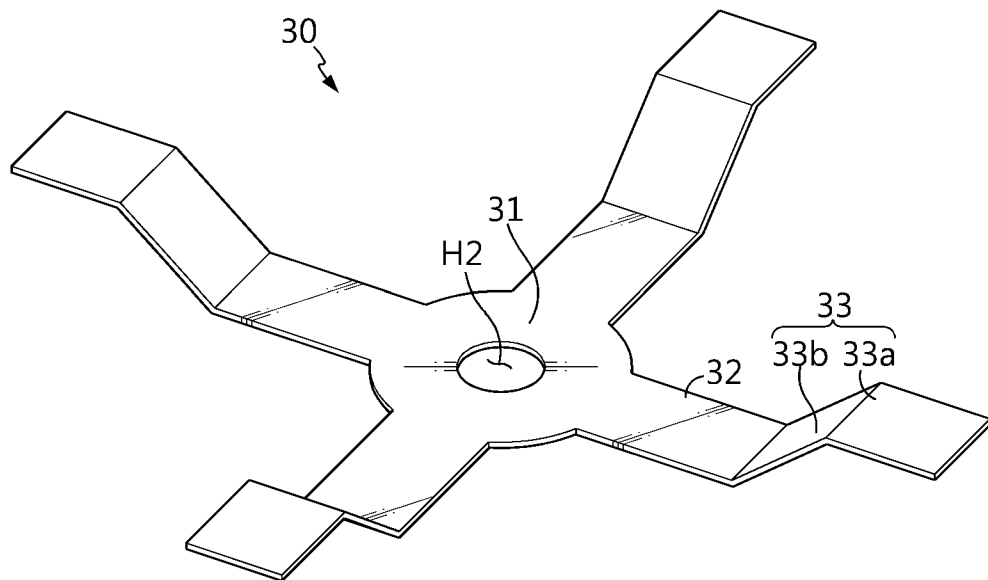




FIG. 5

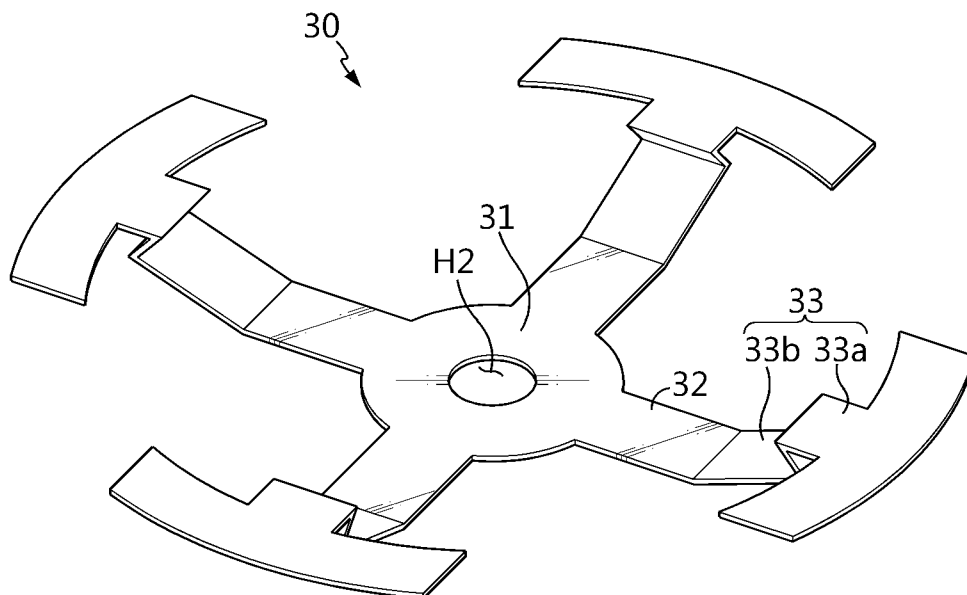


FIG. 6

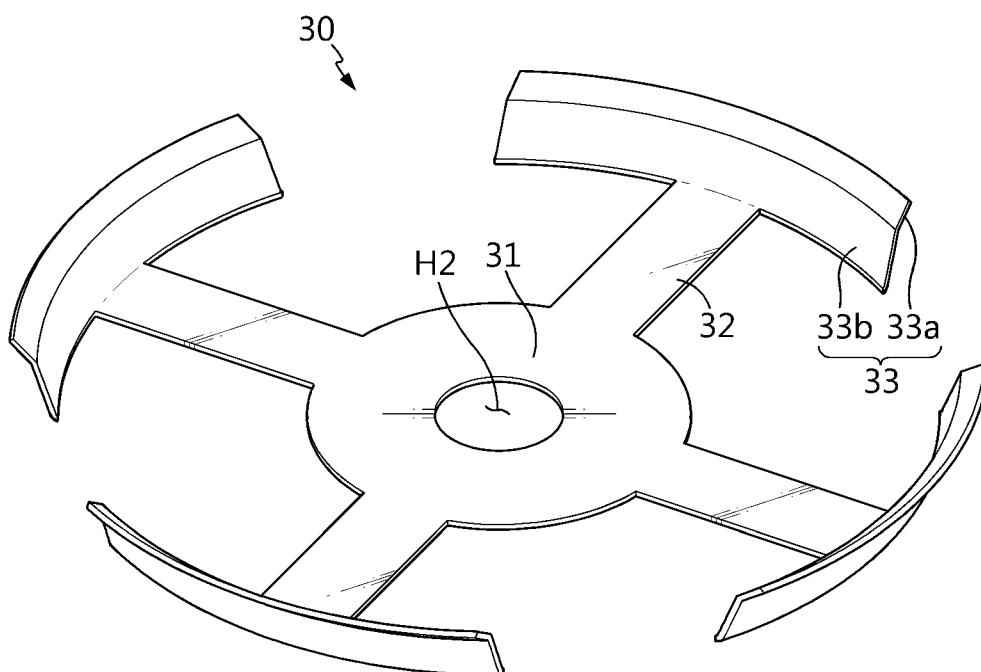


FIG. 7

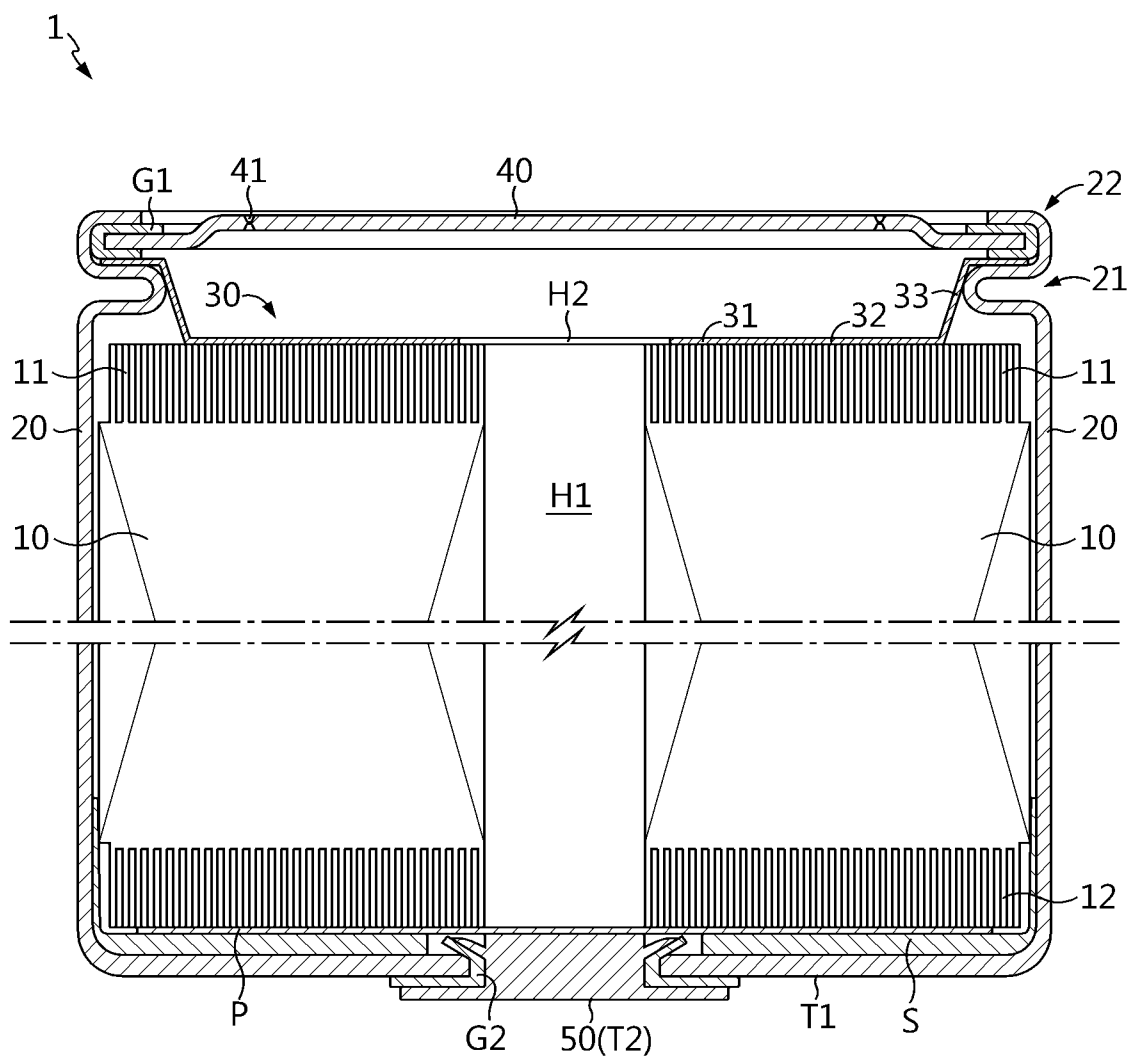


FIG. 8a

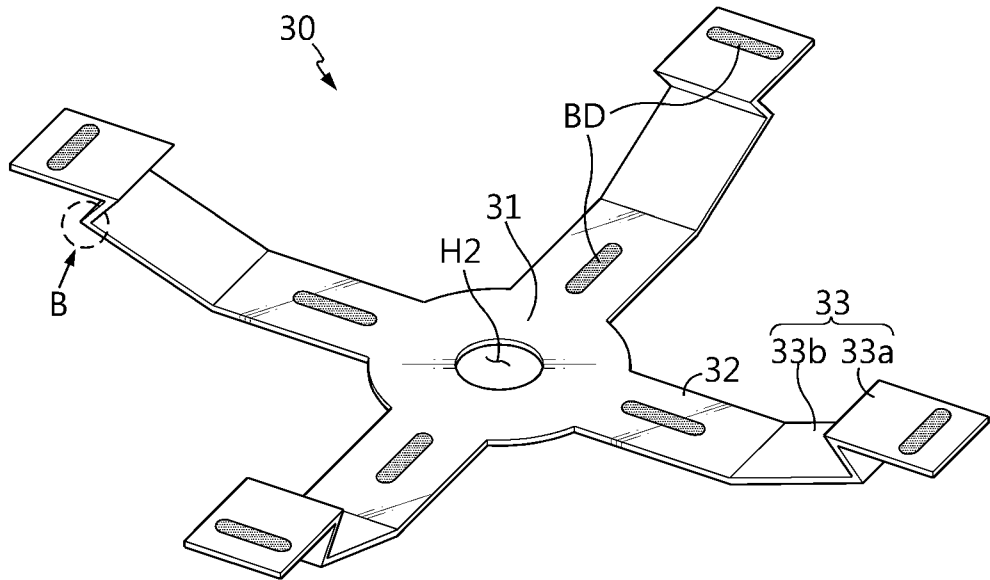


FIG. 8b

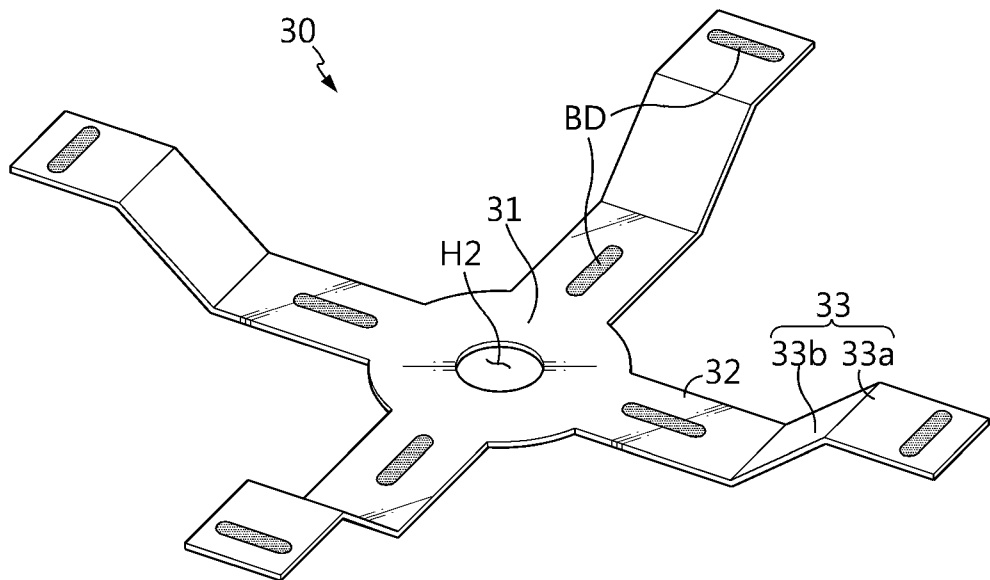


FIG. 9

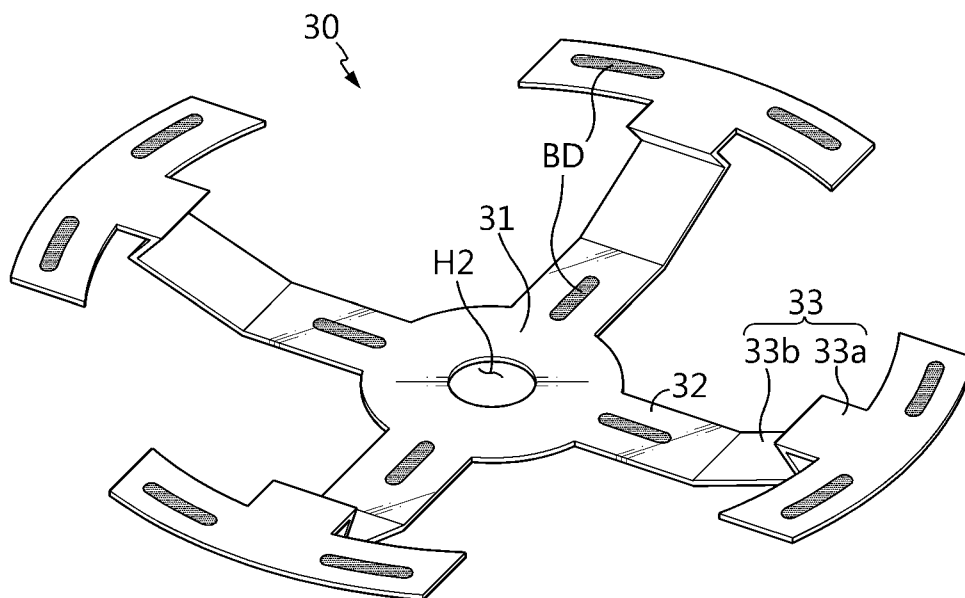


FIG. 10

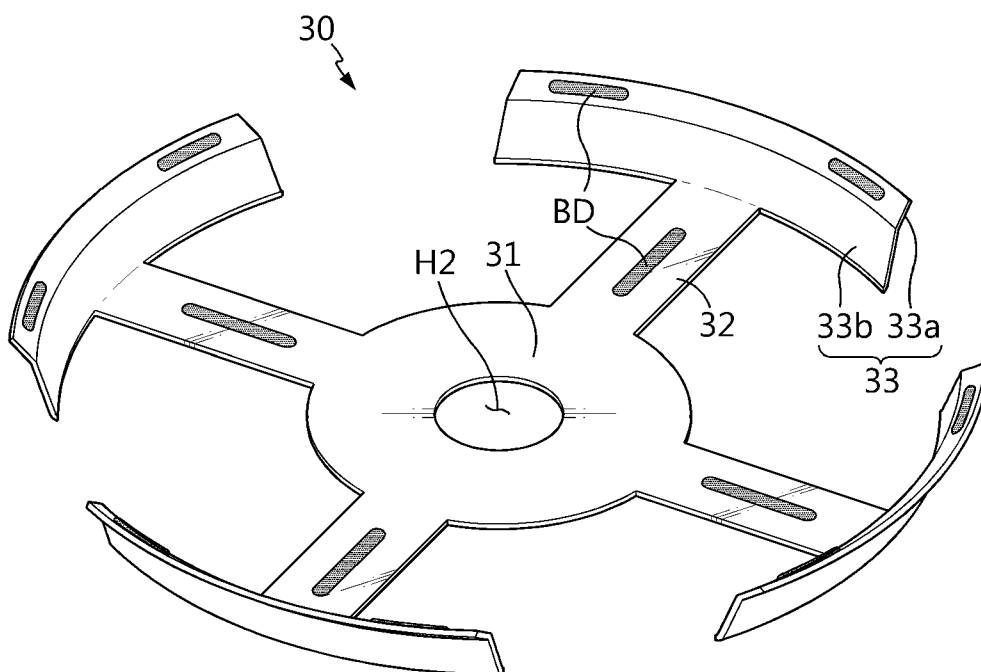


FIG. 11

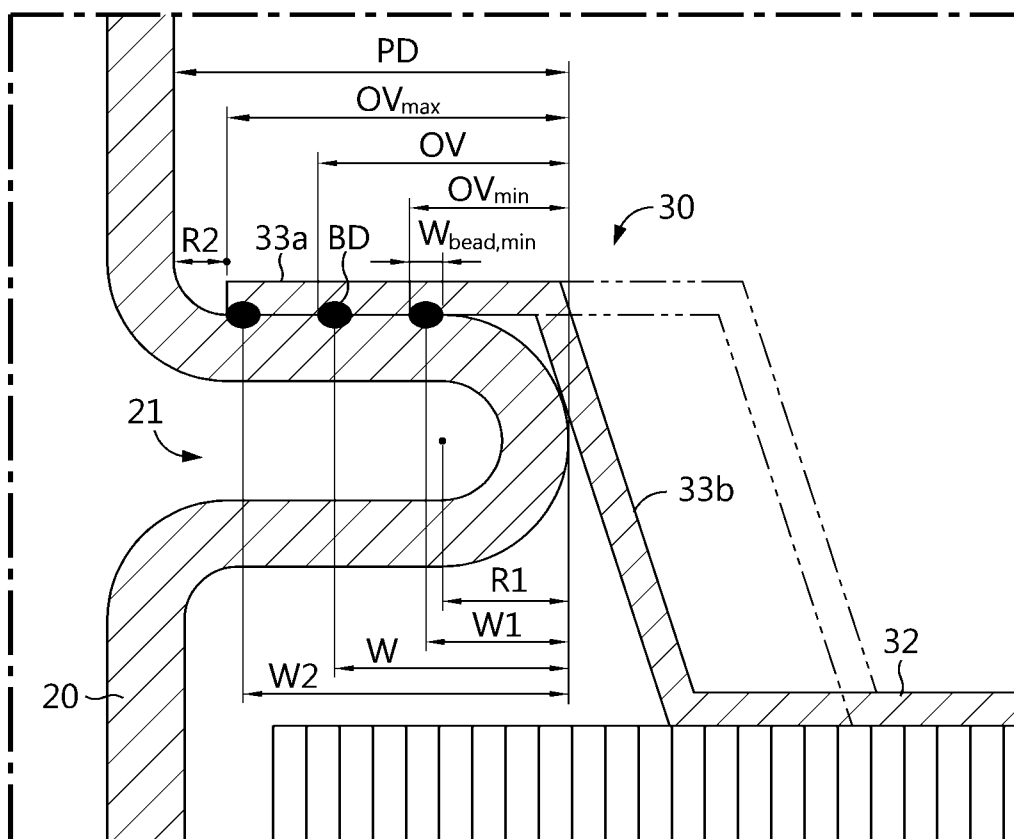


FIG. 12

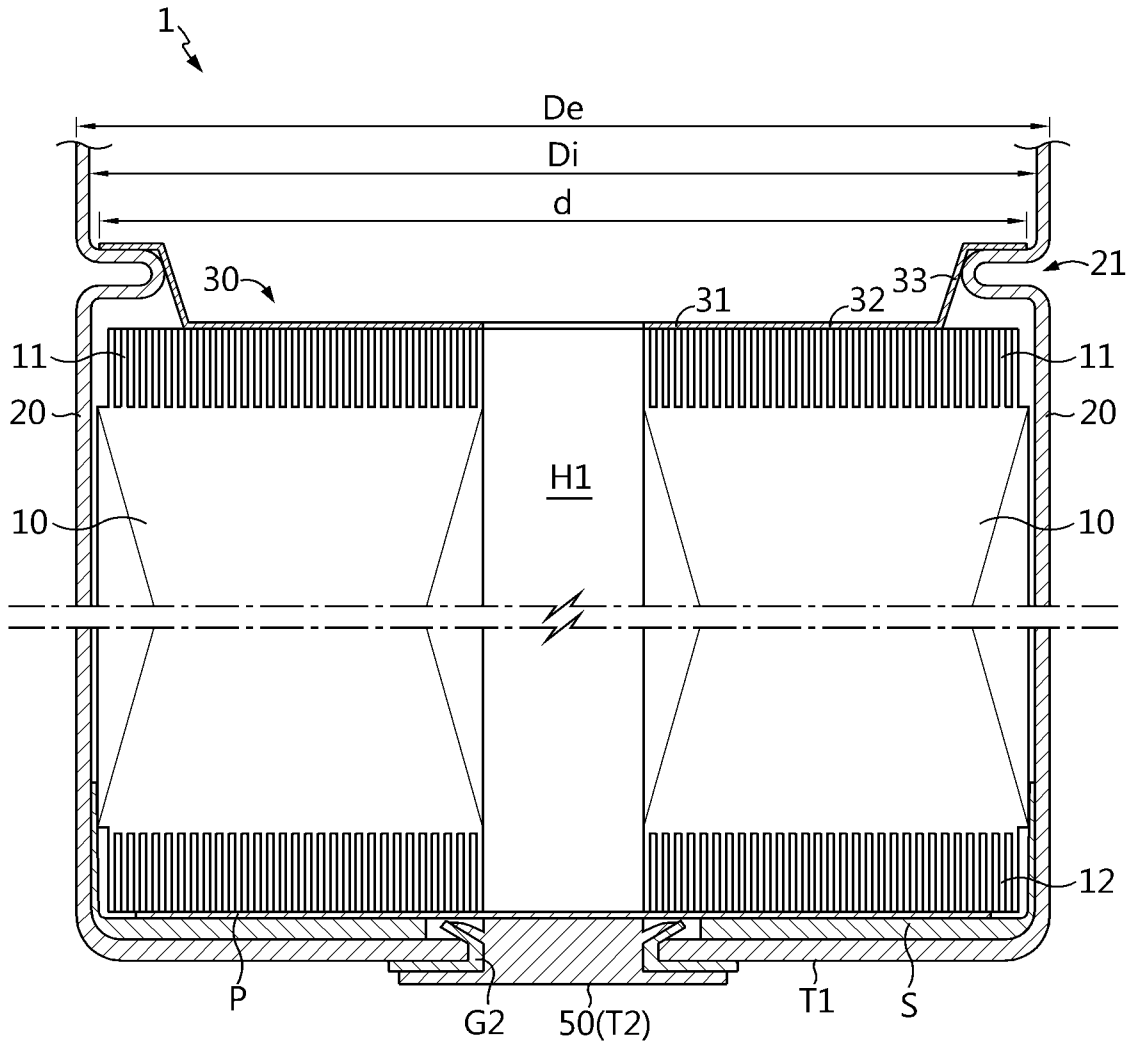


FIG. 13a

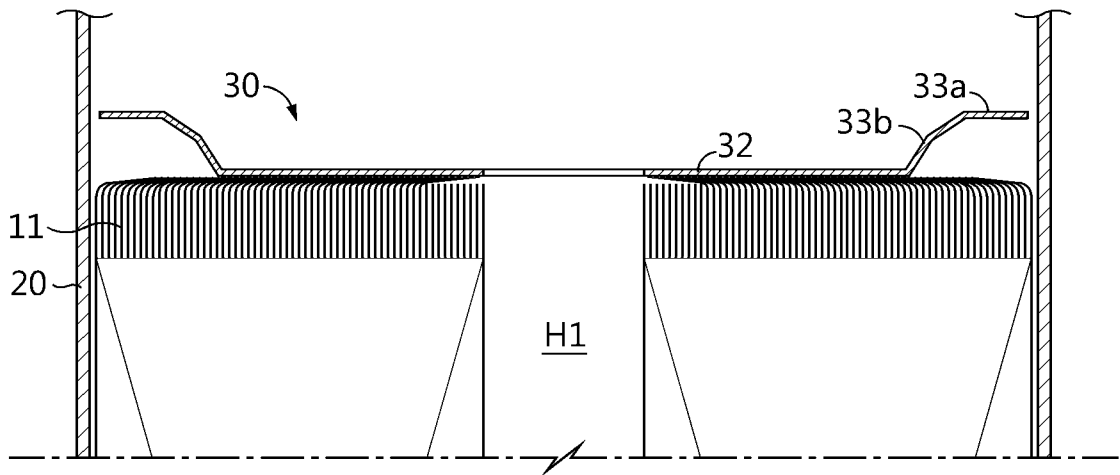


FIG. 13b

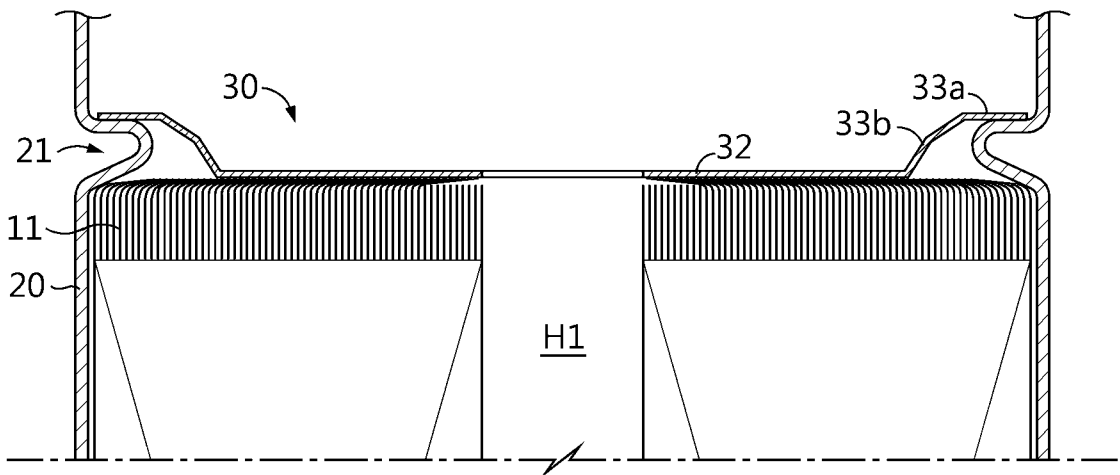


FIG. 13c

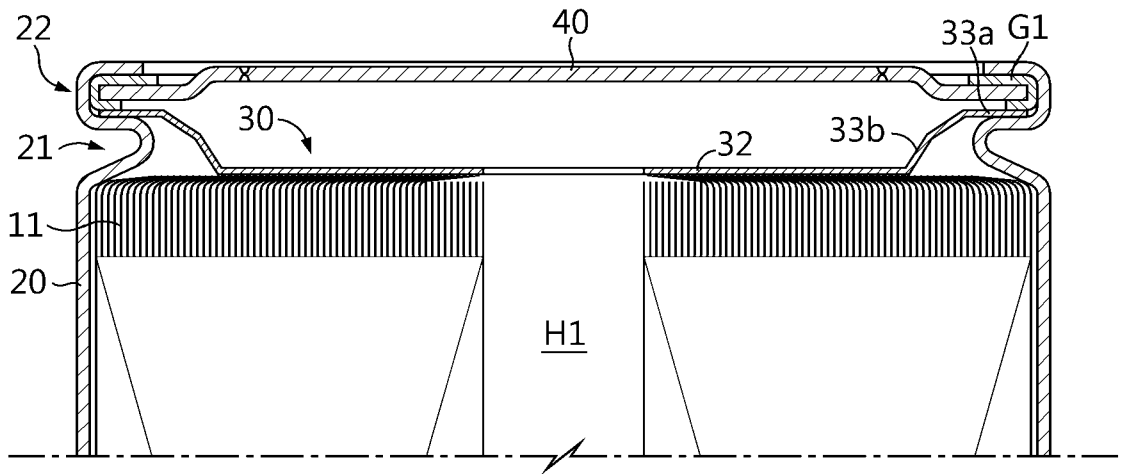


FIG. 13d

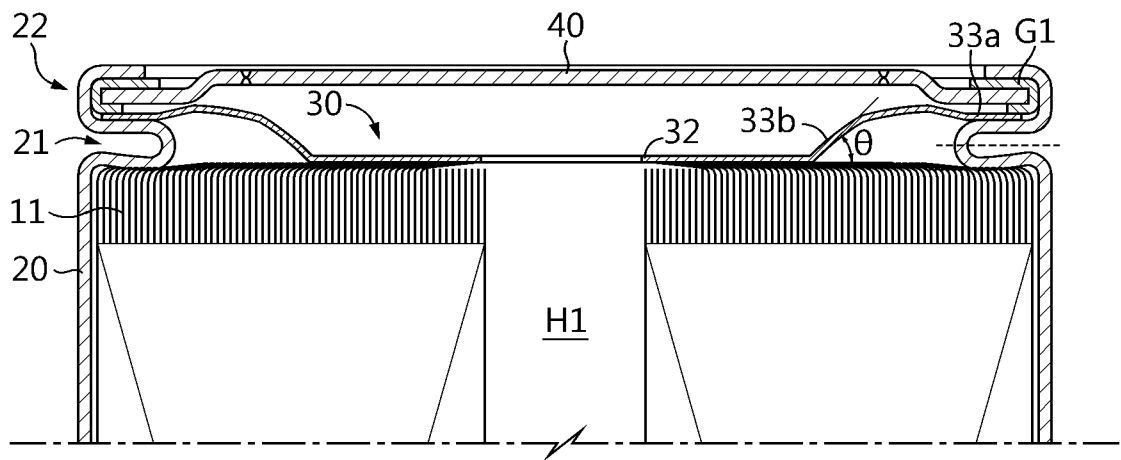




FIG. 13e

	CURRENT COLLECTING PLATE SHAPE BEFORE SIZING	CURRENT COLLECTING PLATE DEFORMED SHAPE AFTER 1 MM-SIZING	STRESS APPLIED BY CURRENT COLLECTING PLATE TO J/R
1		<p>WELDING PORTION LIFTING: 0.72mm</p>	<p>4.5MPa</p>
2		<p>WELDING PORTION LIFTING: 0.99mm</p>	<p>3.7MPa</p>
3		<p>LIFTED HEIGHT: 0.26mm WELDING PORTION LIFTING: 0.02mm</p>	<p>2.0MPa</p>

FIG. 13f

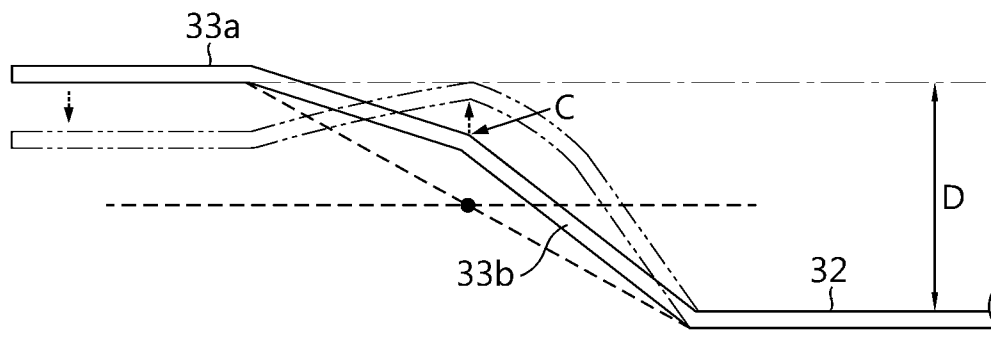


FIG. 13g

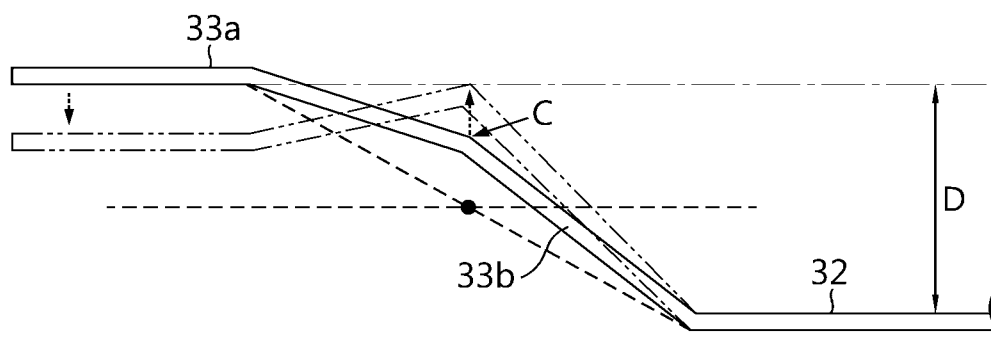
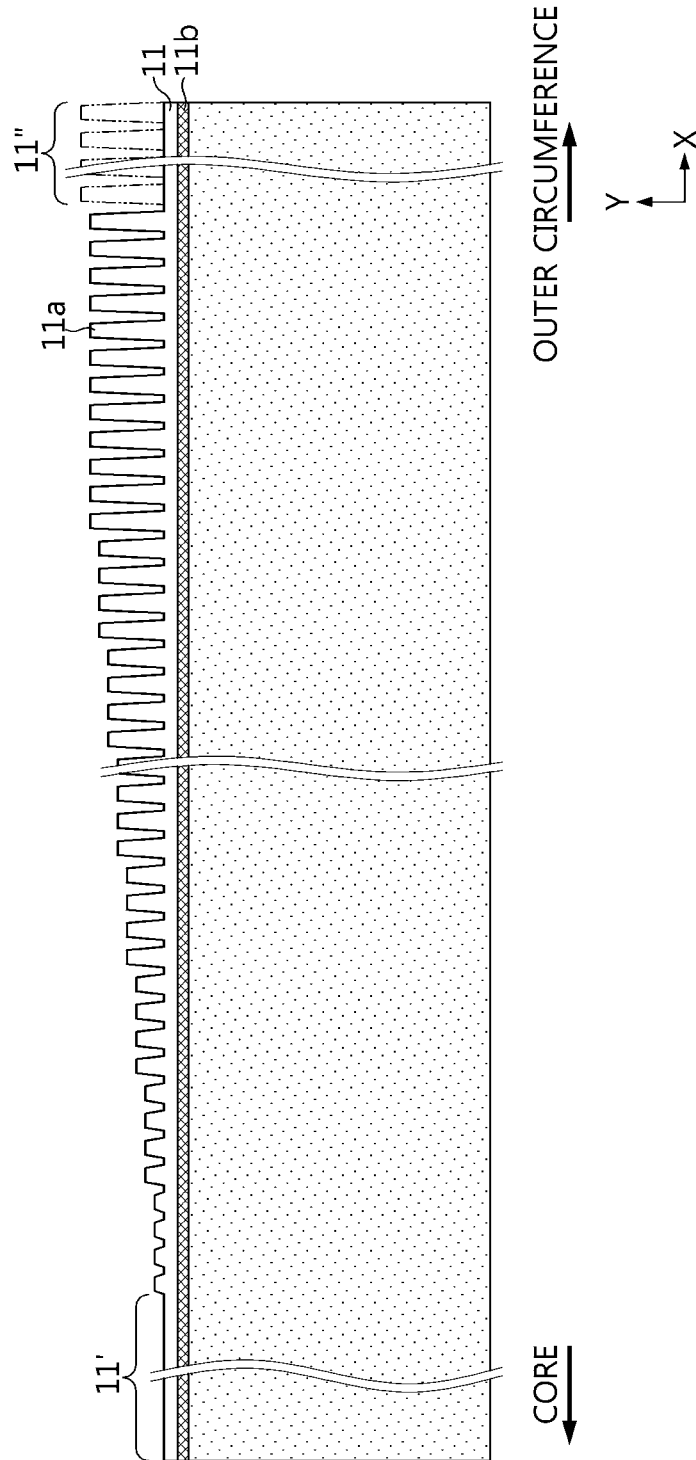
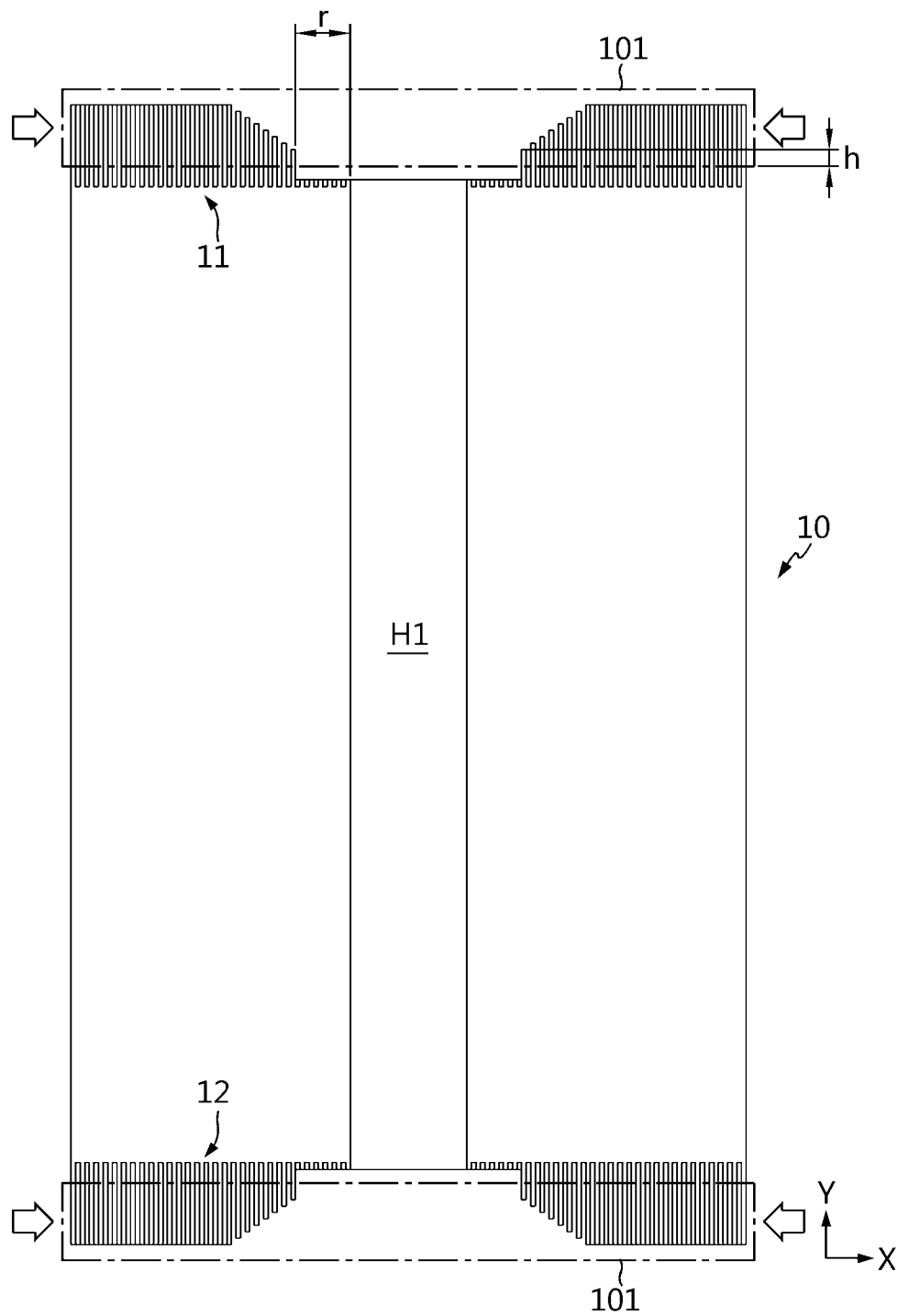


FIG. 14



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FIG. 15



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2022-01-19

FIG. 16a

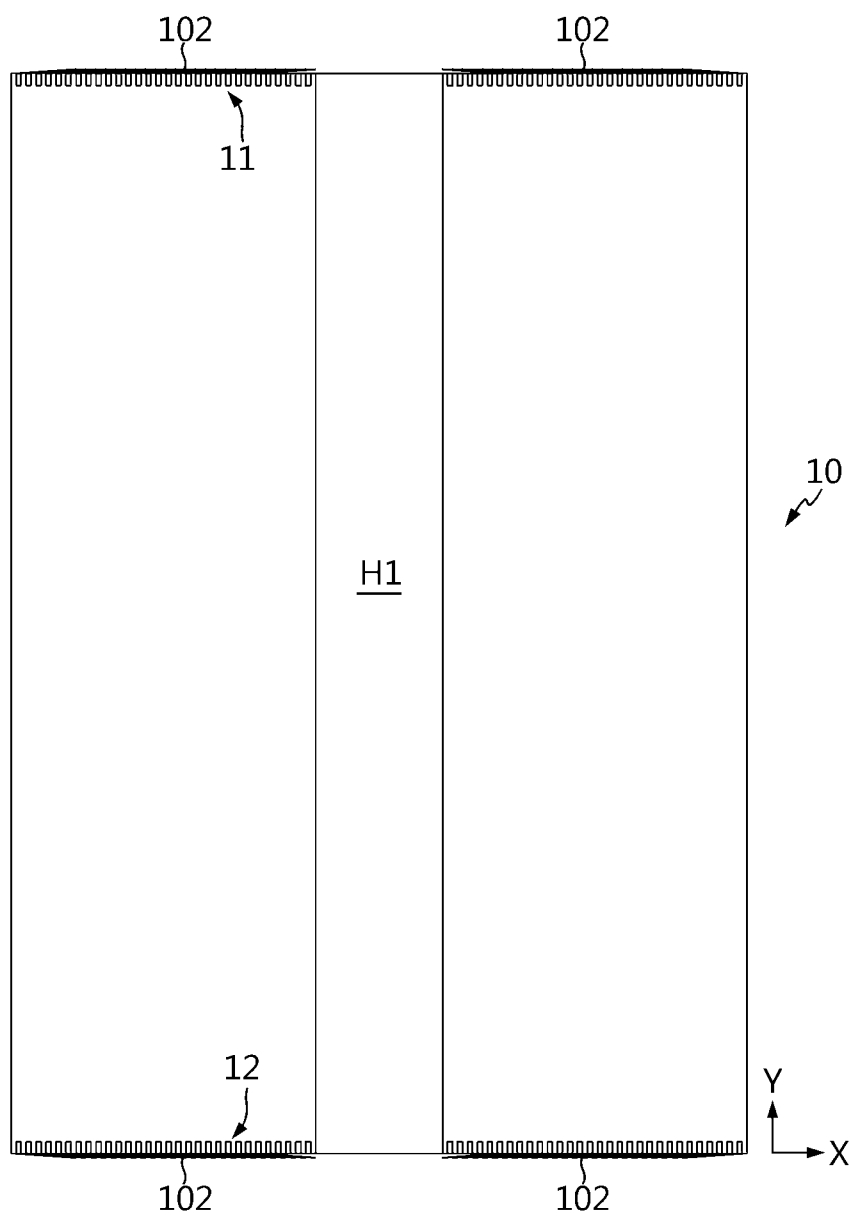


FIG. 16b

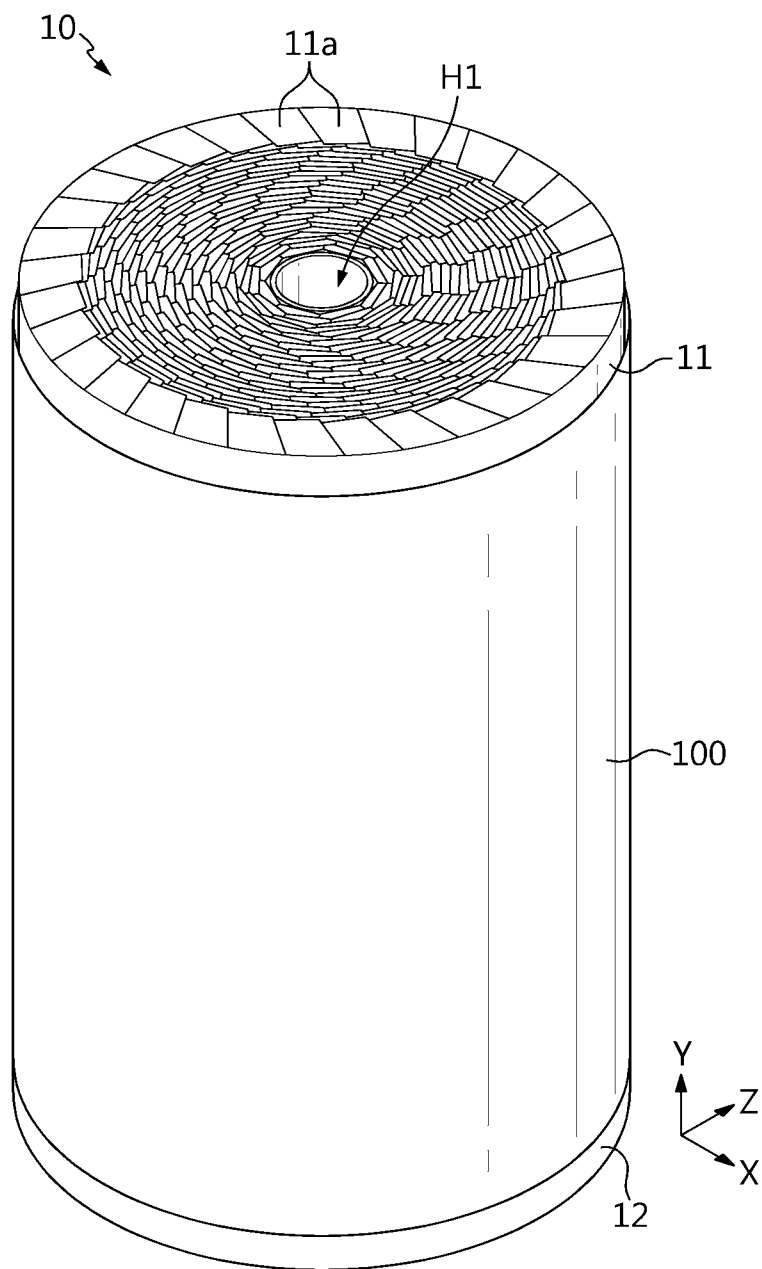




FIG. 17

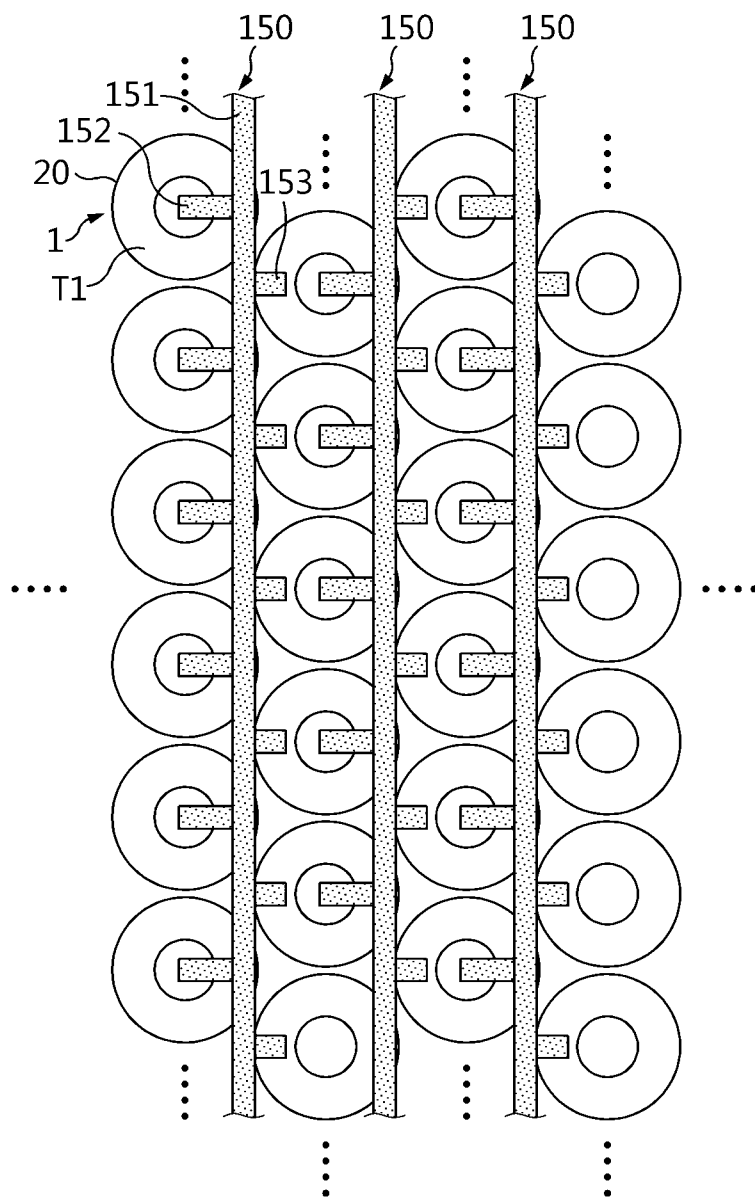


FIG. 18a

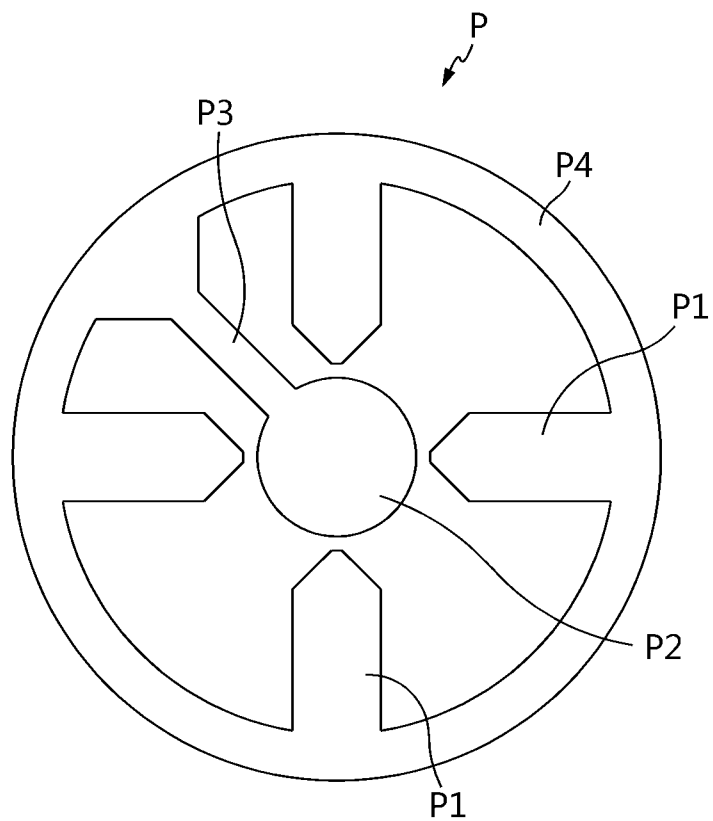


FIG. 18b

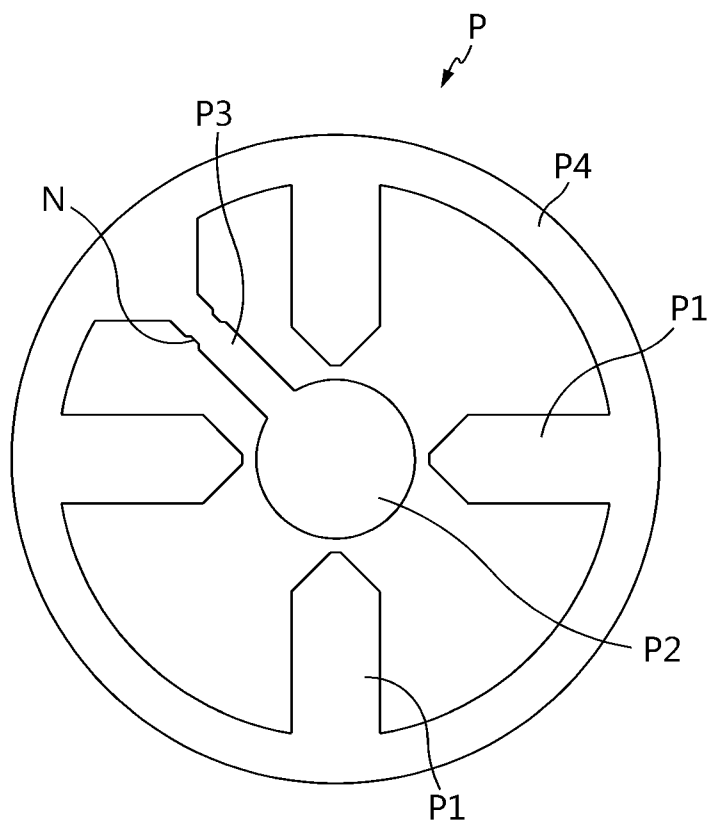


FIG. 19

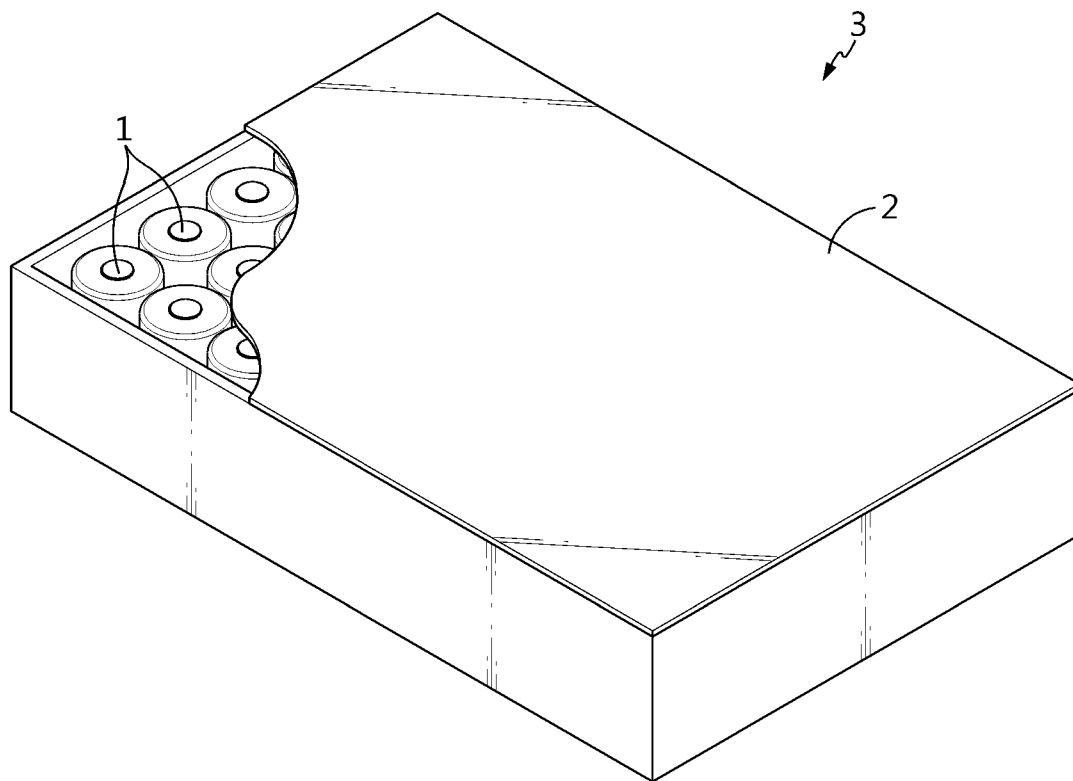


FIG. 20

