

PATENT SPECIFICATION

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(54) BUTTON TYPE ELECTRIC CELLS

(71) We, SOCIÉTÉ ANONYME DITE: SAFT—SOCIÉTÉ DES ACCUMULATEURS FIXES ET DE TRACTION, a French Body Corporate of 156, avenue de Metz 93230 Romainville, France, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to button type electric cells and more particularly cells in which the transformations undergone by the electrochemically active materials cause a change in their overall volume between the charged state and the discharged state. The term electrochemically active materials is used herein to mean both positive and negative active materials together with the electrolyte provided at least one of the components of the electrolyte takes part in the charge and discharge reactions.

The majority of button type cells consist of a first metal cup containing the positive active mass and acting as the collector of the positive electrode, a second metal cup containing the negative active mass and acting as the collector of the negative electrode, an electrolyte impregnated separator between the positive and negative active materials and an insulating seal between the two cups which are fitted into each other. The seal simultaneously seals the assembly and electrically insulates the cups from each other.

In such cells, if the volume of the active materials changes between the charged state and the discharged state, it can follow according to the circumstances either that the button swells or, on the contrary, that a void is created inside the button. In order to avoid the first case, the cell may be provided with a casing whose size corresponds to the state where the active materials take up their maximum volume, but in all cases, when passing from the maximum volume state to the minimum volume state, the void which is generated inside gives rise to some disadvantages.

With primary cells, the problem arises in particular with some cells which have a

soluble negative electrode and where the discharge products of the negative electrode are to be found in the positive compartment while the negative compartment is progressively emptied beginning with the part next to the separator. If the migration of the discharge products towards the positive compartment does not cause sufficient swelling of the positive active material, it can result that the ionic contact between the two electrodes is broken, since the intervening gap has increased. The discharge therefore stops prematurely.

Preferred embodiments of the present invention remedy this disadvantage.

It provides a button type electric cell comprising a first metal cup containing the positive active mass and acting as a current collector for the positive electrode, a second metal cup containing the negative active mass and acting as a current collector for the negative electrode, a separator impregnated with electrolyte between the positive and negative active masses and an insulating seal between the two cups fitted into each other, where the overall volume of the active masses is different in the charged state from in the discharged state, wherein the first cup also contains at least one compartment situated between said first cup and the positive active mass and delimited adjacent this mass by a perforated sheet, said compartment being filled with electrolyte when the active materials of the cell are in that state of charge in which they take up the maximum volume.

In this way, the electrolyte contained in said compartment is attracted by capillary action into the voids generated in the electrodes by the reduction in overall volume of the active materials and the electrochemical reaction can continue until the transformation of the active materials is complete, if the extra volume of electrolyte provided is adequate.

Embodiments of the invention are described by way of example with reference to the accompanying drawing in which:

Figure 1 shows schematically a cross-section of a cell in accordance with the invention; Figure 2 shows in the same way a different

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embodiment of a cell in accordance with the invention; and

Figure 3 shows in the same way a third embodiment of a cell in accordance with the invention.

In figure 1, the electric cell comprises a casing formed by cups 1 and 3, the edges of the cup 1 being turned down over the edges of the cup 3 with a plastics seal 7 interposed between them. The two cups are made of nickel-plated steel (or stainless steel) and the seal 7 is made of polypropylene.

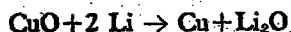
A positive active mass 2 contained in the cup 1 is a mixture of positive active material and of an electron conductor. The positive active material is chosen from among cupric oxide and lead oxide PbO or red lead Pb_3O_4 ; the electron conductor can be graphite or a metal, and is preferably a metal which reduces or cancels the initial discharge voltage peak of the cell, such as zinc, lead or tin as described in French patent N° 74 34 867 published under N° 2 288 401, corresponding to Australian application N° 85 100, British specification n° 1 484 527 and U.S. patent N° 4 018 970.

A negative active mass 4 contained in the cup 3 is lithium. A separator interposed between the masses 2 and 4 is composed of two layers, a layer 5 made of hydrophilic cellulose felt and a layer 6 made of a sheet forming a barrier against particles of the active mass.

In accordance with the invention, the positive active mass 2 has been compressed in a perforated cup 8 made of nickel-plated steel (or stainless steel) whose bottom is in close contact with the bottom of the cup 1, to which it can be welded at 10 to improve the conductivity. The cup 8 provides an annular space 9 round the positive mass which is filled with electrolyte when the cell is in the fresh state. During discharge of the cell, the active mass 4 decreases in volume since the lithium passes into solution and migrates towards the positive compartment where it is accommodated in the form of lithium oxide Li_2O in the pores of the positive mass 2.

The electrolyte carried by the separator 5 no longer fills the middle compartment whose volume has increased. The electrolyte contained in the annular compartment 9 then passes through the empty capillary spaces, firstly of the positive mass, then of the separator 5 and discharge can take place without any increase in the internal resistance of the cell.

The interior volume of the compartment 9 is chosen to be of the order of 0.3 cm^3 per ampère-hour. It is easy to deduce the variation of the overall volume of the active materials by considering the discharge reaction the lithium cupric-oxide cell; the weights (in g) and the volumes (in cm^3) per ampère-hour of these materials are given hereinbelow.



$$1.4842 \text{ g} + 0.2589 \text{ g} \rightarrow 1.1858 \text{ g} + 0.5573 \text{ g}$$

$$0.2319 \text{ cm}^3 + 0.4883 \text{ cm}^3 \rightarrow 0.1329 \text{ cm}^3 + 0.2773 \text{ cm}^3$$

i.e.

$$0.7202 \text{ cm}^3 \rightarrow 0.4102 \text{ cm}^3.$$

The reduction in volume per ampère-hour is therefore 0.31 cm^3 .

An analogous calculation leads to results close to 0.3 cm^3 for lead oxides also.

In figures 2 and 3 the same references as those in figure 1 designate identical components.

Figure 2 shows another form of the perforated partition delimiting the annular compartment containing the reserve of electrolyte. The cup 8 of figure 1 is replaced by a ring 11 which delimits the annular space 9, while the positive mass is in direct contact with the bottom of the cup 1.

Figure 3 also shows another embodiment in accordance with the invention. This time, the compartment 9 is delimited by a perforated cup 12 whose edges are in close contact with the bottom of the cup 1 and can be welded thereto. Assembly is a little more difficult than for the cells of figures 1 and 2, but operation is the same.

It must be understood that other embodiments can be obtained by modifying details, such as the shape of the perforated wall delimiting the compartment 9, without thereby going beyond the scope of the invention.

WHAT WE CLAIM IS:—

1. A button type electric cell comprising a first metal cup containing the positive active mass and acting as a current collector for the positive electrode, a second metal cup containing the negative active mass and acting as a current collector for the negative electrode, a separator impregnated with electrolyte between the positive and negative active masses and an insulating seal between the two cups fitted into each other, where the overall volume of the active masses is different in the charged state from in the discharged state, wherein the first cup also contains at least one compartment situated between said first cup and the positive active mass and delimited



embodiment of a cell in accordance with the invention; and

Figure 3 shows in the same way a third embodiment of a cell in accordance with the invention.

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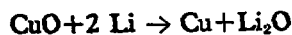
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- adjacent this mass by a perforated sheet, said compartment being filled with electrolyte when the active materials of the cell are in that state of charge in which they take up the maximum volume. 15
- 5 2. A cell according to claim 1, wherein the cell is a primary cell and the active materials have their maximum overall volume in the charged state.
- 10 3. A cell according to claim 2, wherein the negative electrode is soluble.
4. A cell according to claim 3, wherein the positive active material is chosen from the group: cupric oxide, lead oxide PbO and red lead Pb_2O_3 . 15
5. A cell according to claim 4, the volume of electrolyte contained in said compartment is of the order of 0.3 cubic centimetres per ampere-hour of its capacity. 20
6. A button type electric cell substantially as herein described with reference to any one of the figures of the accompanying drawing.

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