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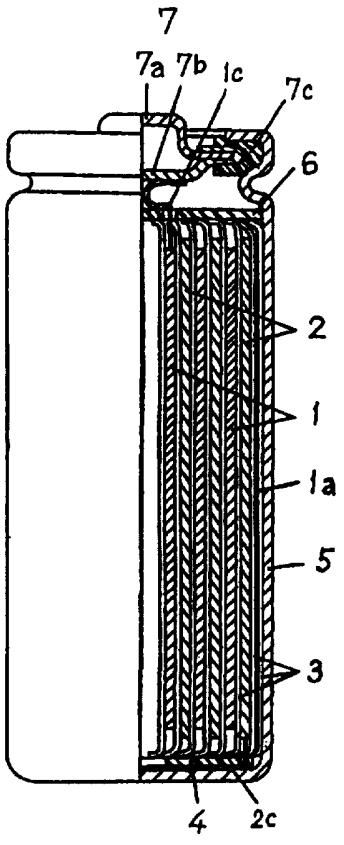
(54) Title: NON-AQUEOUS ELECTROLYTE SECONDARY BATTERIES

(57) Abstract

The invention relates to a non-aqueous secondary battery comprising an electrode group composed by confronting thin positive electrode and negative electrode through a separator, and it is an object thereof to enhance the safety outstandingly without sacrificing the cell capacity more than necessary and without increasing the number of parts. To achieve the object, a metal foil for positive electrode collector is electrically connected to the positive electrode, and the exposed portion of the metal foil for positive electrode collector covers the entire outer surface of the electrode group where the negative electrode is positioned outside through the separator, and its outermost side is wrapped with a separator, and thus constituted electrode group is put into a negative polarity cell container together with non-aqueous electrolyte, and therefore in such severe conditions as to crush the cell, accidents such as cell fire and rupture can be completely eliminated.



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Non-aqueous electrolyte secondary batteries

Technical Field

The present invention relates to a non-aqueous electrolyte secondary battery having an electrode group composed of a positive electrode and a negative electrode of thin type confronting each other through a separator, and more particular to its safety.

Background Art

Conventionally, as non-aqueous electrolyte secondary batteries, using chalcogenide such as oxide, sulfide or selenide of transition metal as positive active material, for example, manganese dioxide, molybdenum disulfide or titanium selenide, metal lithium sheet as negative active material, and organic electrolyte composed of organic solvent solution of lithium salt as non-aqueous electrolyte, the so-called lithium secondary batteries have been studied (aiming at batteries of high voltage, large capacity, and high energy density). In such lithium secondary battery, however, although an intercalation compound excellent in charging and discharging characteristics may be selected as the positive active material, the charging and discharging characteristics of the negative electrode is not always excellent, and it was difficult to assure a long cycle life. Yet, accidents such as fire and rupture due to internal short circuit were likely to occur,

and there were serious problems in safety. The metal lithium in the negative active material of this battery is dissolved as lithium ions in the organic electrolyte due to discharge. When charging, the dissolved lithium ions deposit on the surface of the negative electrode as metal lithium, but all of them do not deposit smoothly as in the initial state, but some of them deposit as dendrite or mossy active metallic crystals. Such active metallic crystals react with the organic solvent in the electrolyte, and their surface is covered with passivation film to be inactivated, not contributing to discharge, and therefore the negative electrode capacity drops as the charging and discharging cycles are repeated. Accordingly, when manufacturing the cells, it was necessary to set the negative electrode capacity extremely larger than that of the positive electrode. Besides, active lithium metallic crystals are likely to form internal short circuit by penetrating through the separator and contacting with the positive electrode. By such internal short circuit, the cell may suddenly generate heat, causing cell rupture or fire accident.

Accordingly, the so-called lithium ion secondary batteries using a material for intercalating and deintercalating lithium ions by charging and discharging as the negative material are proposed, and intensively researched and developed globally, and are now already in practical stage. The lithium ion secondary battery, so far as not overcharged, does not deposit active metallic lithium crystals on the negative electrode surface when charging, and enhancement of safety is expected. Its demand is growing rapidly in recent years because it is

superior to the conventional lithium secondary battery in high-rate charge and discharge characteristics and life cycle. In the lithium ion secondary battery, lithium is the active material, and it may be regarded as a kind of lithium secondary battery, but it is distinguished from the lithium secondary battery using the conventional metallic lithium as the negative electrode.

As the positive active material of the lithium ion secondary battery, a double oxide of lithium and transition metal such as $LiCoO_2$, $LiNiO_2$, $LiMnO_2$, or $LiMn_2O_4$ in discharged state, is used, and as the negative active material, graphite or other carbon material similar in potential to the metallic lithium as being charged is used, in most systems, but in other systems of low voltage operation, in part, a double oxide of lithium and transition metal is used in the negative electrode.

When the lithium ion secondary battery is charged and discharged, the positive active material can reversibly repeat deintercalation and intercalation of lithium ions, and the negative active material, intercalation and deintercalation of lithium ions, so that the cycle life is extremely long. Moreover, because of high voltage and/or large capacity, a battery of high energy density is composed.

However, these lithium ion secondary batteries, like the conventional lithium secondary batteries, employ organic electrolytes of relatively low ionic conductivity. Accordingly, thin positive electrode and negative electrode are fabricated by thinly

forming an active material layer or a mixture layer of active material and conductive agent on a metal foil of current collector, an electrode group is composed by setting the positive electrode and negative electrode oppositely to each other through a thin microporous polyolefin resin membrane separator, and by increasing the confronting surface area of the positive electrode and negative electrode, a practical high-rate charge and discharge characteristic is maintained to expand conformity to many applications. For example, the positive electrode and negative electrode, one piece each of thin and long strip form, are spirally wound through a separator, or plaited like an accordion, or a plurality of positive electrodes and negative electrodes are laminated alternately through separator, and an electrode group is composed.

In these lithium ion secondary batteries, the separator of closing fine pores when raised to a specified temperature and losing the ion conductivity to cut off current is used. Moreover, to prevent fatal deterioration due to overcharge and overdischarge, usually, in order to control in each cell, it is managed by incorporating an electronic protection circuit in the battery pack. Therefore, as far as used normally, the safety is assured, but in abnormal use, it is hard to guarantee safety. For example, when a battery pack in full charge state is crushed by a strong external force such as hitting by an automobile, or when overcharged due to trouble of protection circuit as mentioned above, the separator in the cell is broken, and the positive and negative electrodes are shorted to generate heat by Joule heat or reaction heat, and when

reaching the decomposition temperature of the positive active material, active oxygen is generated. By such active oxygen, the solvent in the organic electrolyte or the other material in the cell are violently oxidized, falling in the state of thermal runaway. As a result, the cell temperature rises sharply in an instant, possibly leading to cell rupture or fire accident. The risk of such accident was also present in the case of disposal of the charged battery pack together with refuse.

To prevent such accidents, usually, in each cell, the temperature fuse, PTC device, other temperature rise preventive means, and explosion-proof safety valve are proved, but it was not sufficient to cope with sudden temperature rise due to thermal runaway. It was hence proposed to compose the cell capable of preventing sudden rise of cell temperature, hence preventing cell rupture and fire experienced hitherto, if the cell is crushed or overcharged to break the separator to short-circuit the positive electrode and negative electrode. A typical example is disclosed in Japanese Laid-open Patent Application No. Hei8-153542, relating to a laminate electrode assembly (electrode group) forming a positive electrode and a negative electrode forming an active material layer at least on one side of a metal foil which is a collector oppositely to each other through a separator, in which the confronting portions of the metal foils of the collector of the positive electrode and negative electrode exposed at least on one side over at least one turn or one layer or more through the separator are provided in any one of the electrode group, outermost portion, innermost portion, and their

intermediate portion, thereby composing a cell.

In such cell composition, when the side surface is pressed the cell is crushed, the separator is torn, and the positive electrode and negative electrode contact with each other, the short-circuit current flows selectively between the metal foils of the collector of positive electrode and negative electrode higher in electronic conductivity than the active material layer, and the positive and negative active materials in charge state are discharged and consumed in a short time, so that the cell temperature may not be raised to a critical state. Moreover, in order to short-circuit securely between exposed portions of the metal foil of the positive and negative electrode collectors, this same publication also discloses means for selectively tearing the separator between the exposed portions of the positive and negative metal foils by interposing a part made of rigid or elastic body at least in one of the exposed portions of the positive and negative electrode metal foils.

As a result of close studies of these proposed cell compositions, in the invention, the cell composition is determined by an electrode group for selectively short-circuiting in the positions of high electronic conductivity between the metal foil of the positive electrode collector and the negative electrode, easy to release heat in the cell, without sacrificing the cell capacity or increasing the number of parts more than necessary. By employing such cell composition, it is intended to present a non-aqueous secondary battery high in reliability and enhanced in safety, capable of securely preventing accidents such as rupture or fire,

even in the event of abnormality of crushing of the cell.

Disclosure of Invention

The invention relates to a non-aqueous electrolyte secondary battery, being a non-aqueous electrolyte secondary battery comprising a electrode group composed by setting thin positive electrode and negative electrode, having an active material layer or a mixture layer of active material and conductive agent formed thinly on a metal foil which is a collector, oppositely through a separator, wherein the entire surface of outside of the electrode group where the negative electrode is positioned outside is covered with the metal foil which is electrically connected to the positive electrode and has no active material layer or no mixture layer of active material and conductive agent through a separator, and its outermost side is covered with a separator to compose the electrode group, which is put in a negative polarity cell container together with non-aqueous electrolyte. In other words, the metal foil for the positive electrode collector for covering the entire surface of the outer side of the electrode group has one side confronting adjacently to the negative electrode and the other surface to the inner side wall of the negative polarity cell container, and by comprising thus composed electrode group, if the cell side surface is pushed by a strong external force and the cell is crushed, the separator on one side or both sides of the metal foil of the positive electrode collector positioned outside of the electrode group is first broken, and the metal foil for the positive electrode short-circuits with at least one of

the negative electrode and the inner wall of the negative polarity cell container, and the positive and negative materials in charged state are discharged and consumed in a short time, and moreover since this short-circuit position is adjacent to the cell container and heat is released easily, thereby preventing sudden rise of cell temperature. As a result, cell rupture, fire or other accidents may be prevented, so that the reliability and safety are successfully enhanced without increasing the number of parts or sacrificing the cell capacity more than necessary.

Brief Description of Drawings

Fig. 1 is a sectional view of a cylindrical non-aqueous electrolyte secondary battery according to an embodiment of the invention.

Fig. 2 shows the positive electrode having exposed surfaces on both sides of the metal foil of the collector over a sufficient length for covering at least the outermost periphery of the electrode group in a cylindrical cell in an embodiment of the invention.

Fig. 3 show comparative examples 1, 2, 3 of the positive electrode for cylindrical cell.

Fig. 4 shows a prior art of positive electrode for cylindrical cell.

Best Mode for Carrying Out the Invention

Referring now to drawings and table, a preferred embodiment

of the invention is described specifically below.

Fig. 1 is a sectional view of a lithium ion secondary cylindrical cell (overall height 70 mm, diameter 20 mm) in an embodiment of a non-aqueous secondary battery of the invention.

In Fig. 1, an electrode group is composed by spirally winding a positive electrode 1 of 57 mm in width and 520 mm in length, and a negative electrode 2 of 59 mm in width, 550 mm in length, and 0.2 mm in thickness, through a separator 3 made of a microporous polypropylene membrane.

The positive electrode 1 is fabricated by adding and mixing an artificial graphite as a conductive agent to an active material made of a double oxide ($LiCoO_2$) of lithium and cobalt prepared by baking a mixture of lithium carbonate (Li_2CO_3) and cobalto-cobaltic oxide (Co_3O_4) in air at 900℃, adding and mixing 5 wt.% of dispersion solution of polytetrafluoroethylene (PTFE) as a binder, coating the both sides of an aluminum (Al) foil 1a with this paste of positive electrode, drying, pressing by roll, and forming a mixture layer 1b of active material and conductive agent. According to the invention, in the positive electrode 1, the portion of 57 mm corresponding to the length of at least one periphery of the outer circumference of the spiral electrode group in Fig. 2 has the Al foil of the collector exposed, without forming any mixture layer of the active material and conductive agent on both sides. A positive electrode lead piece 1c is spot welded to the exposed portion of the Al foil at the opposite side end of the Al foil

exposed portion.

The negative electrode 2 is fabricated by mixing 5 wt.% of styrene-butadiene rubber as binder to the active material made of artificial graphite powder with average particle size of 3 μm, applying negative electrode paste dispersed in carboxymethyl cellulose (CMC) aqueous solution on both sides of the copper (Cu) foil of the collector, drying, pressing by roll, and cutting. A negative electrode lead piece 2c is spot welded to the Cu foil exposed portion at one end of the cut negative electrode 2.

The electrode group has the winding core portion starting with the separator 3, and it is composed by winding at least one turn in the exposed portion 1a of the positive electrode 1 through the negative electrode 2 of the outer circumference and the separator 3, and covering the outermost circumference with the separator 3. The outside diameter of the electrode group was 18 mm.

Afterwards, the upper surface and lower surface of the electrode group are heated by hot air, and the separators 3 extending to the upper end and lower end of the electrode group are shrunk, a bottom insulating plate 4 is fitted, and put in a cell container 5, and a negative electrode lead piece 2c is spot welded to the inner bottom surface of the cell container 5. Then, mounting an upper insulting plate 6 on the electrode group, a groove is cut in specified position of the opening of the cell container 5, and a proper amount of non-aqueous electrolyte is poured in. As the non- aqueous electrolyte, 1 mol of lithium hexafluorophosphate ($LiPF_6$)

is dissolved in a mixed solvent of ethylene carbonate (EC) and diethyl carbonate (DEC) at volume ratio of 1:1, and 1 liter of organic electrolyte was prepared. Later, crimping a terminal plate 7a and a cover plate 7b into one body, a gasket 7c is fitted in the peripheral edge, and a positive electrode lead piece 1c is spot welded to the cover plate 7b of the lower side of this assembled cover. The assembled cover is fitted into the opening of the cell container 5, and the upper edge of the cell container 5 is curved inward to seal, and the cell A is completed.

Fig. 3A, B and C show comparative examples 1, 2 and 3 fabricated for confirming the effect of the invention.

In comparative example 1, the length of the exposed portion of the Al foil of positive electrode is 30 mm long, as compared with the length of 57 mm in the exposed portion of the Al foil of the positive electrode of the invention. When the electrode group is composed by using the positive electrode of the comparative example 1, the entire outer circumference of the electrode cannot be covered with the exposed portion of the Al foil.

In comparative example 2, the positive electrode has an exposed portion of Al foil over a length of 57 mm at the winding core side of the electrode group to which the positive electrode lead piece 1c is welded.

In comparative example 3, the positive electrode is 30 mm long in the exposed portion of the Al foil at the winding core side.

In the prior art shown in Fig. 4, there is no exposed

portion of Al foil, unlike the positive electrodes in the invention and in the comparative examples.

Using the positive electrodes of comparative examples 1, 2, 3and prior art, cells were fabricated by putting the electrode group composed same as in cell A, all the same in other parts, materials and methods. These cells are respectively called B, C, D and E.

In 50 cells each of the fabricated cells A, B, C, D and E, they were charged for 2.0 hours at 20℃, at constant current of 800 mA and constant voltage of 4.2 V per cell. All charged cells were presented for crushing test, and the number of cells breaking out fire was counted. The results are summarized in Table 1. In crushing test, a cylindrical metal rod of 10 mm in diameter of steel or the like is placed so as to be vertical to the cell axial line, at the cell outer wall side of the middle of the overall height of each cell, and the cell is pressed and crushed by a pressing machine until the diameter becomes 1/2.

Table 1

Cell	Positive electrode	Number of cells breaking out fire
A	Invention	0/50
B	Comparative example 1	3/50
C	Comparative example 2	4/50
D	Comparative example 3	3/50
E	Prior art	7/50

As clear from the result in Table 1, fire took place in 7 cells of cells E of the prior art, while no fire was caused in cells A of the invention. In cells B, C and D using the positive electrodes having exposed portion of Al foil in the outer circumference or winding core portion of the electrode group, the number of cells breaking out fire was about half that of cells E, but was not nil.

In the cell A of the invention, as mentioned above, the entire outer circumference of the electrode group is wound at least a turn through a separator with a metal foil for positive electrode conducting electrically with the positive electrode, and the outermost circumference is wrapped with separator to compose the electrode group. In other words, the metal foil for positive electrode wound at least a turn around the outer circumference of the electrode group has one side confronting adjacently to the negative electrode through separator, and other side to the inner wall of the negative polarity cell container through separator. When the cell is crushed in this state, first the separator closer to the outer side in the cell is first torn, and the metal foil of the positive electrode collector selectively short-circuits with at least one of the cell container and the negative electrode of the outermost circumference. As mentioned above, since the outer circumference of the electrode group is turned at least a turn by the metal foil for positive electrode collector conducting electrically to the positive electrode, if any position of the cell side surface is crushed by pressing, short-circuit occurs as stated above,

and it is judged that there is no firing cell.

By contrast, in the cell B, as mentioned above, since the entire outer circumference of the electrode group is not covered with the exposed portion of the Al foil of the positive electrode, the metal rod for crushing test may not always press the exposed portion of the Al foil. This seems why firing cells cannot be completely eliminated in the cell B.

Or, in the cells having exposed portion of Al foil of the positive electrode collector at the winding core side of the electrode group as in the cells C and D, if these cells are crushed, the separator of the exposed portion of the metal foil of the positive electrode of the winding core portion is not always torn. When the positive and negative active materials contact directly with each other due to breakage of separator, thermal runaway may occur in certain cells. Such electrode group composition is advantageous in that the cell capacity is hardly sacrificed as disclosed in Japanese Laid-open Patent Application No. Hei8-153542, but firing cells cannot be eliminated completely, which is a problem in the aspect of reliability. Accordingly, as proposed in the same publication, separator breakage parts made of metal bars were inserted into the winding core, and these cells were evaluated in crushing test, and it was confirmed that the firing cells could be nearly eliminated. In such cell composition, however, since the number of parts increases, the cell manufacturing cost and weight are increased, and hence it is not a beneficial measure.

As mentioned above, according to the proposal disclosed in

Japanese Laid-open Patent Publication Application Hei8-153542, the cell is composed by disposing the confronting portions of the metal foils of the positive electrode and negative electrode collectors having at least one side exposed through separator, over a length of one turn or one layer, in any one of the outermost side, innermost side, and the intermediate portion of the electrode group, whereas, in the invention, the metal foil for positive electrode not forming at all the active material layer or a mixture layer of active material and conductive agent on both sides electrically conducts with the positive electrode, the entire outer surface of the electrode group having the negative electrode positioned at the outer side is covered with the metal for positive electrode through separator, and the electrode group having the outermost side wrapped with separator is put in the negative polarity cell container. In the invention, the reason why exposed portion is not provided in the metal foil of the negative electrode collector is that the active material in charged state of lithium ion secondary battery and lithium secondary battery, for example, the carbon material in which lithium is inserted expressed as C6Li and metallic lithium are both highly conductive, and if short-circuited, active oxygen generation source is not obtained unless directly contacting with the positive active material. Therefore, in the cell composition of the invention, the capacity of negative electrode or cell is not sacrificed. It is a benefit of the invention that the entire outer surface of the electrode group is covered with a very thin metal foil for positive electrode collector and separator. In such cell composition, the cell capacity is slightly sacrificed, but the

reliability is high in cell crushing, and the safety is assured, which is important beyond anything.

So far, the cylindrical cell is described as the embodiment, but the invention is not limited to the cylindrical cell alone. It may be also applied to the oval cell using an oval section electrode group by forming a thin and long positive electrode and negative electrode in a flat plate in the winding core portion through a separator, and plaiting down in one direction and winding up, similarly to the prismatic cell using an electrode group by plaiting down a thin and long positive electrode and negative electrode in an accordion form through a separator, and a prismatic cell using an electrode group alternately laminating a plurality of positive electrodes and negative electrodes through separators. Of the cells of these shapes, however, in the prismatic cell, in the case of the electrode plate plaiting down both positive electrode and negative electrode of thin and long type into an accordion form through separator, the exposed portion of metal foil of the collector must be provided at both ends of the positive electrode. In the case of the electrode group composed by alternately laminating a plurality of positive electrodes and negative electrodes through separators, by using the negative electrodes one more than the positive electrodes, the negative electrode is positioned at the outer side, and two metal foils for positive electrode collector are disposed at the outer side through separator as dummy plates, and the outermost side is wrapped with separator. In this case, of course, the negative electrodes, and positive electrode and dummy plate are respectively connected parallel

electrically.

In the embodiment, the active material was LiCoO2 in the positive electrode, and carbon in the negative electrode, but the invention is not limited to these systems alone. For example, as the positive active material, a double oxide of lithium and transition metal expressed as $LiMO_2$ or LiM_2O_4 (M: one selected from the group consisting of Mn, Fe, Co, and Ni) may be used. As the negative active material, aside from carbon, metallic lithium, Nb, Ti, and other transition metal oxide may be used.

In the embodiment, the microporous polypropylene membrane is used as the separator, but, depending on the purpose, the membrane separator may be made of polyolefin such as polyethylene or mixture of polyethylene and polypropylene.

As the non-aqueous electrolyte of the invention, not limited to the organic electrolyte, the technology may be sufficiently applied to polymer solid electrolyte, too.

Industrial Applicability

Thus, the invention presents a non-aqueous secondary battery characterized by conducting a positive electrode and a metal foil for positive electrode collector electrically, confronting the positive electrode and negative electrode through a separator, covering the entire outer surface of the electrode group having the negative electrode positioned at its outer side with the metal foil for positive electrode collector, wrapping the entire outer side with a

separator, and putting thus constituted electrode group into a negative polarity cell container. By employing such cell composition, without sacrificing the cell capacity more than necessary and without increasing the number of parts, fire or rupture accidents do not occur even in severe conditions for crushing the cell by pressing strongly from the side, the reliability is high, and the safety is extremely enhanced.

CLAIMS

1. A non-aqueous electrolyte secondary battery, being a non-aqueous electrolyte secondary battery comprising a electrode group composed by setting thin positive electrode and negative electrode, having an active material layer or a layer of mixture of active material and conductive agent formed thinly on a metal foil which is a current collector, respectively oppositely through a separator, wherein a metal foil for positive electrode collector is electrically connected to said electrode, the entire surface of outside of the electrode group where the negative electrode is positioned outside is covered with said metal foil for positive electrode collector through a separator, moreover its outermost side is covered with a separator, and thus constituted electrode group is put in a negative polarity cell container together with non-aqueous electrolyte.

2. A non-aqueous electrolyte secondary battery according to claim 1, being a non-aqueous electrolyte secondary battery comprising an electrode group composed by winding a thin long positive electrode and negative electrode spirally through a separator, wherein a metal foil for positive electrode collector is electrically connected to the outer circumferential end of the positive electrode, the negative electrode is wound so as to be positioned on the outer circumference of the electrode group, its entire outer circumferenceis covered and wound with the metal foil for positive electrode collector through a separator,

its outer circumference is further wrapped with a separator, and thus constituted electrode group is put in a negative polarity cylindrical cell container together with non-aqueous electrolyte.

3. A non-aqueous electrolyte secondary battery according to claim 1, being a non-aqueous electrolyte secondary battery comprising an electrode group with an oval section composed by forming a thin long positive electrode and negative electrode through a separator in a flat plate in the winding core portion, and plaiting down and winding in one direction, wherein a metal foil for positive electrode collector is electrically connected to the outer circumferential end of the positive electrode, the negative electrode is wound so as to be positioned on the outer circumference of the electrode group, its entire outer circumference is covered and wound with the metal foil for positive electrode collector through a separator, its outer circumference is further wrapped with a separator, and thus constituted electrode group is put in a negative polarity oval cell container together with non-aqueous electrolyte.

4. A non-aqueous electrolyte secondary battery according to claim 1, being a non-aqueous electrolyte secondary battery comprising an electrode group composed by plaiting down a thin long positive electrode and negative electrode through a separator in an accordion form, wherein a metal foil for positive electrode collector is electrically connected to both ends of the positive electrode, the negative electrode covers the entire both outer surfaces of the electrode group positioned at both outer sides through a separator with the metal

foil for positive electrode collector, and the outermost side is further wrapped with a separator, and thus constituted electrode group is put in a negative polarity prismatic cell container together with non-aqueous electrolyte.

5. A non-aqueous electrolyte secondary battery of any one of claims 1, 2, 3 and 4, wherein the metal foil for the positive electrode collector connected electrically to the positive electrode has an exposed portion not forming at all the active material layer or the layer of mixture of active material and conductive agent, on both side of a specified area of the metal foil, when fabricating the positive electrode by forming the active material or a layer of mixture of active material and conductive agent on the metal foil for the collector.

6. A non-aqueous electrolyte secondary battery characterized by forming an electrode group by alternately laminating positive electrodes and negative electrodes which have an active material layer or a layer of mixture of active material and conductive agent formed thinly on a metal foil which is a collector, being one negative piece more than the positive electrodes through separator, confronting the entire surface of the negative electrode of both outer sides with two dummy plates made of metal foil for positive electrode collector through the separators, wrapping the outermost side with the separator, connecting the positive electrodes and dummy plates, and negative electrodes each other electrically, and putting thus constituted electrode group into a negative polarity prismatic cell container together with non-aqueous electrolyte.

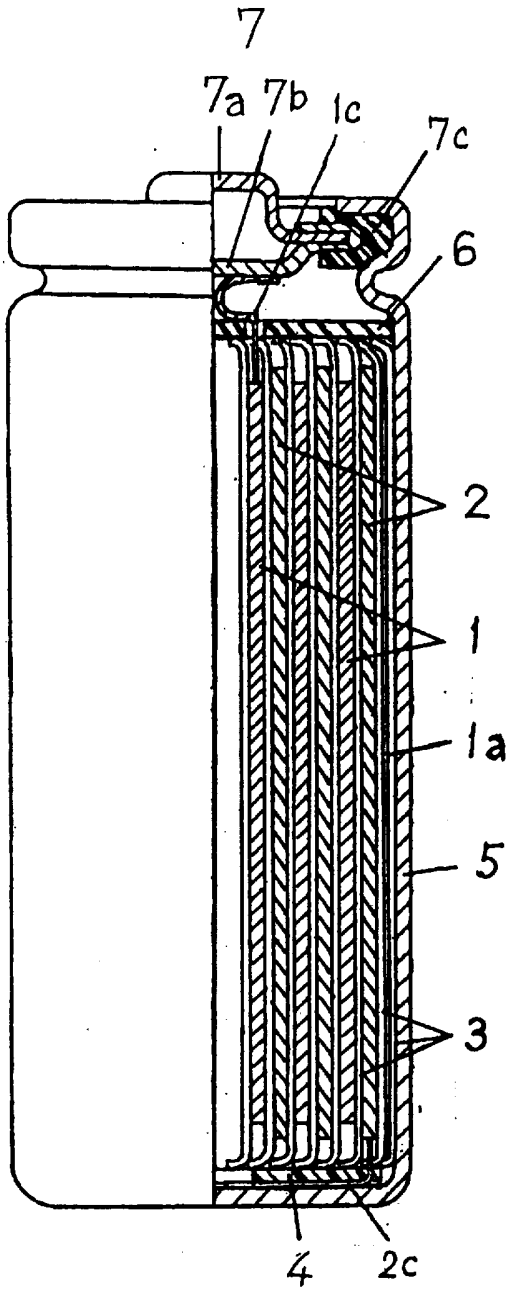

Fig. 1

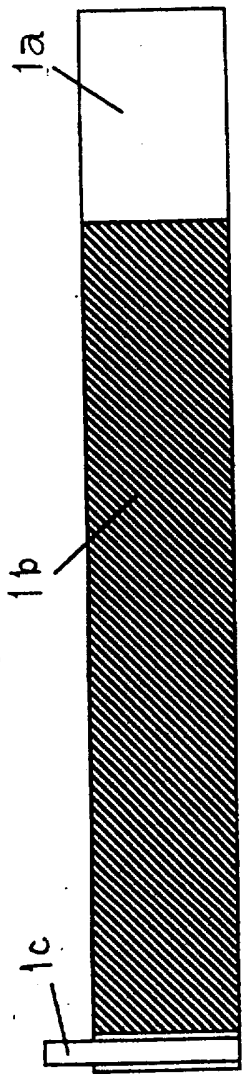

Fig. 2

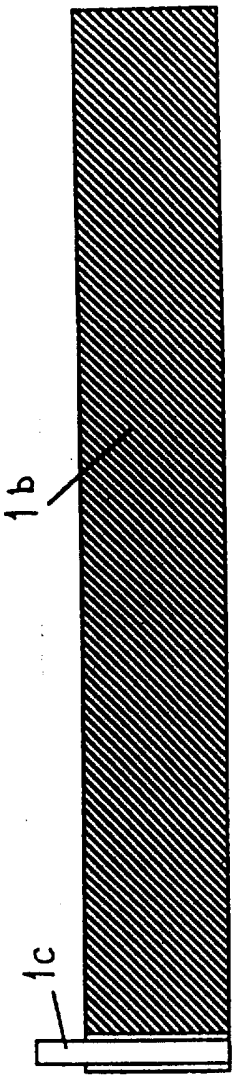

Fig. 4

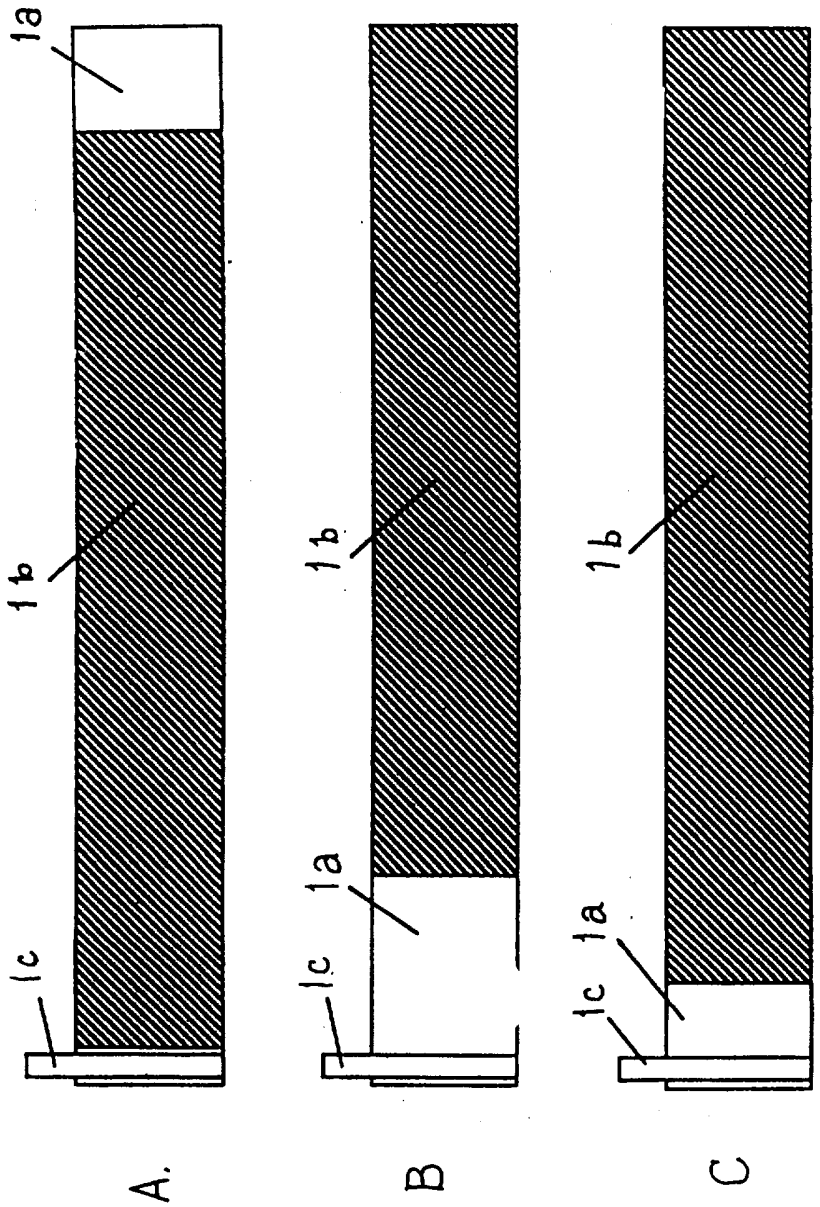

Fig. 3

Reference Numerals

1	Positive electrode
1a	Metal foil for positive electrode collector
1b	Active material layer or mixture layer of active material and conductive agent
1c	Positive electrode lead piece
2	Negative electrode
3	Separator
4	Bottom insulating plate
5	Cell container
6	Upper insulating plate
7a	Terminal plate
7b	Cover plate
7c	Gasket

INTERNATIONAL SEARCH REPORT

Interna al Application No
PCT/JP 97/01040

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01M10/40 H01M10/04

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01M

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 225 153 A (DURACELL INT) 23 May 1990 see page 6, paragraph 3 - page 7, paragraph 1 see page 10; example 1 see page 12, paragraph 4; claims 1-11 ---	1,2
P,X	WO 96 10273 A (ASAHI CHEMICAL IND ;YAMASHITA MASAYA (JP)) 4 April 1996 cited in the application see figures 6,7 ---	1
A	US 4 622 277 A (BEDDER PAUL L ET AL) 11 November 1986 see column 3, line 23 - column 8, line 23 ---	1,2,5,6
A	US 4 385 101 A (CATANZARITE VINCENT O) 24 May 1983 see column 10, line 3 - column 12, line 62 --- -/--	1,2,4,5

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
25 June 1997	10. 07. 97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+ 31-70) 340-3016	De Vos, L

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5 322 746 A (WAINWRIGHT DAVID) 21 June 1994 see column 4, line 23 - column 10, line 56	1,2,5
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