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Voor: Fused button battery

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(54) **Fused button battery**

(57) The present invention relates to a single cell cylindrical battery, such as a button cell or a button battery, that can be regarded to have the shape of a slice of a cylinder, and to a method preventing upper digestive and upper respiratory tract injury after accidental ingestion of the single cell cylindrical battery. It is noted that in some case ingestion has even led to the death in particular of children or small size adults, or people with a mental limitation, or people with a prior narrowing of structures in which the battery can be lodged. The structures in which the battery can be lodged are both the pharyngeal, upper digestive and upper respiratory tracts.. As ingestion itself can not always be prevented, a relatively safe battery has been developed, which mitigates problems associated with ingestion.

NL B1 2027247

Fused button battery

100572NL00

FIELD OF THE INVENTION

The present invention relates to a single cell cylindrical battery, such as a button cell, or a button battery, or a watch battery, that can be regarded to have the shape of a slice of a cylinder, and to a method preventing upper digestive tract injury after accidental ingestion of the single cell cylindrical battery. It is noted that in some case ingestion has even led to the death in particular of children or small size adults, or people with a mental limitation or people with a prior narrowing of structures in which the battery can be lodged. The structures in which the battery can be lodged are both the digestive and upper respiratory tracts. As ingestion itself can not always be prevented, a relatively safe battery has been developed, which mitigates problems associated with ingestion.

BACKGROUND OF THE INVENTION

The invention is in the field of a single cell cylindrical battery, also referred to as a watch battery or a button cell. Typically, it relates to a small cell shaped as a typically short cylinder. A diameter thereof is typically limited to 5 to 25 mm whereas a height typically is 1 to 6 mm, hence relatively small objects. Button cells with relatively larger diameters are typically referred to as coin cells. Primary and secondary button batteries comprise an electrochemical stack typically enclosed by a metal casing. A typical casing comprises a metal bottom can and a metal top cap which are electrically isolated from each other, such as by a polymer gasket. The bottom casing is typically crimped or deformed around the cap in the manufacturing process resulting in a tight seal. Typically, the internal surfaces of the can and cap are connected to the cathode electrode and the anode electrode of the electrochemical stack, respectively, and therefore may be considered to act as the positive and negative terminal of the button cell. Typically, these internal contacts are established by the pressure resulting from the deformation and the manufacturing process. As other batteries, button cells can be used to provide electronics devices with power, typically relatively small electronic devices. Most button cells have low self-discharge and hold their charge for a long time if not used.

Button cells may be considered as primary cells, which unfortunately are usually disposable primary cells, as opposed to secondary cells that can be reversible charged/discharged. Common anode materials are zinc or lithium. Common cathode materials are manganese dioxide, silver oxide, carbon monofluoride, cupric oxide or oxygen from the air. Relatively high-power devices may use a zinc–air battery which have much higher capacity for a given size.

Cells are typically mechanically interchangeable. However, voltage, amperage, power output may vary significantly. In view of intended use cells are optimised for different loads, such as by using different electrolytes.

Button cells are found to be potentially very dangerous in particular for aforementioned categories of people. Button cells that are swallowed can result in severe damage of vital organs that may result in death. In this respect reference can be made to Voelker J, et al., "Severe tracheobronchial harm due to lithium button battery aspiration: An in vitro study of the pathomechanism and injury pattern.", Int. J. Pediatr. Otorhinolaryngol. 2020 Dec;139:110431, and Jatana KR, et al., "Button battery safety: industry and academic partnerships to drive change." Otolaryngol Clin North Am. 2019;52:149-161. Basic mechanisms of such injury have been described in Jatana KR, Rhoades K, Milkovich S, Jacobs IN. Basic mechanism of button battery ingestion injuries and novel mitigation strategies after diagnosis and removal. Laryngoscope. 2017 Jun;127(6):1276-1282 Reference may also be made to P. Doekes in "Button battery induced oesophageal lesions: how and when?", MsC thesis, R.U. Groningen, July 2015.

Some documents relate to discoursing children from ingesting batteries, such as having batteries with unpleasant taste, or unpleasant colour. Some button batteries may be provided with an adhesive sticker for preventing a short-circuit by sealing of one or both of the electrodes. This may prevent some accidents from happening in the first place and the latter only functions for new (non-used) batteries. Experiments demonstrate that this yields a deceptive sense of security, as the seal of the stickers is never electrically complete.

Some documents recite button cells with a coil electrode with thermal securing. For instance, EP 3252843 A1 recites a button cell which comprises a housing, an electrode-separator assembly, and metallic diverters, which electrically connect the at least one positive electrode and the at least one negative electrode to one of the housing halves each, and at least one of the diverters is provided with a thermal fuse, which respond to a temperature difference rather than to an electric short-cut.

Some documents recite fuses to prevent thermal explosions. And some documents provide materials that change electrical properties, in that a conductive path is transferred into a non-conducting path, e.g., from a stress to a non-stress status. And some further documents recite fuses in battery-systems, in order to prevent too strong currents in said system as a whole.

So, to the knowledge of the inventors none of the documents recites a solution for preventing damage to a human body after accidental ingestion of the single cell cylindrical battery. Therefore, there is a need for an improved single cell cylindrical battery.

The present invention therefore relates to a single cell cylindrical battery and further aspects thereof, which overcomes one or more of the above disadvantages, without compromising functionality and advantages.

SUMMARY OF THE INVENTION

It is an object of the invention to overcome one or more limitations of a single cell cylindrical battery of the prior art and at the very least to provide an alternative thereto. The present single cell cylindrical battery, such as a button cell or a button battery, comprising at least one positive electrode (e_p), at least one negative electrode (e_n), in between said electrodes at least one solid or fluid electrolyte (e_l), at least one positive terminal (t_p)in electrical contact with the at least one positive electrode, at least one negative terminal (t_n) in electrical contact with the at least one negative electrode, and at least one electrical fuse (f) in between and in electrical contact with said negative or positive electrode and said negative or positive terminal, respectively. The present fuse may be regarded as an electrically conductive element that loses the ability to conduct the electrical current in a controlled and predefined manner. In general, a fuse is regarded an electrical safety device that provides overcurrent protection of an electrical circuit. Its main component is typically a metal wire or metal strip that is adapted to melt when too much current flows through it. Evidently it then stops the current from flowing. As it melts, it may be considered to be a sacrificial device; once a fuse has operated it results in an open circuit, and the present battery is as a consequence not functioning as such any longer. Fuses may be designed to have specific current and voltage ratings, breaking capacity and response times, depending on the application. The time and current operating characteristics of fuses are chosen to provide adequate protection without jeopardizing functionality. Wiring regulations usually define a maximum fuse current rating for particular circuits. A fuse is therefore a means of removing power. The present single cell cylindrical battery provides a simple solution to the above problems, which prevents continuous discharging of the present battery, especially when ingested, such as by children. The inventors indicate that the external short circuit caused by ingested results in a current peak above 0.5 Ampere, whereas the maximum current use of button cells is approximately 0.1 Ampere at a limited time interval of less than 15 sec, typically less than 5 sec. The invention is a fuse that operates within this current window, not affecting the normal working and breaking the short circuit upon ingestion. Therewith the present battery largely prevents injury resulting from discharging when ingested, by breaking the circuit, resulting in only a fraction of the reactions that cause the injury. Most or all of serious injury is therewith prevented, as well as casualties. The present fuse can be integrated in an existing or new single cell cylindrical battery without any major changes, amongst others in view of the flat design of the fuse. The present battery is therefore safer.

Details of the present single cell cylindrical battery can e.g. be found in IEC60086, which international standard document and its contents are incorporated by reference. The term "watch battery" is considered to be encompassed by the present single cell cylindrically battery. To give some examples: type B or C systems (Li-based) have a nominal voltage of 3.0 V, and end-point voltage of 2.0 V, and an open circuit voltage of 3.00-3.70 V. Type L or S systems (Zn-based) have a nominal voltage of about 1.5 V, and end-point voltage of 1.0/1.2 V, and an open circuit voltage of 1.50-1.70 V. A discharge resistance is in the order 10-100 kΩ.

In a further aspect the present invention relates to a method of preventing injury after accidental ingestion of the single cell cylindrical battery according to the invention, in particular of children, or small sized adults, or people with a mental limitation, or people with a prior narrowing of digestive or upper respiratory tract, or in the mouth, or in the nose, or in the pharynx., comprising providing the single cell cylindrical battery, preventing short circuit by the at least one electrical fuse (f) which at least one electrical fuse breaks the short circuit when ingested. A reason that specifically children (or likewise small human beings) suffer most, is that ingestion of a single battery is found to cause a short circuit in the oesophageal region, where it often becomes lodged and does not pass through the digestive tract. When for instance a button battery is ingested, in particular one with a diameter of 20 mm, the ionically conducting environment of the upper digestive tract of children effectively creates an external short circuit of the battery. This is found to drive a local chemical reaction raising the pH near one pole of the battery and lower the pH near the other pole. The non-physiological pH is found to effectively dissolve the local wall, leading to the injury of adjacent tissue.

The present invention provides a solution to one or more of the above mentioned problems and overcomes drawbacks of the prior art.

Advantages of the present invention are detailed throughout the description.

DETAILED DESCRIPTION OF THE INVENTION

In an exemplary embodiment of the present single cell cylindrical battery the at least one fuse comprises at least one dielectric layer (d), and embedded in said dielectric layer at least one electrically conducting wire (w). The term “wire” may refer to a wire, such as a wire with a circular cross-section, and likewise to a conducting path between two points, such as a (thin) line of conducting material, in particular a substantially flat line. A sheet or the like may be provided, wherein the sheet is made of said at least one dielectric material, and the at least one electrically conducting wire is incorporated therein. The wire is typically in electrical contact with two electrically conducting terminals on either side of said dielectric layer.

In an exemplary embodiment of the present single cell button battery the fuse is in between the positive terminal, also referred to as can, and the positive electrode, and/or the fuse is in between the negative terminal, also referred to as cap, and the negative electrode, thereby replacing a direct electrical contact of said electrode with the respective terminal by an electrical contact through the fuse via fuse terminals.

In an exemplary embodiment of the present single cell button battery the electrically conducting terminals of the fuse comprise a material such as aluminium, nickel, stainless steel, gold or another material that is electrochemically stable at the potential of the contacted electrode.

In an exemplary embodiment of the present single cell cylindrical battery the fuse has a thickness of 10-300 μm, preferably 20-100 μm, more preferably 30-70 μm, such as 40-60 μm. In this respect the term “fuse” refers to a total thickness, optionally including elements as depicted in figs. 4a-c. The fuse is therewith relatively thin, and forms no mechanical barrier for implementing into a battery. It also has a limited impact on the battery capacity. Also, the thin fuse prevents short circuitry rather quickly, typically within a few seconds, such as within one or two seconds.

In an exemplary embodiment of the present single cell cylindrical battery the dielectric material is selected from cellulose comprising materials, such as paper, from polymeric materials, from glass, from fibrous material, from a gas, in particular air, or a combination thereof. The selected dielectric material being stable against the constituents (solvents) of the liquid electrolytes used. These types of materials can be implemented in a battery without jeopardizing other functionality thereof, and in addition are easy to implement.

In an exemplary embodiment of the present single cell button battery the fuse embedded in the dielectric material is crossing a cavity within said dielectric material therewith forming a conductive path, in particular a cavity that is filled with a gas, such as helium, or argon, or wherein said cavity is vacuum, with a lower heat conductivity then the dielectric material. Said fuse conductive path is thereby fully or partly suspended in vacuum or gas.

In an exemplary embodiment of the present single cell button battery the fuse conducting path (w) has a cross sectional area of <2000 μm^2, more preferably <500 μm^2, such as 1-100 μm^2.

In an exemplary embodiment of the present single cell button battery the fuse conducting path (w) has a circular cross sectional area with a diameter < 100 µm, more preferably < 50 µm, such as 1-10 µm.

In an exemplary embodiment of the present single cell button battery the fuse is sacrificed (blown) at a power of > 100 W (I^2V), preferably at a power of > 1W, more preferably at a power of > 0.1 W, such as > 0.05W, in particular sacrificed in a time < 60 sec, preferably < 10 sec, such as < 5 sec, more in particular sacrificed at a peak-current of > 1A, preferably >0.5A, more preferably >0.2 A, such as > 0.1A. Likewise the fuse is sacrificed (blown) after an energy consumption within the give times of >1000 J, in particular >10 J, more in particular >1 J, such as >0.1 J. The fuse can be designed in view of a typical use in combination with its function to be sacrificed.

In an exemplary embodiment of the present single cell cylindrical battery the wire has a diameter (or equivalent dimension) of 10-200 µm, preferably 20-100 µm, more preferably 30-70 µm, such as 40-60 µm. In addition to a relatively thin wire, or as an alternative thereto, the wire may have a limited width as well, therewith contributing to preventing short circuitry.

In an exemplary embodiment of the present single cell cylindrical battery the fuse wire has a melting point of < 100°C, preferably< 60°C, e.g. in order to prevent burns and in order to act quickly as a fuse..

In an exemplary embodiment of the present single cell cylindrical battery the fuse wire has a resistivity of < 100Ω, preferably < 10Ω, more preferably < 5Ω, such as < 1Ω.

In an exemplary embodiment of the present single cell cylindrical battery the fuse wire comprises an electrically conductive material such as aluminium, nickel, tin, copper, lead, silver, stainless steel, or a combination thereof, preferably copper.

In an exemplary embodiment of the present single cell cylindrical battery the negative terminal is an insulated top cap.

In an exemplary embodiment of the present single cell cylindrical battery the positive terminal is a metallic bottom.

In an exemplary embodiment of the present single cell cylindrical battery the electrolyte comprises a conductive material such as silver, alkaline, mercury, zinc, lithium, or a combination thereof.

In an exemplary embodiment of the present single cell cylindrical battery the electrode each individually comprise a conductive material such as zinc, lithium, Mn, Ni, Ag, C, Cu, or oxides thereof, or fluorides thereof.

In an exemplary embodiment of the present single cell cylindrical battery the battery provides a nominal voltage of 0.1-5 V, preferably 1.-4V, such as 2-3 V. It is noted that even batteries that under intended circumstances do not provide much power anymore, and hence may be considered to be (fully) used, still can cause the upper digestive tract injuries.

In an exemplary embodiment of the present single cell cylindrical battery the battery provides a current of 100-2000 mA, preferably 150-1000 mA, such as 200-500 mA.

In an exemplary embodiment of the present single cell cylindrical battery the battery provides a capacity of 100-2000 mAh, preferably 150-1000 mAh, such as 200-500 mAh.

In an exemplary embodiment of the present single cell cylindrical battery the single cell cylindrical battery has a diameter of 4-44 mm, preferably 5.8-24.5 mm, more preferably 7.9-23.0 mm, such as 10.0-20.0 mm (diameter typically ±0.15 mm), and a height of 1-10 mm, preferably 1.6-5.4 mm, more preferably 2.5-3.2 mm, as these types of batteries are found to cause most of the injuries and so on. In particular batteries of types YY20XX, such as CR20XX, and in particular CR2016, CR2020, CR2025, and CR2032 are considered.

In an exemplary embodiment of the present single cell cylindrical battery comprises a housing for providing structural integrity, such as wherein the at least one positive electrode is a can and the at least one negative electrode is a cap.

In an exemplary embodiment of the present single cell cylindrical battery the fuse comprises a fuse top (1) and a fuse bottom (2) of an electrically insulating material, a fuse top contact (3) and a fuse bottom contact (6) incorporated in the fuse top (1) and fuse bottom (2), respectively, a fuse centre contact (4) and a fuse ring contact (7) in between the fuse top (1) and fuse bottom (2), wherein the fuse (5) is in electrical contact with the fuse ring contact (7) and the fuse centre contact (4), wherein the fuse centre contact (4) is in electrical contact with the fuse bottom contact (6), and wherein the fuse ring contact (7) is in electrical contact with the fuse top contact (3).

In an exemplary embodiment of the present single cell cylindrical battery an optical fuse symbol at an outside of the battery is provided, in particular a fuse system according to fig. 6.

In an exemplary embodiment of the present single cell cylindrical battery an optical symbol at an outside of the battery is provided indicative of a broken fuse.

The invention will hereafter be further elucidated through the following examples which are exemplary and explanatory of nature and are not intended to be considered limiting of the invention. To the person skilled in the art it may be clear that many variants, being obvious or not, may be conceivable falling within the scope of protection, defined by the present claims.

FIGURES

Figure 1-3, 4a-c show schematics of the present device, fig. 5 shows a worked open version of a battery, and fig. 6 shows electrical fuse symbols.

DETAILED DESCRIPTION OF FIGURES

In the figures:

e_p at least one positive electrode

e_n at least one negative electrode

e_l in between said electrodes at least one solid or fluid electrolyte

t_p at least one positive terminal in electrical contact with the at least one positive electrode

t_n at least one negative terminal in electrical contact with the at least one negative electrode

f at least one electrical fuse

d at least one dielectric layer

w at least one electrically conducting wire

1 fuse top

2 fuse bottom

3 top contact fuse

4 centre contact fuse

5 fuse wire

6 bottom contact fuse

7 ring contact fuse

10 fuse

11 fuse bottom part

12 fuse top part

Figure 1 shows a schematic layout of a typical single cell cylindrical battery, with a height and diameter.

Figure 2 shows a detailed cross-sectional layout with a single cell cylindrical battery, such as a button cell or a button battery, comprising at least one positive electrode (e_p), at least one negative electrode (e_n), in between said electrodes at least one solid or fluid electrolyte (e_l), at least one positive terminal (t_p)in electrical contact with the at least one positive electrode, at least one negative terminal (t_n) in electrical contact with the at least one negative electrode, and at least one electrical fuse (f) in between and in electrical contact with said negative or positive electrode and said negative or positive terminal, respectively, and wherein the at least one fuse comprises at least one dielectric layer (d), and embedded in said dielectric layer at least one electrically conducting wire (w) (see fig. 3 for top view details).

Such a cell has been tested by sub-merging it in a liquid that resembles the electrical conductivity of a throat environment. The liquid comprised a standard Ringer's lactate solution (Ringer's lactate solution comprises: 130-131 mEq of sodium ion = 130mmol L^{-1}, 109-111 mEq of chloride ion = 109 mmol L^{-1}, 28-29 mEq of lactate ion = 28 mmol L^{-1}, 4-5 mEq of potassium ion = 4 mmol L^{-1}, 2-3 mEq of calcium ion = 1.5 mmol L^{-1} and has a pH of 6.5. The acidity of the mouth is typically pH 6.2 - 7.4.). The CR2032 battery was sub-merged therein, wherein the battery was adapted to comprise the present fuse. A rapid breaking of short circuitry was observed by measuring the current provided by the battery, typically within 0.2 seconds. As such, effects of an ingested battery, such as damage to the esophagus, such as chemical reactions, are found to be reduced significantly. This model experiment predicts a reduction of >90%, and typically >99%, leaving only minor effects present, as it takes some time for the fuse to break. In such an experiment the result of short-circuiting a Duracell CR2016 battery, showed a cloud of oxidation material (mainly NiO_2) and bubbles of hydrogen gas.

Figs. 4a-c show details of the present fuse. Therein an example is built up of small elements. The fuse 10 is formed as a circular-shaped element which can be integrated/incorporated within an existing battery. An example for the battery taken is a CR2032. The fuse has a fuse bottom part 11 and a fuse top part 12. Therein elements as a fuse top 1, a fuse bottom 2, a fuse top contact 3, a fuse centre contact 4, a fuse wire 5, a fuse bottom contact 6, and a fuse ring contact 7 can be seen. The fuse itself electrically contacts ring 7 and centre 4. The whole fuse is in contact with an electrical terminal of the battery by bottom contact 6 and with an adjacent electrode of the battery by contact 3. The fuse bottom 2 and fuse top 1 are typically made of an electrically insulating material, such as a dielectric, or cellulose, as explained in the description. An electrical current therefore passes from a terminal to contact 6, to ring contact 7, via the fuse 5 to central contact 4, then to fuse top contact 3, and further to an electrode.

Fig. 5 shows a work-open version of the present button cell battery. Therein the at least one positive terminal t_p in electrical contact with the at least one positive electrode e_p, with the present fuse comprising at least one dielectric layer d, and at least one electrically conducting wire w, in between said electrodes at least one solid or fluid electrolyte e_l, at least one negative electrode e_n, and at least one negative terminal t_n in electrical contact with the at least one negative electrode.

Fig. 6 shows three typically used symbols for an electrical fuse.

The next section is added to support the search, and the section thereafter is considered to be a full translation thereof into Dutch.

1. Single cell cylindrical battery, such as a button cell or a button battery, comprising
at least one positive electrode (e_p),
at least one negative electrode (e_n),
in between said electrodes at least one solid or fluid electrolyte (e_l),
at least one positive terminal (t_p)in electrical contact with the at least one positive electrode,

at least one negative terminal (t_n) in electrical contact with the at least one negative electrode, and

at least one electrical fuse (f) in between and in electrical contact with said negative or positive electrode and said negative or positive terminal, respectively.

2. Single cell cylindrical battery according to embodiment 1, wherein the at least one fuse comprises at least one dielectric layer (d), and embedded in said dielectric layer at least one electrically conducting wire (w).

3. Single cell cylindrical battery according to embodiment 1 or 2, wherein the fuse is in between the positive terminal and the positive electrode, and/or wherein the fuse is in between the negative terminal and the negative electrode.

4. Single cell cylindrical battery according to any of embodiments 1-3, wherein the fuse comprises fuse terminals, in particular from a material that is electrochemically stable at the operating potential of the battery, such as aluminium, nickel, stainless steel, or gold.

5. Single cell cylindrical battery according to any of embodiments 2-4, wherein dielectric material comprises a cavity, and the fuse embedded in the dielectric material forms a conductive path over said cavity, in particular a cavity that is filled with a gas, such as helium, or argon, with a lower heat conductivity then the dielectric material.

6. Single cell cylindrical battery according to embodiment 5, wherein the fuse conducting path (w) has a cross sectional area of <2000 μm^2, more preferably <500 μm^2, such as 1-100 μm^2.

7. Single cell cylindrical battery according to embodiment 5 or 6, wherein the fuse conducting path (w) has a circular cross sectional area with a diameter < 100 µm, more preferably < 50 µm, such as 1-10 µm.

8. Single cell cylindrical battery according to any of embodiments 1-7, wherein the fuse has a thickness of 10-200 µm, preferably 20-100 µm, more preferably 30-70 µm, such as 40-60 µm, and/or

wherein the wire has a diameter of 10-200 µm, preferably 20-100 µm, more preferably 30-70 µm, such as 40-60 µm, and/or

wherein the fuse is sacrificed at a power of > 100 W, and/or

wherein the fuse is sacrificed in a time < 60 sec, and/or

wherein the fuse is sacrificed at a peak-current of > 1A, and/or

wherein an optical fuse symbol at an outside of the battery is provided, and/or

wherein an optical symbol at an outside of the battery is provided indicative of a broken fuse.9. Single cell cylindrical battery according to any of embodiments 1-8, wherein the dielectric material is selected from cellulose comprising materials, such as paper, from polymeric materials, from glass, from fibrous material, from a gas, in particular air, or a combination thereof.

10. Single cell cylindrical battery according to any of embodiments 1-9, wherein the fuse wire has a melting point of < 100°C, and/or

wherein the fuse wire has a resistivity of < 100Ω, and/or

wherein the fuse wire comprises an electrically conductive material such as aluminium, nickel, tin, copper, lead, silver, stainless steel, or a combination thereof, and/or
wherein the negative terminal is an insulated top cap, and/or
wherein the positive terminal is metallic bottom.

11. Single cell cylindrical battery according to any of embodiments 1-10, wherein the anode comprises a conductive material such as silver, alkaline, mercury, zinc, lithium, or a combination thereof, and/or
wherein the electrode each individually comprise a conductive material such as zinc, lithium, Mn, Ni, Ag, C, Cu, or oxides thereof, or fluorides thereof,

12. Single cell cylindrical battery according to any of embodiments 1-11, wherein the battery provides a nominal voltage of 0.1-5 V, and/or a current of 100-2000 mA, and/or a capacity of 100-2000 mAh.

13. Single cell cylindrical battery according to any of embodiments 1-12, wherein the single cell cylindrical battery has a diameter of 4-44 mm, and a height of 1-10 mm.

14. Single cell cylindrical battery according to any of embodiments 1-13, comprising a housing for providing structural integrity, such as wherein the at least one positive electrode is a can and the at least one negative electrode is a cap.

15. Single cell cylindrical battery according to any of embodiments 1-14, wherein the fuse comprises a fuse top (1) and a fuse bottom (2) of an electrically insulating material, a fuse top contact (3) and a fuse bottom contact (6) incorporated in the fuse top (1) and fuse bottom (2), respectively, a fuse centre contact (4) and a fuse ring contact (7) in between the fuse top (1) and fuse bottom (2), wherein the fuse (5) is in electrical contact with the fuse ring contact (7) and the fuse centre contact (4), wherein the fuse centre contact (4) is in electrical contact with the fuse bottom contact (6), and wherein the fuse ring contact (7) is in electrical contact with the fuse top contact (3).

16. Method of preventing oesophageal injury after accidental ingestion of the single cell cylindrical battery according to any of embodiments 1-15, in particular of children, or small sized adults, or people with a mental limitation, or people with a prior narrowing of digestive or upper respiratory tract., or in the mouth, or in the nose, or in the pharynx, comprising
providing the single cell cylindrical battery,
preventing short circuit by the at least one electrical fuse (f) which at least one electrical fuse breaks the circuit when ingested.

Conclusies:

1. Een enkelcellige cilindrische batterij, zoals een knoopcel of een knoopcelbatterij, omvattend

ten minste één positieve elektrode (e_p),

ten minste één negatieve elektrode (e_n),

tussen deze elektroden ten minste één vaste of vloeibare elektrolyt (e_l),

minstens één positieve pool (t_p) in elektrisch contact met de minstens één positieve elektrode,

ten minste één negatieve pool (t_n) in elektrisch contact met de minstens één negatieve elektrode, en

ten minste één elektrische zekering (f) tussen en in elektrisch contact met genoemde negatieve of positieve elektrode en genoemde respectievelijke negatieve of positieve pool.

2. Eéncellige cilindrische batterij volgens conclusie 1, waarin de ten minste één zekering omvat ten minste één diëlektrische laag (d), en ingebed in genoemde diëlektrische laag ten minste één elektrisch geleidende draad (w).

3. Enkelcellige cilindrische batterij volgens conclusie 1 of 2, waarbij de zekering zich tussen de positieve pool en de positieve elektrode bevindt, en/of waarbij de zekering zich tussen de negatieve pool en de negatieve elektrode bevindt.

4. Een enkelcellige cilindrische batterij volgens een van de conclusies 1-3, waarin de zekering zekeringspolen omvat, in het bijzonder van een materiaal dat elektrochemisch stabiel is op het werkingspotentiaal van de batterij, zoals aluminium, nikkel, roestvrij staal, of goud.

5. Een enkelcellige cilindrische batterij volgens een van de conclusies 2-4, waarin het diëlektrische materiaal een holte omvat, en de zekering die in het diëlektrische materiaal is ingebed, een geleidende baan over deze holte vormt, in het bijzonder een holte die is gevuld met een gas, zoals helium, of argon, met een lagere warmtegeleidbaarheid dan het diëlektrische materiaal.

6. Enkelcellige cilindrische batterij volgens de conclusie 5, waarbij de geleidende baan van de zekering (w) een doorsnede heeft van $<2000\ \mu m^2$, bij voorkeur $<500\ \mu m^2$, zoals $1\text{-}100\ \mu m^2$.

7. Enkelcellige cilindrische batterij volgens conclusie 5 of 6, waarbij de geleidende baan van de zekering (w) een cirkelvormige doorsnede heeft met een diameter < 100 µm, bij voorkeur < 50 µm, zoals 1-10 µm.

8. Enkelcellige cilindrische batterij volgens een van de conclusies 1-7, waarbij de zekering een dikte heeft van 10-200 µm, bij voorkeur 20-100 µm, liever 30-70 µm, zoals 40-60 µm, en/of

waarin de draad een diameter heeft van 10-200 µm, bij voorkeur 20-100 µm, liever 30-70 µm, zoals 40-60 µm, en/of

waarin de zekering wordt opgeofferd bij een vermogen van > 100 W, en/of

waarin de zekering wordt opgeofferd in een tijd < 60 sec, en/of

waarin de zekering wordt opgeofferd bij een piekstroom van > 1A, en/of

waarin een optisch zekeringssymbool aan een buitenzijde van de batterij is aangebracht, en/of waarin een optisch symbool aan een buitenzijde van de batterij is aangebracht ter aanduiding van een gebroken zekering.

9. Enkelcellige cilindrische batterij volgens een van de conclusies 1-8, waarin het diëlektrische materiaal is gekozen uit cellulose-houdende materialen, zoals papier, uit polymere materialen, uit glas, uit vezelachtig materiaal, uit een gas, in het bijzonder lucht, of een combinatie daarvan.

10. Een enkelcellige cilindrische batterij volgens een van de conclusies 1-9, waarin de zekeringsdraad een smeltpunt heeft van < 100°C, en/of
waarin de zekeringsdraad een weerstand heeft van < 100Ω, en/of
waarbij de zekeringsdraad een elektrisch geleidend materiaal zoals aluminium, nikkel, tin, koper, lood, zilver, roestvrij staal, of een combinatie daarvan omvat, en/of
waarin de negatieve pool een geïsoleerde bovenkap is, en/of
waarin de positieve pool een metalen bodem is.

11. Enkelcellige cilindrische batterij volgens een van de conclusies 1-10, waarin de anode een geleidend materiaal zoals zilver, alkaline, kwik, zink, lithium, of een combinatie daarvan omvat, en/of
waarin de elektrode elk afzonderlijk een geleidend materiaal zoals zink, lithium, Mn, Ni, Ag, C, Cu, of oxiden daarvan, of fluoriden daarvan, omvat.

12. Enkelcellige cilindrische batterij volgens een van de conclusies 1-11, waarbij de batterij een nominale spanning van 0,1-5 V, en/of een stroom van 100-2000 mA, en/of een capaciteit van 100-2000 mAh levert.

13. Een enkelcellige cilindrische batterij volgens een van de conclusies 1-12, waarin de enkelcellige cilindrische batterij een diameter van 4-44 mm en een hoogte van 1-10 mm heeft.

14. Enkelcellige cilindrische batterij volgens een van de conclusies 1-13, omvattend een behuizing voor het verstrekken van structurele integriteit, zoals waarin de ten minste een positieve elektrode een blik is en de ten minste een negatieve elektrode een dop is.

15. Een enkelcellige cilindrische batterij volgens een van de conclusies 1-14, waarbij de zekering omvat een zekering bovenkant (1) en zekering onderkant (2) van een elektrisch isolerend materiaal, een zekering bovencontact (3) en zekering ondercontact (6) respectievelijk opgenomen in de zekering bovenkant (1) en de zekering onderkant (2), een zekering middencontact (4) en een zekeringsringcontact (7) tussen de zekering bovenkant (1) en zekering onderkant (2), waarbij de zekering (5) in elektrisch contact staat met het zekeringsringcontact (7) en het zekeringsmiddencontact (4), waarbij het zekeringsmiddencontact (4) in elektrisch contact staat met het zekering ondercontact (6), en waarbij het zekeringsringcontact (7) in elektrisch contact staat met het zekering bovencontact (3).

16. Werkwijze ter voorkoming van slokdarmletsel na het per ongeluk inslikken van de enkelcellige cilindrische batterij volgens een van de conclusies 1-15, in het bijzonder bij kinderen, of kleine volwassenen, of mensen met een mentale beperking, of mensen met een voorafgaande vernauwing van het spijsverteringskanaal of de bovenste luchtwegen, of in de mond,

of in de neus, of in de keelholte, omvattend het verstrekken van de enkelcellige cilindrische batterij,

het voorkomen van kortsluiting door ten minste één elektrische zekering (f) die bij inname het circuit verbreekt.

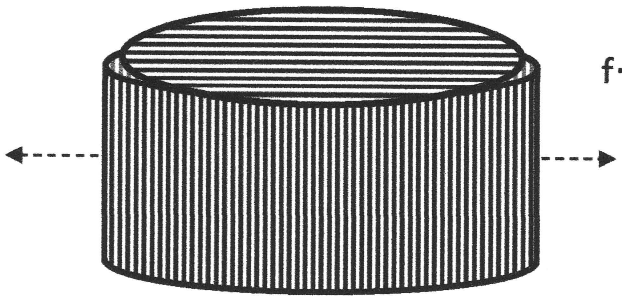


Fig. 1

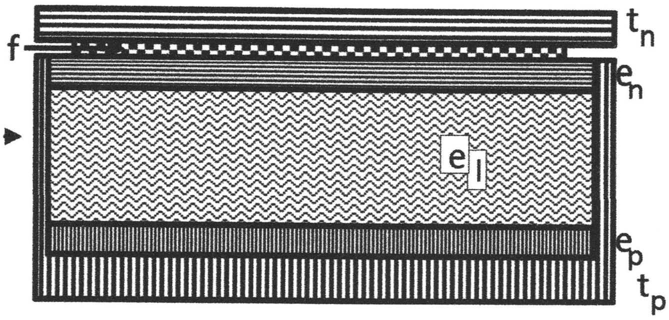


Fig. 2

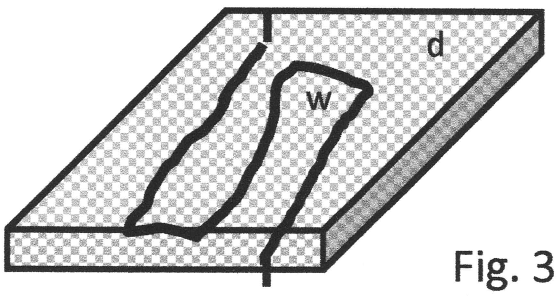


Fig. 3

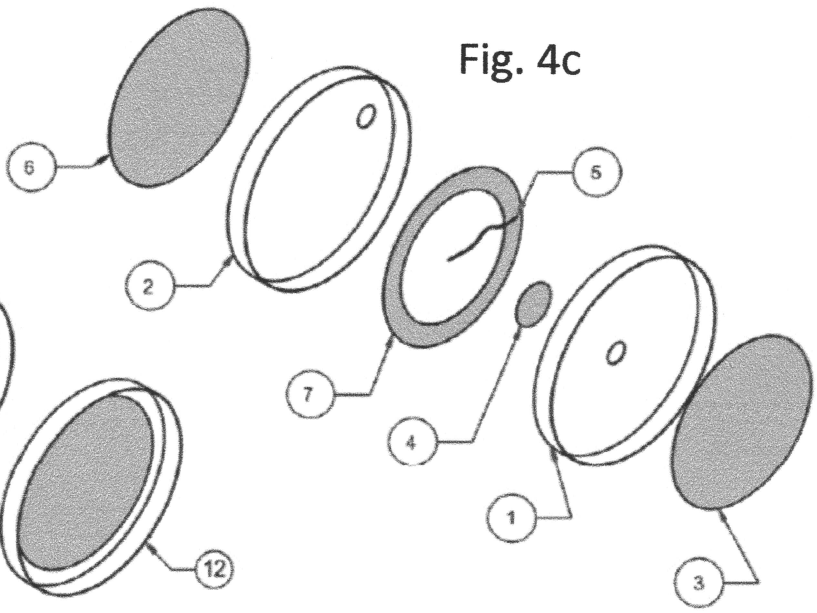
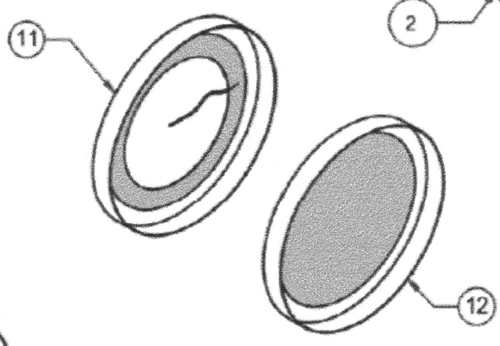


Fig. 4c

Fig. 4b



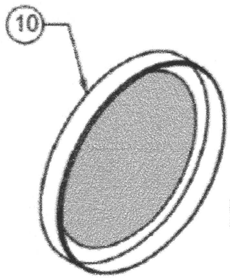


Fig. 4a

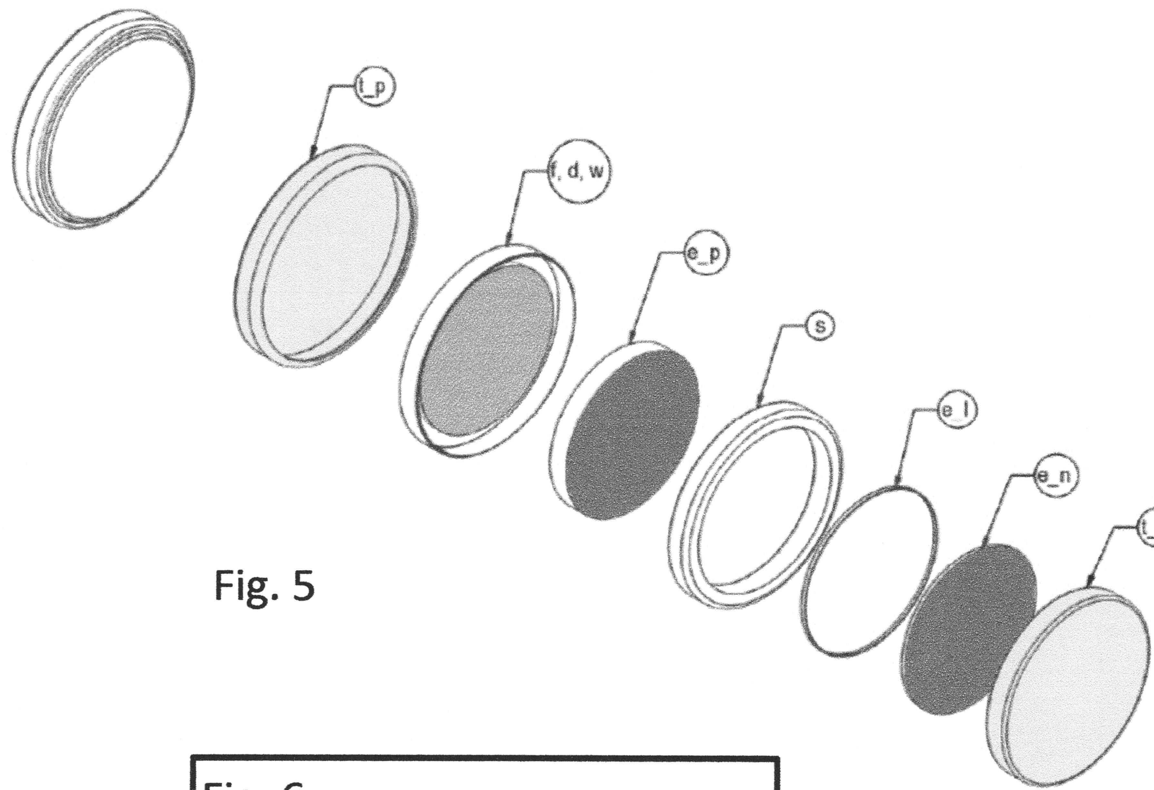
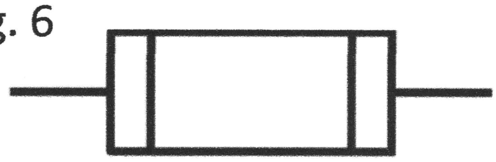


Fig. 5

Fig. 6



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