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***Journal of Power Sources***

**LEAD-ACID****6210837****ELECTRODE GRID FOR LEAD STORAGE BATTERIES**

Jurgen Bauer; Christine Standke-Thiemann; Albert Tonnesen; GERMANY assigned to Varta Batterie Aktiengesellschaft

Electrode grids for lead storage batteries comprise a lead alloy which, in addition to calcium and tin and, if appropriate, silver, contains aluminum, the aluminum content being in the range of approximately 0.012–0.02 wt.%, and the average grain diameter in the web and frame area of the grids is 200–600  $\mu\text{m}$ . Preferably, the aluminum content is in the range of approximately 0.014–0.02%, the calcium content is approximately between 0.04 and 0.06%, the tin content is approximately between 0.5 and 1.0%, and optionally 0.5–0.7%, and the silver content is approximately between 0.005 and 0.06%.

**6211651****METHOD AND APPARATUS FOR CHARGING A VALVE-REGULATED LEAD-ACID BATTERY**

Seiji Nemoto; JAPAN assigned to JAPAN Storage Battery Company Ltd.

A charging method and a charging apparatus which can be used particularly for charging a valve-regulated lead-acid battery using a Pb–Sb alloy grid as a positive electrode grid. Primary constant-current charging is performed with a predetermined current value. The primary constant-current charging is further continued for an extension time  $t_a$  after the battery voltage reaches a change-over voltage  $V_c$ . After the extension time has passed, the charging is changed over to secondary constant-current charging using a current value smaller than that of the primary constant-current charging. The extension time for continuing the primary constant-current charging is preferably set so as to be shorter as the battery temperature is higher. Also a secondary charging time for executing the secondary constant-current, charging is preferably set so as to be shorter as the battery temperature is higher.

**6214489****METHOD AND APPARATUS TO OBTAIN THE AGITATION OF ELECTROLYTE INSIDE A LEAD-ACID STORAGE BATTERY**

Olimpio Stocchiero; ITALY

The invention concerns a method to obtain the agitation of the electrolyte inside a lead-acid storage battery comprising at least one canalization duct of electrolyte which is immersed inside the storage battery. Said method consists in: connecting said canalization duct of electrolyte with a device realizing repetitive and alternative cycles of pressure

decrease and of return to the initial pressure in the section of tube which connects said device to said canalization duct, said cycles causing the movement of the electrolyte being sucked and dropped, respectively, in said canalization duct.

**6216764****METHOD AND APPARATUS FOR MAKING LEAD-ACID BATTERIES**

Teruo Goshima; Kazuo Okada; JAPAN assigned to Yuasa Corporation, Yuasa Engineering Ltd.

A cast-on method and its apparatus for joining battery plates to a post in which heat capacity of a mold for forming a post and a strap is less than five times of heat capacity of metals to be introduced in the mold. The mold is made of materials having less linear thermal expansion coefficient preferably less than  $18 \times 10^{-6} \text{ K}^{-1}$ . The mold may be dipped into calmly flowing molten metal keeping a constant level.

**6216811****ACID RETENTION SYSTEM FOR A VEHICLE BATTERY**

Matthew J. Herc; USA assigned to DaimlerChrysler Corporation

A battery tray that includes a system for controlling the flow of fluid is provided. The battery tray includes a base surface having a retention cup formed therein. The retention cup collects aqueous sulfuric acid discharged from the battery. The retention cup includes a vent or slot formed therein to allow its contents to evaporate over time. A system of troughs and channels are included in the base surface to direct fluid flow towards the retention cup. The battery tray effectively controls the flow of aqueous sulfuric acid so that the acid does not contact neighboring vehicular components. If aqueous sulfuric acid contacts metal vehicle components, it will promote corrosion of the components.

**6218045****SEALED LEAD-ACID STORAGE BATTERY**

Masayuki Ide; Takehiro Sasaki; Takuro Nakayama; Toshihiro Inoue; JAPAN assigned to Matsushita Electric Industrial Company Ltd.

A sealed lead-acid storage battery having a long trickle life, being excellent in the welded strength between the container cover and the top lid covering the part of the container cover where a vent valve is provided, and having a high reliability is disclosed. The battery comprises: a container for accommodating an electrode group, a container cover for closing an open end of the container by being bonded to the open end of the container with a resin adhesive, and a top lid for covering a part of the container cover where a vent valve is provided by being bonded to the container cover by means of ultrasonic welding, wherein the container is formed with a denatured polyphenylene ether resin containing a flaky inorganic

substance of humidity non-transmitting property, whereas the container cover and the top lid are formed with acrylonitrile-butadiene-styrene resin containing no flaky inorganic substance of the humidity non-transmitting property.

**6225005**

**LEAD-ACID BATTERY AND PRODUCING METHOD THEREOF**

Masaaki Shiomi; Yuichi Okada; Tadashi Shiroya; JAPAN assigned to Japan Storage Battery Company Ltd.

In a lead-acid battery, a positive active material includes tin in an amount of from not less than 0.2% to not more than 5% based on the weight thereof. The density of the positive active material after formation is from not less than  $3.75 \text{ g cc}^{-1}$  to not more than  $5.0 \text{ g cc}^{-1}$ . When the lead-acid battery is produced by a battery container formation, a time required between the injection of an electrolyte and the beginning of battery container formation is from not less than 0.1 h to not more than 3 h.

**6225006**

**FAMILY OF LEAD-ACID BATTERIES USING A STANDARDIZED CONTAINER AND HAVING VOLTAGE THAT CAN BE PRESELECTED AS NECESSARY**

William H. Kump; Steven R. Peterson; USA assigned to GNB Technologies Inc.

A method of making lead-acid batteries uses a container standardized for a 12 V battery and dual flag straps in the inner cells so that batteries with voltages of two, four, six, or twelve can be preselected as desired, the more preferred embodiments having one terminal cell with either two terminal bases or dual flags so as to minimize the assembly equipment required.

**6228537**

**ELECTRODE GRID FOR LEAD BATTERIES**

Gerolf Richter; Joachim Illmann; Peter Streuer; GERMANY assigned to VB Autobatterie GmbH

The invention pertains to an electrode grid for lead batteries with a rectangular grid frame, pasting accessory rails arranged on it, and a group of grid cross members which form the skeleton to hold the active mass, the pasting accessory rails extending on both sides of the electrode grid solely in the pasting direction and, especially on the front and back side of the electrode grid, are arranged offset from each other.

**FUEL CELL**

**6214486**

FUEL CELL AND METHOD OF CONTROLLING SAME  
Takafumi Okamoto; JAPAN assigned to Honda Giken Kogyo Kabushiki Kaisha

A fuel gas and an oxygen containing gas are supplied downwardly through different passages into a first manifold plate, a first surface pressure generating plate, a separator body, a second surface pressure generating plate, a second manifold plate, a first gasket, a solid polymer electrolyte membrane, and a second gasket, into which cooling water is supplied upwardly. The cooling water rises upwardly in the separator body to reduce a temperature distribution in a fuel cell.

**6214487**

**INTEGRAL SENSORS FOR MONITORING A FUEL CELL MEMBRANE AND METHODS OF MONITORING**

Ronald J. Kelley; Robert J. Mulligan; Steven D. Pratt; Sivakumar Muthuswamy; Bobby Dean Landreth; Robert W. Pennisi; USA assigned to Motorola Inc.

A membrane electrode assembly consists of a polymer electrolyte membrane with an electrode on each side. The polymer electrolyte membrane has an integral sensor disposed on the surface. The sensor monitors the physical, thermal, chemical or electrical state of the membrane electrode assembly. Information obtained from the sensor is used to identify a defective membrane electrode assembly, and the operation of the fuel cell is altered based on the identified defective membrane electrode assembly.

**6215272**

**FUEL CELL DEVICE**

Hideo Ohara; Makoto Uchida; Yuko Fukuoka; Yasushi Sugawara; Nobuo Eda; Keiichi Iiyama; JAPAN assigned to Matsushita Electric Industrial Company Ltd.

A fuel cell device, wherein, after an output voltage from a main body of a fuel cell is converted using a converter, the relation between the resultant predetermined output voltage  $V_1$  and an output voltage  $V_2$  from a secondary battery is so set as to satisfy  $V_1 > V_2$ . When, at the time of a sudden change of an external load, the output voltage  $V$  from the main body of the fuel cell becomes lower than a predetermined voltage  $V_3$ , an output to a charge controlling unit is stopped. When the output voltage  $V$  from the main body of the fuel cell is lowered even further and becomes lower than a predetermined voltage  $V_4$ , an output to an auxiliary device, which is necessary for driving the fuel cell device, is switched from the output from the converter to the output from the secondary battery.

**6217822**

**METHOD OF MAKING STRAIGHT FUEL CELL TUBES**

Brian P. Borglum; USA assigned to Siemens Westinghouse Power Corporation

A method and an apparatus for making straight fuel cell tubes are disclosed. Extruded tubes comprising powders of

fuel cell material and a solvent are dried by rotating the extruded tubes. The rotation process provides uniform circumferential drying which results in uniform linear shrinkage of the tubes. The resultant dried tubes are very straight, thereby eliminating subsequent straightening steps required with conventional processes. The method is particularly useful for forming inner air electrode tubes of solid oxide fuel cells.

#### 6218034

### **CATHODE CYLINDER FOR USE IN METAL-AIR FUEL CELL BATTERY SYSTEMS AND METHOD OF FABRICATING THE SAME**

Sadeg M. Faris; Tsepin Tsai; Thomas J. Legbandt; Wayne Yao; Muguo Chen; USA assigned to Reveo Inc.

In an air-metal fuel cell battery (FCB) system, wherein metal-fuel tape, the ionically-conductive medium and the cathode structures are transported at substantially the same velocity at the locus of points at which the ionically-conductive medium contacts the moving cathode structure and the moving metal-fuel tape during discharging and recharging modes of operation. In a first generalized embodiment of the present invention, the ionically-conductive medium is realized as an ionically-conductive belt, and the metal-fuel tape, ionically-conductive belt, and movable cathode structure are transported at substantially the same velocity at the locus of points which the ionically-conducting belt contacts the metal-fuel tape and the cathode structure during system operation. In a second generalized embodiment of the present invention, the ionically-conductive medium is realized as a solid-state (e.g. gel-like) film layer integrated with the metal-fuel tape, and the metal-fuel tape, ionically-conductive film layer and movable cathode structure are transported at substantially the same velocity at the locus of points which the ionically-conducting film layer contacts the metal-fuel tape and the cathode structure during system operation. In a third generalized embodiment of the present invention, the ionically-conductive medium is realized as a solid-state film layer integrated with the movable cathode structure, and the metal-fuel tape, ionically-conductive film layer and movable cathode structure are transported at substantially the same velocity at the locus of points which the ionically-conducting film layer contacts the metal-fuel tape and the cathode structure during system operation. By transporting the movable cathode structure, ionically contacting medium and metal-fuel tape within the system as described above, generation of frictional forces among such structures are minimized during system operation, and, thus, the damage to the cathode structure and metal-fuel tape is substantially reduced.

#### 6218035

### **PROTON EXCHANGE MEMBRANE FUEL CELL POWER SYSTEM**

William A. Fuglevand; Shiblihan I. Bayyuk; Greg Alden Lloyd; Peter David DeVries; David R. Lott; John

P. Scartozzi; Gregory M. Somers; Ronald G. Stokes; USA assigned to Avista Laboratories Inc.

A proton exchange membrane fuel cell power system for producing electrical power is described and which includes a plurality of discrete fuel cell modules having at least two membrane electrode diffusion assemblies, each of the membrane electrode diffusion assemblies having opposite anode and cathode sides; a pair of current collectors are individually disposed in juxtaposed ohmic electrical contact with opposite anode and cathode sides of each of the membrane electrode diffusion assemblies; and individual force application assemblies apply a given force to the pair current collectors and the individual membrane electrode diffusion assemblies. The proton exchange membrane fuel cell power system also includes an enclosure mounting a plurality of subracks which receive the discrete fuel cell modules. Additionally, a control system is disclosed which optimizes the performance parameters of the discrete proton exchange membrane fuel cell modules.

#### 6218036

### **SOLID ELECTROLYTE FUEL CELL**

Akira Shiratori; JAPAN assigned to Murata Manufacturing Company Ltd.

A solid electrolyte fuel cell has an air electrode, a fuel electrode and a solid electrolyte film disposed between the air electrode and the fuel electrode. The solid electrolyte film is formed of yttria-stabilized zirconia in which alumina is added, the concentration of the supplemented alumina at a surface layer section of the solid electrolyte film being larger than that at a center layer section of the solid electrolyte film.

#### 6218037

### **PROCESS FOR THE PRODUCTION OF AN INSULATING COMPONENT FOR A HIGH TEMPERATURE FUEL CELL, AND HIGH TEMPERATURE FUEL CELL**

Horst Greiner; Karl Kempter; GERMANY assigned to Siemens Aktiengesellschaft

A process for the production of an insulating component from a ceramic material for a high temperature fuel cell includes the following steps: in a first step, a ceramic material is converted into a dispersion by wet preparation with a water-soluble binder. In a second step, the dispersion is poured to form a water-containing layer. In a third step, the water-containing layer is converted at elevated temperature to form a rubbery layer. In a fourth step, the binder is burnt off from the rubbery layer at elevated temperature. In a fifth step, the layer from which the binder has been burnt off is set at elevated temperature. In a sixth and a seventh step, the layer which has been set is processed in accordance with the

dimensions of the insulating component and consolidated by sintering.

#### 6218038

### REGULATING A FLOW THROUGH A FUEL CELL

Uriel M. Oko; Wieslaw J. Zielinski; USA assigned to Plug Power Inc.

An assembly includes fuel cell plates and a valve. The fuel cell plates are arranged to form a fuel cell, and the plates establish a manifold passageway to communicate a fluid for the fuel cell. At least one of the plates includes flow channels to communicate the fluid through the fuel cell. The valve selectively regulates communication of the fluid between the manifold passageway and the channels.

#### 6218039

### CLAMPING APPARATUS AND METHOD FOR A FUEL CELL

Kevin L. Mease; Adam K. Brunner; Larry A. Pitts; Alan F. Winslow; USA assigned to Plug Power Inc.

A fuel cell assembly includes a stack assembly having fuel cell plates and a frame having a bottom section and at least two side sections integrally formed with the bottom section. The stack assembly is placed on the frame bottom section, and one or more fasteners are used to attach the frame to an upper portion of the stack assembly to apply a compressive force on the stack assembly.

#### 6224993

### ELECTROLYTE FOR SOLID OXIDE FUEL CELLS

Joseph Jay Hartvigsen; Singaravelu Elangovan; Robert Phillip Merrill; Ashok Chandrashekhar Khandkar; USA assigned to Sofco

An electrolyte, and a process for its formation, for a solid oxide fuel cell comprising an electrolyte plate and a supporting member. The electrolyte plate includes an upper and a lower surface. The support member includes a plurality of non-intersecting support members which are positioned on at least one of the upper and the lower surfaces of the electrolyte plate.

#### 6224994

### SOLID POLYELECTROLYTE-TYPE FUEL CELL

Michio Asukabe; Chiaki Yamada; Michiaki Katoh; Shinji Nezu; JAPAN assigned to Aisin Seiki Kabushiki Kaisha

A solid polyelectrolyte membrane for a fuel cell includes (a) a hydrocarbon polymer grafted fluorine polymer, which contains sulfonic acid groups; and (b) whisker fibers, fixed to the grafted fluorine polymer. The fiber may be surface-treated with a silane coupling agent which reacts with the fluorine polymer and the fibers, prior to graft-copolymerization.

#### 6228519

### METAL-AIR FUEL CELL BATTERY SYSTEMS HAVING MECHANISM FOR EXTENDING THE PATH LENGTH OF METAL-FUEL TAPE DURING DISCHARGING AND RECHARGING MODES OF OPERATION

Sadeg M. Faris; Tsepin Tsai; USA assigned to Reveo Inc.

Disclosed is a method and apparatus for extending path-length of metal-fuel tape during discharging and/or recharging operations so that a supply of metal-fuel tape contained within a cassette device or on a supply reel can be rapidly discharged and/or recharged in an improved manner. During discharging operations, a plurality of discharging heads are selectively arranged about the extended path-length of metal-fuel tape so as increase the rate at which electrical power is powered from the system. During recharging operations, a plurality of recharging heads are selectively arranged about the extended path-length of metal-fuel tape to decrease the time required to recharge the metal-fuel tape transported through the system.

#### 6228520

### CONSINTERABLE CERAMIC INTERCONNECT FOR SOLID OXIDE FUEL CELLS

Yi-Hung Chiao; USA assigned to The Dow Chemical Company

A composition which is densifiable at low temperatures in an air atmosphere suitable for use as an interconnect layer in a solid oxide fuel cell. Binary alloying of SrO and CaO with LaCrO<sub>3</sub> is used to form a compound having the general formula La<sub>(1-x)</sub>(Sr, Ca)<sub>x</sub>CrO<sub>3</sub> which is a stabilized form of LaCrO<sub>3</sub> and has the desirable properties for a fuel cell interconnect layer.

#### 6228521

### HIGH POWER DENSITY SOLID OXIDE FUEL CELL HAVING A GRADED ANODE

Jai-Who Kim; Kuan-Zong Fung; Anil V. Virkar; TAIWAN assigned to The University of Utah Research Foundation

The present invention concerns a high power density solid oxide fuel cell having a cathode, electrolyte and graded porous anode. The graded porosity of the anode allows easy transport of fuel gases thereby minimizing concentration polarization. Power densities of about 1.8 W cm<sup>-2</sup> at 800°C and about 0.8 W cm<sup>-2</sup> at about 650°C have been achieved with graded porous anodes as thick as 0.75 mm. These fuel cells having a graded porous anode are more durable and mechanically reliable than those found in the art.

**BATTERY MATERIALS****6200703****BINDER SOLUTION AND ELECTRODE-FORMING COMPOSITION FOR NON-AQUEOUS-TYPE BATTERY**

Hidetora Kashio; Katsuo Horie; Takumi Katsurao; Fumio Shibata; Aisaku Nagai; JAPAN assigned to Kureha Kagaku Kogyo Kabushiki Kaisha

A vinylidene fluoride polymer binder solution for forming an electrode for a non-aqueous-type battery is formed by adding an acid, preferably an organic acid, as a stabilizer to a solution of a vinylidene fluoride polymer in an organic solvent. The acid is preferably added in an amount sufficient to ensure a pH of at most 9 when measured with respect to a 10-times dilution of the binder solution with deionized water. The acid addition is effective for preventing a problematic viscosity increase in the binder solution and also gelling of an electrode-forming composition formed by adding a powdery electrode material in the binder solution.

**6200706****NON-WOVEN FABRIC FOR SEPARATOR OF NON-AQUEOUS ELECTROLYTE BATTERY AND NON-AQUEOUS ELECTROLYTE BATTERY USING THE SAME**

Tetsuya Ashida; Takahiro Tsukuda; JAPAN assigned to Mitsubishi Paper Mills Ltd.

The object of the present invention is to provide a non-woven fabric for separators of non-aqueous electrolyte batteries which is superior in adhesion to electrodes, causes no breakage of the separator and neither slippage nor space between electrode and the separator at the time of fabrication of battery, provides superior battery processability, such as rollability with electrodes, causes no internal short-circuit due to contact between electrodes caused by shrinking or burning of the non-woven fabric even when electrodes generate heat owing to external short-circuit, whereby ignition of the battery can be inhibited, has no pin holes and is superior in retention of electrolyte and penetration of electrolyte, and which can give non-aqueous electrolyte batteries superior in capacity, battery characteristics and battery storage characteristics. Specifically, the non-woven fabric for separators of non-aqueous electrolyte batteries according to the present invention has a thickness non-uniformity index ( $R_{py}$ ) of 1000 mV or less or a center surface average roughness  $SRa$  of 6  $\mu\text{m}$  or less in whole wavelength region as measured using a tracer method three-dimensional surface roughness meter.

**6201071****POLYETHER COPOLYMER, SOLID POLYMER ELECTROLYTE AND BATTERY**

Katsuhito Miura; Masanori Yanagida; Kazumasa Hinoue; Yoshiro Furukawa; JAPAN assigned to Daiso Company Ltd.

A solid polymer electrolyte containing a polyether copolymer having a weight-average molecular weight of  $10^4$  to  $10^7$  which may optionally be cross-linked and which contains (A) 1–99 mol% of a repeating unit derived from a monomer represented by the formula (I): [figure] wherein  $R^1$  represents a divalent organic group; (B) 99–1 mol% of a repeating unit derived from ethylene oxide; and (C) 0–15 mol% of a repeating unit derived from a monomer having one epoxy group and at least one reactive functional group, an electrolyte salt compound, and a plasticizer has an excellent ionic conductivity.

**6203941****FORMED IN SITU SEPARATOR FOR A BATTERY**

Samuel Firestone Reichert; Bernice Shou-Hua Chang; Kevin Keough; Andrew C. Harvey; Robert Francis Kovar; Thomas M. Tiano; USA assigned to Eveready Battery Company Inc.

A battery including a polar solvent transportive, ionically conductive separator formed directly on an electrode is prepared by applying a coating composition containing a polymer or gel dispersed in a polar solvent directly to the electrode surface and solidifying materials in the coating composition to form a separator membrane.

**6203947****LONG CYCLE-LIFE ALKALI METAL BATTERY**

Emanuel Peled; Diana Golodnitsky; Ela Strauss; ISRAEL assigned to Ramot University Authority for Applied Research and Industrial Development Ltd.

The present invention provides a cathode for use in a secondary electrochemical cell, such cathode being coated with a very thin, protective film, permeable to ions. The protective film of the cathode usually has a thickness of up to about 0.1  $\mu\text{m}$  and it provides protection against high voltage charging and overdischarging. The present invention further provides a secondary electrochemical cell comprising such a cathode.

**6203949****SOLID ELECTROLYTE FOR AN ELECTROCHEMICAL CELL COMPOSED OF AN INORGANIC METAL OXIDE NETWORK ENCAPSULATING A LIQUID ELECTROLYTE**

Grant M. Ehrlich; USA assigned to Yardney Technical Products Inc.

A solid polymer electrolyte for an electrochemical cell is prepared by a sol-gel process in which an active metal ion conducting liquid electrolyte, e.g. a lithium-ion electrolyte, containing a salt which is stable in the presence of water, e.g. lithium bisperfluoroethanesulfonimide ( $\text{LiN}(\text{SO}_2\text{C}_2\text{F}_5)_2$ ), is admixed in aqueous solution with an alkoxide, e.g. silica alkoxide, to form a liquid precursor which is added to

the electrochemical cell between the anode and cathode thereof and allowed to solidify in situ to form the solid electrolyte.

#### 6207314

##### BASE MATERIAL FOR A FUEL BATTERY

Hiroshi Tsukuda; Toshiro Nishi; Nagao Hisatome; Toru Houjyou; JAPAN assigned to Mitsubishi Heavy Industries Ltd.

A material for a base tube of a fuel battery, comprising a mixture of at least two components selected from the group consisting CaO, ZrO<sub>2</sub>, NiO, MgO, SrO, Al<sub>2</sub>O<sub>3</sub>, TiO<sub>2</sub>, and BaO. Such material suppresses cracks of an electrolyte and also suppress leakage after rapid temperature increase and decrease, thus, providing a reliable fuel battery.

#### 6210513

##### METHOD FOR MANUFACTURING SOLID POLYMER ELECTROLYTE/ELECTRODE COMPOSITES, BATTERY PRODUCED USING THE METHOD AND METHOD FOR PRODUCING THE SAME

Motoyuki Hirata; Junji Yotsuyanagi; Toshikazu Moriguchi; JAPAN assigned to Showa Denko KK

Disclosed are a method for manufacturing a solid polymer electrolyte film/electrode composite, in which a porous electrode made from an electrochemically active substance is used as an electrode and the pressure inside the porous electrode is reduced in order to fix the solid polymer electrolyte (SPE) film or pre-solid polymer electrolyte (pre-SPE) film to the porous electrode, a battery obtained by impregnating the electrode in the solid polymer electrolyte film/electrode composite with an electrolytic solution under reduced pressure and a method for producing such. The invention provides a thin, uniform film-shaped solid polymer electrolyte/electrode composite with ease. The battery fabricated with the composite is free of defects, such as short, has high performance, and hence, is useful.

#### 6214490

##### FOAM COLLECTOR FOR ELECTROCHEMICAL CELLS

Paul Pate; USA assigned to Eveready Battery Company Inc.

An improved current collector for electrochemical cells is formed of a conductive porous foam. The foam is preferably a nickel foam as is often used as an electrochemical cell substrate. The high porosity foam's compressibility and resiliency provide an adaptive contact surface which accommodates variations in the shape and position of electrodes and other circuit elements. By using this material as an improved current collector, electrochemical cells are more easily produced with reduced internal resistance. Improved methods of assembly are a result of the nature of the high porosity foam material and its compliance. The foam col-

lector may be used as a pressure connection or welded to the spiral edge of jelly-roll electrode assemblies. To increase effective contact area and also improve resistance to vibration forces, portions of the collector are compressed in a radial space between a jelly-roll assembly and the surrounding container. Foam current collectors according to the invention also have a low profile increasing the productive volume of the cell. The foam collector may be connected to the spiral edge of negative or positive electrodes of standard jelly-roll configuration cells. The advantages of reduced resistance is particularly beneficial to high drain rate cells such as nickel-metal hydride cells.

#### 6214493

##### MANGANESE OXIDE-BASED MATERIAL FOR AN ELECTROCHEMICAL CELL

Peter George Bruce; Anthony Robert Armstrong; GREAT BRITAIN assigned to The University Court of the University of St. Andrews

A novel layered material for use in electrochemical cells is provided, together with a method for producing the layered material, and a cell having the layered material as the positive electrode. The material is of the form  $Q_qM_nM_zO_2$ , where Q and M are any element, y is any number greater than zero, and q and z are any number greater than or equal to zero, and the material has a layered structure. Methods of preparing the manganese oxide material are provided, using an ion exchange reaction or an ion removal reaction. Use of the material in an electrochemical cell is demonstrated.

#### 6214891

##### PROCESS FOR PRODUCING A CATION-EXCHANGING POLYMER ELECTROLYTE MEMBRANE (PEM)

Arnold Schneller; Helmut Witteler; GERMANY assigned to Hoechst Research and Technology Deutschland GmbH and Company KG

A method for preparing a cation exchange membrane, comprising the introduction of an organic polymer having sulfonic acid groups and of finely disperse electrically conductive particles of a catalyst material into a liquid phase, the resulting suspension being used to coat a foil of a cation exchange material on at least one side, wherein the organic polymer having sulfonic acid groups is soluble in an aprotic polar solvent and contains units of the formulae (Ar<sup>1</sup>X) and (Ar<sup>2</sup>Y) which are at least partially substituted by sulfonic acid groups, Ar<sup>1</sup> and Ar<sup>2</sup> being identical or different bivalent arylene radicals, X being oxygen or sulfur and Y being a carbonyl radical, sulfoxide radical or sulfonyl radical and said material being dissolved in a solvent, a finely dispersed electrically conductive catalyst material being suspended in the solution and this suspension being used to coat a foil which contains a polymeric cation exchanger having sulfonic acid groups and the coating which still

contains solvent being treated with a liquid which is miscible with the solvent, but in which the dissolved cation exchange material is insoluble, so that pores are formed in the top layer of the membrane.

**6218051**

**SEPARATOR MATERIAL FOR SECONDARY LITHIUM BATTERIES**

Akihito Yokohata; JAPAN assigned to NGK Spark Plug Company Ltd.

Separator materials for secondary lithium batteries comprising as the base material a vinylidene fluoride-hexafluoropropylene (VdF-HFP) copolymer resin, wherein polymer particles having a higher softening point than the copolymer are blended and dispersed in the separator. As the polymer particles, fluorinated polymer particles are preferable. The separator materials for secondary lithium batteries are free from short-circuiting during the step of the heat lamination of the separator on electrode membranes.

**LITHIUM BATTERIES**

**6218048**

**METHOD OF PRELIMINARILY HEAT TREATING POSITIVE ELECTRODES OF SECONDARY LITHIUM AND LITHIUM-ION BATTERIES AND RESULTING POSITIVE ELECTRODES AND BATTERIES**

Vesselin Maney; Titus Faulkner; D. Wayne Barnette; John Francis Engel; USA assigned to FMC Corporation

The present invention includes a method of preparing secondary lithium and lithium-ion batteries with improved coulombic efficiency, improved cycling and storage performance at elevated temperatures, and lower rates of transition metal dissolution. In accordance with the present invention, the positive electrode material is thermally treated at a temperature of between 50 and 120°C to produce a passivating film having lithium-ion conductivity. The present invention also includes a secondary lithium or lithium-ion cell having positive electrode material covered with a thermally-activated thin passivating film having lithium-ion conductivity and a positive electrode material formed of particles of a lithium intercalation compound with a passivating film on the surface of the particles.

**6218049**

**CATHODE FOR AN ELECTROCHEMICAL CELL**

John B. Bates; Nancy J. Dudley; Greg R. Gruzalski; Christopher F. Luck; USA assigned to UT-Battelle LLC

Described is a thin-film battery, especially a thin-film micro-battery, and a method for making same having application as a

backup or primary integrated power source for electronic devices. The battery includes a novel electrolyte which is electrochemically stable and does not react with the lithium anode and a novel vanadium oxide cathode. Configured as a microbattery, the battery can be fabricated directly onto a semiconductor chip, onto the semiconductor die or onto any portion of the chip carrier. The battery can be fabricated to any specified size or shape to meet the requirements of a particular application. The battery is fabricated of solid-state materials and is capable of operation between -15 and 150°C.

**6218050**

**CARBONACEOUS MATERIAL FOR NEGATIVE ELECTRODE OF LITHIUM SECONDARY BATTERY AND LITHIUM SECONDARY BATTERY USING SAME**

Sang-Young Yoon; Ryoji Mishima; Toshiaki Tsuno; JAPAN assigned to Samsung Display Devices Company Ltd.

Disclosed is carbonaceous material for a negative electrode of a lithium secondary battery and a lithium secondary battery made using the carbonaceous material. The carbonaceous material includes a silica film coated on a surface of carbon particles of the carbonaceous material, thereby minimizing both direct contact of the carbon particles with an organic electrolyte and co-intercalation of the organic electrolyte and lithium ions within a structure of the carbon. The lithium secondary battery includes a negative electrode deposited with the carbonaceous material, a counterpart electrode made of lithium metal, electrolyte made of a propylene carbonate/ethylene carbonate solution containing 1 mol l<sup>-1</sup> of LiPF<sub>6</sub>, and a polypropylene separator.

**6225002**

**DIOXOLANE AS A PROTECTOR FOR LITHIUM ELECTRODES**

Yevgeniy S. Nimon; Steven J. Visco; May-Ying Chu; USA assigned to PolyPlus Battery Company Inc.

Disclosed are dioxolane-treated lithium electrodes, battery cells containing such dioxolane-treated lithium electrodes, battery cell electrolytes containing dioxolane, and methods of treating lithium electrodes with dioxolane and battery cells containing such dioxolane-treated lithium electrodes. Treating lithium with dioxolane prevents the lithium from reacting with a wide range of substances which can contaminate battery cells, particularly moisture and other protic impurities that might otherwise react with the lithium to the detriment of its function as a negative electrode in a battery cell. Battery cells containing dioxolane as an electrolyte co-solvent in accordance with the present invention exhibit improved cycling performance over cells not containing dioxolane. Moreover, the dioxolane treatment does not negatively impact sulfur utilization and improves the lithium's electrochemical function as the negative electrode in the battery cell.



**6225010****LITHIUM-ION SECONDARY BATTERY AND MANUFACTURE THEREOF**

Kouji Hamano; Yasuhiro Yoshida; Hisashi Shiota; Shigeru Aihara; Michio Murai; Takayuki Inuzuka; Sho Shiraga; JAPAN assigned to Mitsubishi Denki Kabushiki Kaisha

A lithium-ion secondary battery. The battery maintains an electrical connection between electrodes without using a firm case and can have an increased energy density at a reduced thickness while exhibiting excellent charge and discharge characteristics. The battery includes a plurality of electrode laminates each having a positive electrode, a negative electrode and a separator. The positive electrode includes a positive electrode active material layer and a positive electrode current collector. The negative electrode includes a negative electrode active material layer and a negative electrode current collector. This separator is impregnated with a lithium ion-containing electrolytic solution and is interposed between the electrodes in intimate contact. The positive electrode, negative electrode and separator are joined together in intimate contact with porous adhesive resin layers having through holes. The through holes are filled with electrolytic solution to connect the positive electrode active material layer, the negative electrode active material layer and the separator layer.

**6225785****ELECTRICAL SAFETY TEST APPARATUS AND TEST METHOD FOR RECHARGEABLE LITHIUM BATTERIES**

George Wing Au; Fee Chan Leung; USA assigned to The United States of America as represented by the Secretary of the Army

A voltage is applied to a lithium battery resulting in a constant-current charging rate until the lithium battery reaches 270% of the minimum specified capacity, or until the lithium battery vents, or at a charging rate of three times the specified or rated minimum charging current for a predetermined minimum duration or time. The predetermined minimum duration of time is a function of the lithium battery's rated capacity and the rated or specified charging current. In one embodiment of the present invention, an increased voltage is utilized when testing a lithium battery having more than one cell. The present invention helps to detect lithium battery vents that may fail under use. The present invention is applicable to many military and specialized industrial applications where improper venting of the lithium batteries may result in failure and injury due to risk of fire or exposure of the lithium battery or cell.

**6228529****LITHIUM SECONDARY BATTERY**

Kenshin Kitoh; JAPAN assigned to NGK Insulators Ltd.

A lithium secondary battery, including a positive electrode, a negative electrode, a separator, an internal electrode body, and an organic electrolyte, the positive and the negative electrodes being wound through the separator so that the positive and negative electrodes are not brought into direct contact with each other, wherein when the number of turns of the positive or negative electrodes per unit length (turns per cm) along the direction of diameter of the internal electrode body is multiplied by total thickness (cm) of the electrode active material layers, being designated as a correction winding density (turns), the correction winding density is not less than 0.73 (turns).

**6228531****ELECTRODE MODIFICATION USING SURFACE ASSOCIATED LITHIUM SALTS AND AN ASSOCIATED PROCESS FOR FABRICATION OF AN ELECTRODE**

Eric S. Kolb; Martin Van Buren; Denis G. Fauteux; USA assigned to Mitsubishi Chemical Corporation

The present invention is directed to an electrode, and associated fabrication process, for use in an electrochemical cell. The electrode has an active material comprising a transition metal oxide. A lithium salt having an organic component is associated with the surface of the transition metal oxide so as to increase compatibility with an associated electrolyte. In another embodiment, a lithium salt of saccharin may be adsorbed onto the surface of the transition metal oxide.

**6228532****LITHIUM SECONDARY CELL**

Taishi Tsuji; Takako Miyake; Shuuichi Yanagisawa; JAPAN assigned to Pioneer Corporation

There is provided a lithium polymer secondary cell in which reduction of the film thickness of a solid electrolyte can be realized. The lithium-ion secondary cell consists essentially of a composite electrode as a positive electrode having a positive electrode layer, containing a mercaptide compound and a conductive material, carried on a collector; the hydrogen atom of at least one mercapto group in the mercaptide compound being substituted with a lithium atom; a poly-electrolyte; and a lithium negative electrode.

**6228536****LITHIUM-ION BATTERY CELL HAVING AN OXIDIZED/REDUCED NEGATIVE CURRENT COLLECTOR**

James A. Wasynczuk; USA assigned to Hughes Electronics Corporation

A lithium-ion battery cell assembly includes a negative electrode having a negative current collector contacting a negative electrode active material. The negative current

collector is prepared by providing a piece of a negative current collector metal, thereafter oxidizing the piece of the negative current collector metal, and thereafter reducing the piece of the negative current collector metal. The negative electrode is assembled with a positive electrode with an intermediate separator. An electrolyte saturates the electrodes and the separator, and provides a lithium-ion path between the negative and the positive electrodes.

### **NICKEL HYDRIDE BATTERIES**

**6210498**

#### **HYDROGEN STORAGE ALLOYS AND METHODS AND IMPROVED NICKEL-METAL HYDRIDE ELECTRODES AND BATTERIES USING SAME**

Stanford R. Ovshinsky; Rosa T. Young; Benjamin Chao; USA assigned to Energy Conversion Devices Inc.

Reversible hydrogen storage alloys and methods and electrodes formed therefrom for nickel-metal hydride batteries, in which the alloys are quenched from a melt at cooling rates selected to provide a high degree of disorder with an optimum local environment.

**6214492**

#### **HYDROGEN-ABSORBING ALLOY, ELECTRODE AND SECONDARY BATTERY**

Tatsuoki Kono; Isao Sakai; Hideki Yoshida; Takamichi Inaba; Masaaki Yamamoto; Shiro Takeno; JAPAN assigned to Kabushiki Kaisha Toshiba

There is provided a hydrogen-absorbing alloy comprising at least one crystal phase consisting essentially of at least one unit cell which has a laminate structure comprising at least one  $A_2B_4$  subcell and at least one  $AB_5$  subcell, and the aforementioned at least one unit cell satisfying the following formula (1), wherein A is at least one kind of element which is capable of generating heat of formation  $\Delta H$  ( $\text{kJ mol}^{-1}$ ) of less than  $20 \text{ kJ mol}^{-1}$  at the occasion of generating a hydride from one mole of hydrogen at a temperature of  $25^\circ\text{C}$ , B is at least one kind of element which is capable of generating heat of formation  $\Delta H$  ( $\text{kJ mol}^{-1}$ ) of not less than  $20 \text{ kJ mol}^{-1}$  at the occasion of generating a hydride from one mole of hydrogen at a temperature of  $25^\circ\text{C}$ , and X is a ratio in number of the aforementioned at least one  $A_2B_4$  subcell to the aforementioned at least one  $AB_5$  subcell.

**6225004**

#### **NICKEL POSITIVE ELECTRODE FOR ALKALINE STORAGE BATTERIES AND METHOD FOR PRODUCING THE SAME**

Kiyoshi Hayashi; JAPAN assigned to Matsushita Electric Industrial Company Ltd.

Disclosed is a nickel positive electrode which can best utilize the effects of plural additives and exhibits a high

capacity and a long cycle-life. The nickel positive electrode contains a nickel hydroxide powder and a plurality of additives including cobalt oxide and a secondary additive, the secondary additive being encapsulated in a capsule of cobalt oxide.

### **OTHER BATTERIES**

**6200699**

#### **MERCURY-FREE PRIMARY ALKALINE CELL**

Horst-Udo Jose; Hans-Joachim Feistner; GERMANY assigned to Varta Batterie Aktiengesellschaft

A galvanic cell has an anode gel, an alkaline electrolyte, and a cathode material, separated from the anode gel by a separator. The anode gel has mercury-free zinc powder, and the cathode material has manganese dioxide, as well as salt-like calcium compounds in solid form.

**6200700**

#### **ALKALINE SECONDARY BATTERY**

Mutsumi Yano; Mitsunori Tokuda; Mitsuzou Nogami; Shin Fujitani; Koji Nishio; JAPAN assigned to Sanyo Electric Company Ltd.

The present invention is directed to an alkaline secondary battery comprising a positive electrode, a zinc-based negative electrode, and an alkaline electrolyte solution, wherein the positive electrode includes a central cavity for receiving the zinc-based negative electrode, and the negative electrode includes a central cavity for holding the alkaline electrolyte solution. The battery is arranged such that the positive electrode presents a smaller capacity than the negative electrode at least in an initial charge/discharge period.

**6203939**

#### **HIGH TEMPERATURE BATTERY AND ELECTROLYTES**

John T.R. Wilson; USA

A high temperature battery of one or more cells is disclosed in which each cell is made by holding an anode electrode and a cathode electrode, of different metallic substances, together through a fused flux wetted to an electrode, which fused flux is an electrolyte, to make an anode-to-cathode contact, and the anode-to-cathode contact is heated, by a heat source, to a high temperature above a threshold temperature to generate voltaic voltage, in excess of any thermoelectric voltage; such batteries with electrodes of various configurations are disclosed. The heat-activated flux and electrolyte, such as borax, may have vegetable-growth ashes or chemical constituents of ashes, such as lithium carbonate, added to the heat-activated flux and electrolyte to catalyze or improve the current-generating capability of the battery. The preferred anode substance is aluminum, and the preferred cathode substance is copper. With the preferred cathode and anode substances and a heat-activated flux and electrolyte

of fused borax between the cathode and anode, the open circuit voltage generated per cell when heated increases from 0.05 V at 304°C to 1.3 V at 651°C; the threshold temperature in this case is 279°C. Also disclosed is means to move the anode metal with respect to the cathode metal, when the heat-activated flux and electrolyte is fluid, for changing the battery characteristics and for replacing depleted heat-activated flux and electrolyte.

#### 6207321

##### SODIUM SECONDARY BATTERY

Masayuki Fukagawa; Keiichi Iwamoto; Nozomu Kawasetsu; Katsuzou Sudou; Akihiro Sawata; JAPAN assigned to Mitsubishi Heavy Industries Ltd.

A sodium secondary battery which assures excellent sealing and can be manufactured in a simple manner is provided. The battery includes a negative electrode chamber defined by the inside of a bottom-closed, hollow cylindrical, solid electrolyte accommodated in an outer case and a positive electrode chamber formed outside the solid electrolyte and containing a porous electrode 4 impregnated with sulfur which serves as a positive electrode active substance. A cover, which closes the opening portion of the outer case, is fastened to the outer case by use of bolts and the interposition of an insulator.

#### 6207324

##### ZINC SULFUR BATTERY

Stuart Licht; ISRAEL assigned to Technion Research and Development Foundation Ltd.

An electric storage cell comprises a zinc anode and a sulfur cathode, wherein the zinc and the sulfur are in contact with an aqueous solution containing sulfur during the process of battery discharge. In this invention, specific conditions for the aqueous sulfur electrolyte are chosen to overcome the normal ineffectiveness of zinc oxidation in the presence of aqueous zero valent sulfur. Normally, a zinc anode cannot be oxidized in an aqueous solution containing sulfur, because the product of the discharge would be zinc sulfide. This zinc sulfide is a highly insoluble salt and creates a layer which passivates the zinc and renders it completely ineffective to battery discharge. The performance of the battery is made possible by high OH<sup>-</sup> and HS<sup>-</sup> ion concentrations formed by the addition of salts to the aqueous zero valent sulfur solution, and permits effective and efficient battery discharge.

#### 6207326

##### SECONDARY BATTERY

Soichiro Kawakami; Shinya Mishina; Naoya Kobayashi; JAPAN assigned to Canon Kabushiki Kaisha

A secondary battery exhibiting a long cycle-life and comprising a negative pole activating material made of lithium or

zinc is provided, the battery at least having a negative pole made of lithium or zinc serving as the negative pole activating material, an electrolyte (electrolytic solution), a separator, a positive pole made of a positive pole activating material, a collecting electrode and a battery case, wherein at least the surface of the negative pole is covered with a film having a structure which allows ions relating to the battery reactions to pass through. Since growth of dendrites of lithium or zinc at the time of charge can be prevented, short-circuiting between the negative pole and the positive pole can be prevented. Therefore, the charge/discharge cycle-life can significantly be lengthened. As a result, a lithium secondary battery, a nickel-zinc secondary battery, an air-zinc secondary battery, a bromine-zinc secondary battery and a silver oxide-zinc secondary battery of long cycle-life can be manufactured.

#### 6210831

##### CATHODES COMPRISING ELECTROACTIVE SULFUR MATERIALS AND SECONDARY BATTERIES USING SAME

Alexander Gorkovenko; Terje A. Skotheim; Zhe-Sheng Xu; Leonid I. Boguslavsky; Zhongyi Deng; Shyama P. Mukherjee; USA assigned to Moltech Corporation

The present invention pertains to solid composite cathodes which comprise (a) an electroactive sulfur-containing cathode material which in its oxidized state, comprises a polysulfide moiety of the formula, S<sub>m</sub>, wherein *m* is an integer from 3 to 10; and (b) a non-electroactive particulate non-fibrous material having a strong adsorption of soluble polysulfides. The present invention also pertains to electric current producing cells comprising such solid composite cathodes, and methods of making such solid composite cathodes and electric current producing cells.

#### 6215312

##### METHOD AND APPARATUS FOR ANALYZING AN AGZN BATTERY

Steven Hoenig; Patrick M. Rudai; Thirumalai G. Palanisamy; Harmohan Singh; USA

A method and apparatus for diagnosing the status of a battery having high and low voltage plateau states corresponding to its state of charge in which the battery open circuit voltage is measured (S106) to determine its voltage state and its internal resistance also is measured (S114). A battery having a low voltage state (S116) is tested to determine if its internal resistance is greater than a predetermined maximum resistance (S118) and if it does the battery is considered as possibly having a low electrolyte level, and if it does not the battery is subjected to a current ramp test to determine from the voltage response a point of current transition (S130) due to a battery chemical gassing reaction. The battery state of charge (S132) is determined from curves or algorithms of state of charge versus current

transition. Each of a battery of high voltage state (S116) whose internal resistance is less than the maximum internal resistance and one whose internal resistance is greater than the maximum internal resistance and has been subjected to reconditioning by applying successive current pulses (S124, S126) to reduce its internal resistance is subjected to a current ramp test (S134) to determine the point of current transition and the state of charge of such battery is determined (S136) from a different set of curves or algorithms of state of charge versus current transition. Capacity of a battery of the two voltage state types is determined by charging it to its capacity (S144), applying a current ramp (S144) to determine the point of current transition and determining capacity from curves or algorithms of battery capacity versus current transition (S150).

#### 6218055

### **ELECTROCHEMICAL POWER CELLS AND METHOD OF IMPROVING ELECTROCHEMICAL POWER CELL PERFORMANCE**

Pinakin M. Shah; Marvin L. Kronenberg; Richard F. Bis; Donald L. Warburton; Joseph J. Bytella; Dayal T. Meshri; USA assigned to Mine Safety Appliances Company

A small, portable electrochemical power cell, having an output voltage of over 4 V, and preferably over 5 V, includes an anode, a cathode having a fluorine compound and an electrolyte having an organic sulfur-containing compound to maintain ionic conductivity between the anode and the cathode. A method of fabricating such an electrochemical power cell includes the step adding an electrolyte having an organic, sulfur-containing compound to maintain electrical conductivity between the anode and the cathode. An electrochemical power cell having a lithium anode, a  $\text{CoF}_3$  cathode, an electrolyte to maintain ionic conductivity between the anode and the cathode and a cobalt complexing material within the electrolyte to complex cobalt ions is described.

#### 6225009

### **ELECTROCHEMICAL CELL WITH A NON-LIQUID ELECTROLYTE**

Niles A Fleischer; Joost Manassen; Joel Lang; Eli Rosh Chodesh; Marvin S. Antelman; ISRAEL assigned to ECR — Electro-Chemical Research Ltd.

A non-liquid electrolyte containing electrochemical cell which operates efficiently at room temperature. The cell includes (a) a non-liquid electrolyte in which protons are mobile; (b) an anode active material based on an organic compound which is a source of protons during cell discharge, or an anode active material including a metal whose

cation can assume at least two different non-zero oxidation numbers; and (c) a solid cathode including a compound which forms an electrochemical couple with the anode. Anode and cathode active materials can be chosen so that the cell has the feature that the electrochemical reactions at the anode and cathode are at least partially reversible. An important feature of the cell is that no thermal activation is required for its operation, therefore, the cell efficiently operates under ambient temperatures.

### **COMPONENTS AND/OR CHARGES**

#### 6198251

### **METHOD FOR SEQUENTIALLY CHARGING BATTERIES IN SITU**

Frank L. Landon; USA assigned to Fluor Corporation

A plurality of batteries located in battery-operated devices by a charger through a distributor where there is no communication between the distributor and the batteries in the battery-operated devices are charged in automated sequence in situ by a charger through a distributor where there is no communication between the distributor and the batteries, preferably using pulsed charge technology. In preferred embodiments, the pulsed charge technology includes both forward and reverse pulses.

#### 6225784

### **BATTERY CONTROL APPARATUS FOR BATTERY CARRIED BY HYBRID VEHICLE**

Naoki Kinoshita; Akira Fujimura; Nobuyuki Kawarada; JAPAN assigned to Honda Giken Kogyo Kabushiki Kaisha

The battery control apparatus of the present invention is provided for a hybrid vehicle with a combustion engine for outputting driving force, an electric motor for generating a force for assisting the output from the engine, and a power storage unit (battery) for supplying power to the motor and for storing energy regenerated by the motor acting as a generator when the assisting force is not required. The battery control apparatus comprises: a remaining battery charge calculator for calculating remaining battery charge; a battery temperature measuring device (temperature sensor) for measuring the temperature of the battery; a charging permitting device for permitting charging when the remaining battery charge, which was calculated by the remaining battery charge calculator, is equal to or below a predetermined value; and a charging/discharging controller for setting the predetermined value, based on the temperature of the battery measured by the battery temperature measuring device.