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**LEAD ACID****5540127****PROCESS AND APPARATUS FOR FORMING BATTERY PLATES**

Binder Richard R; Cantillon Daniel; Schneider Jeffrey  
Menomonee Falls, WI, UNITED STATES assigned to  
Globe-Union Inc

A process for cutting a moving strip to form a series of plates, such as battery plates, includes the initial step of transporting the strip past a rotary divider including a cutter having radial blades configured to cut the strip into the plates. The cutter further has a set of blades for cutting individual pieces from the strip, which pieces are not part of the plates. As the cutter blades cut the strip to form the plates and pieces, a vacuum system applies suction to draw the pieces cut from the strip inwardly into the cutter through holes in the cutter, and then out of the cutter. The holes are each located adjacent each one of the corresponding blades and are shaped and positioned to permit the cut-away piece to pass through. In a preferred embodiment, the vacuum system includes a pair of vacuum manifolds that apply suction at opposite ends of the cylindrical cutter. An apparatus for carrying out the foregoing process accordingly includes a rotary divider as described above provided with a vacuum system. Battery plates made according to the foregoing process are improved in that the two lower corners have a rounded shape lacking a sharp edge which tends to tear an adjacent separator. Such a plate may be inserted bottom end first into a separator envelope to form a plate element for use in a lead-acid battery.

**5540915****METHOD FOR MAKING HIGHLY OXIDIZED LEAD POWDER USED FOR A LEAD STORAGE BATTERY**

Yasuda Hiroshi; Yonezu Kazuyoshi; Takahashi Katsuhiro; Yamamoto Kenzo Toyohashi, JAPAN assigned to Matsushita Electric Industrial Co Ltd

Highly oxidized lead powder containing red lead not

more than 90% is efficiently produced by maturing the lead powder material at a low temperature section of a furnace keeping the temperature less than 100°C by spraying water to the material and then, by heating the same from 400° to 500°C at a high temperature section of the furnace. The highly oxidized lead powder produced in this method is preferable as active material of a lead storage battery, that is, a paste preparation and formation treatment become easy and a long life electrode is obtained.

**5541013****SEALED TUBULAR LEAD-ACID BATTERY**

Shiomi Masaaki; Hayashi Toshiaki; Takahashi Katsuhir  
Kyoto, JAPAN assigned to Japan Storage Battery Co  
Ltd

A sealed tubular lead-acid battery is provided which offers high-rate discharging performance and long cycle life by loading granules of fine particles of silicon dioxide both in a gap between a separator and around each of a positive and negative plate, as well as around the assembled element comprising a separator and the plates. An electrolyte is retained on the positive plate, the negative plate, the separator, and the granules of fine silicon dioxide particles.

**5543243****BATTERY ELECTROLYTE CIRCULATION SYSTEM**

Brecht William B Seal Beach, CA, UNITED STATES assigned to Trojan Battery Company

PCT No. PCT/US93/11698 Sec. 371 Date Aug. 23, 1994 Sec. 102(e) Date Aug. 23, 1994 PCT Filed Dec. 1, 1993 PCT Pub. No. WO95/15586 PCT Pub. Date Jun. 8, 1995. A liquid electrolyte battery comprises a number of electrolytic cells, an inlet port extending into a first electrolytic cell, an electrolyte transport channel residing within each electrolytic cell, a number of carry-over passages hydraulically connecting adjacent electrolytic cells, an outlet port extending from a last electrolytic cell, and a pump for introducing an electrolyte solution or air into the electrolytic cells. The

battery electrolyte is replenished by introducing an electrolyte solution into the first electrolytic cell, causing the electrolyte level to rise and be hydraulically transported through the carry-over passages to fill each electrolytic cell. The electrolyte exiting the last electrolytic cell is collected and reintroduced back into the first electrolytic cell and circulated throughout the battery. The electrolyte exiting the battery may be collected in an electrolyte reservoir and circulated through a temperature management device to ensure a battery temperature within design parameters. The electrolyte level in each electrolytic cell is adjusted to a predetermined level by introducing air into the battery causing the hydraulic transport of an electrolyte volume residing above an inlet end of the outlet port through the outlet port in the last electrolytic cell, and the electrolyte volume above an inlet end of the carry-over passage through the carry-over passage in each other electrolytic cell. The air exiting the last electrolyte cell may be vented or treated for the removal of hazardous gases.

**5544681**

### **CORED BATTERY PLATES FOR LEAD/ACID BATTERIES**

Feldstein Robert Pelham, NY, UNITED STATES assigned to Derafe Ltd

Methods for fabricating cored structures are provided. The cored structures may particularly find usefulness as cored battery plates for use in lead/acid batteries. A pre-formed core element is provided, and on its surfaces there is placed a thin layer of an active surface material. That active surface material is one which may enter into a chemical or electrochemical process when in use and in the presence of an electrolyte or other agent which will promote such chemical or electrochemical process. In the case of lead/acid batteries, the active surface is lead or lead oxide. The core element is generally one which does not bond with the active surface material, but will if the active surface material is ion bombarded or neutral atom embedded into the surface of the core, and where the amount of bombardment or embedment is determined by controlling the accelerator voltage. A typical cored battery plate for lead/acid batteries will have titanium or other low resistivity metal, with titanium at its outer surface in any event, and with lead having been ion implanted onto the surface of the titanium until such time as an essentially pure lead

surface is attained. Further lead may be placed using other methods until sufficient lead is present as to form the active lead surface. The lead may be subsequently oxidized.

**5547634**

### **METHOD FOR ADDING ALUMINUM AND CALCIUM TO MOLTEN LEAD**

Hibbins Stephen G; Timpano Fernando A; Zuliani Douglas J Renfrew, CANADA assigned to Timminco Limited

Process and apparatus for adding calcium and aluminum to molten lead to produce a lead-calcium alloy suitable for battery grids. Particles of calcium and aluminum metal or alloys thereof are fed into the interior of a tubular housing having a wall extending down into the molten lead and having a bottom opening at a relatively large depth below the lead surface and having openings in its wall at a relatively small depth below the lead surface. A rotary impeller which acts at least partially as a centrifugal impeller is positioned in the housing to cause swirling of lead carrying the particles within the housing, the shape of the housing and the nature and position of the impeller being such as to ensure that lead carrying the particles is swirled against the housing wall and recirculated within the housing before the lead leaves the housing.

### **FUEL CELL**

**5541014**

### **INDIRECT-FIRED GAS TURBINE DUAL FUEL CELL POWER CYCLE**

Micheli Paul L; Williams Mark C; Sudhoff Frederick A Sacramento, CA, UNITED STATES assigned to The United States of America as represented by the United States Department of Energy

A fuel cell and gas turbine combined cycle system which includes dual fuel cell cycles combined with a gas turbine cycle wherein a solid oxide fuel cell cycle

operated at a pressure of between 6 to 15 atms tops the turbine cycle and is used to produce CO<sub>2</sub> for a molten carbonate fuel cell cycle which bottoms the turbine and is operated at essentially atmospheric pressure. A high pressure combustor is used to combust the excess fuel from the topping fuel cell cycle to further heat the pressurized gas driving the turbine. A low pressure combustor is used to combust the excess fuel from the bottoming fuel cell to reheat the gas stream passing out of the turbine which is used to preheat the pressurized air stream entering the topping fuel cell before passing into the bottoming fuel cell cathode. The CO<sub>2</sub> generated in the solid oxide fuel cell cycle cascades through the system to the molten carbonate fuel cell cycle cathode.

**5541015**

### **FUEL CELL USING A SEPARATE GAS COOLING METHOD**

Tajima Osamu; Hamada Akira; Tanaka Junji; Yoshimoto Yasunori; Miyai Keigo; Nishizawa Nobuyoshi; Tsutsumi Masaru; Ikenaga Tomotoshi; Nakato Kunihiro; Hori Kiyoshi Hyogo, JAPAN assigned to Sanyo Electric Co Ltd

A fuel cell comprising a stack including a stack including a plurality of cell units and a plurality of gas separators and at least one cooling plate, one of the gas separator and the cooling plate being interposed between adjacent cell units, the fuel cell being characterized in that; each gas separator and the cooling plate, respectively, have oxidant gas channels on one of surfaces that opposes to have contact with one of electrode surfaces of the cell unit to as to flow an oxidant gas in a direction vertical to a direction of a cooling air flowing through the cooling plate; each gas separator and the cooling plate, respectively, have fuel gas channels, a fuel-gas-supply inner manifold for taking in a fuel gas, and a fuel-gas-exhaust inner manifold for releasing the fuel gas having passed through the fuel gas channels on the other surface that opposes to have contact with the other electrode surface of the cell unit so as to flow the fuel gas in a direction parallel to the direction of the cooling air flowing through the cooling plates; and an inlet of the fuel-gas-supply inner manifold and an outlet of the fuel-gas-exhaust inner manifold are formed so as to supply and release the fuel gas in a same direction of the oxidant gas flowing through the oxidant gas channels.

**5543238**

### **FUEL CELL AND METHOD FOR MOISTENING THE ELECTROLYTE OF THE FUEL CELL**

Strasser Karl Erlangen, GERMANY assigned to Siemens Aktiengesellschaft

A fundamental problem which exists in fuel cells having an electrolyte that conducts oxygen ions, hydroxide ions or protons, is that of moistening air of combustion gases for preventing the electrolyte from drying out or thinning and thus preventing defective operation of the fuel cell during air operation. The construction and financial cost, in particular, for moistening of the air is of concern in such a device. In a low-temperature fuel cell, in particular a PEM fuel cell, and a method for moistening the electrolyte of the fuel cell, according to the invention, that disadvantage is avoided by providing that exhaust gas which occurs on the cathode side of the fuel cell is at least partially recirculated into the cathode of the fuel cell. Consequently, the water content of the electrolyte can be set within wide limits by simple adjustment of the recirculated exhaust-gas quantity. Therefore, economical use of the PEM fuel cell becomes possible. The invention can be used in principle for all fuel cells having an electrolyte which conducts oxygen ions, hydroxide ions or protons.

**5543239**

### **ELECTRODE DESIGN FOR SOLID STATE DEVICES, FUEL CELLS AND SENSORS**

Virkar Anil V; Fung Kuan-Zong; Tanner Cameron W Salt Lake City, UT, UNITED STATES assigned to Electric Power Research Institute

An improved electrode design for solid state devices, fuel cells, sensors and the like is made by incorporation of a porous layer of the electrolyte material over the dense electrolyte, and by the introduction of an electrocatalyst into the porous layer such that it is also continuous. The resulting electrode structure of dense electrolyte/porous electrolyte, continuous electrocatalyst and gas phase are present creating an enhanced three phase (TPB) length over that of conventional designs. The design allows for improved performance at lower

temperatures which means a lower cost of materials, fewer problems from oxidation and corrosion, and improved durability. In a preferred embodiment, the dense electrolyte and porous electrolyte is yttria-stabilized zirconia (YSZ), and the electrocatalyst is selected from silver; platinum; rhodium; palladium; iridium; ruthenium;  $(La_{1-x}Sr_x)MnO_3$ , wherein  $x$  is 0 to 0.5;  $(La_{1-x}Sr_x)CoO_3$ , wherein  $x$  is 0 to 0.6;  $(La_{1-x}Sr_x)(Co_{1-y}Fe_y)O_3$ , wherein  $x$  is 0 to 0.4 and  $y$  is 0 to 0.8;  $In_2O_3-PrO_{1.83}-ZrO_2$ , having composition ratios of  $In_2O_3$  of 0-90%,  $PrO_{1.83}$  of 10-60% and  $ZrO_2$  of 0 to 50%;  $TbO_2$  being 35 to 40% doped with YSZ;  $SnO_2$  being 0 to 20% doped with  $In_2O_3$ ;  $ZrO_2$  being 0 to 40% doped with  $In_2O_3$ ;  $Sm_{0.5}Sr_{0.5}CoO_3$ ;  $La_{0.6}Ca_{0.4}MnO_3$ ;  $Y_{1-x}Ca_xFeO_3$ , wherein  $x$  is 0 to 1;  $SrCo_{1-x}Fe_xO_3$ , wherein  $x$  is 0.2 to 0.8;  $TiO_2$  being 0-30% doped with YSZ; or mixtures thereof.

**5543240**

### FUEL CELL STACK

Lee Seo-jae; Kim Il-gon; Lee Jong-woo Suwon, REPUBLIC OF KOREA assigned to Samsung Electronics Co Ltd

A fuel cell stack is provided in which a reaction gas can be uniformly distributed among fuel cell units disposed within the stack. In particular, the fuel cell stack contains a plurality of fuel cell blocks which are stacked upon each other, and each fuel cell block contains a plurality of fuel cell units which are stacked upon each other. The reaction gas is supplied to each fuel cell block via an external manifold located outside the fuel cell stack. An internal manifold is located within each fuel cell block and receives the reaction gas from the external manifold. Subsequently, the internal manifold distributes the gas to each fuel cell unit. As a result, the fuel cell stack is able to uniformly distribute the reaction gas to each fuel cell unit, thereby increasing the efficient utilization of fuel.

**5543241**

### FUEL CELL

Nishioka Masat; Hamada Akira; Tateyama Eij; Nishizawa Nobuyoshi; Tsutsumi Masaru Osaka, JAPAN assigned to Sanyo Electric Co Ltd

The present invention discloses a cell structure and a fuel cell that includes at least one cell structure. The cell structure comprises a cell including an electrolyte plate, an anode, and a cathode, the anode being formed on one surface of the electrolyte plate, the cathode being formed on the other surface of the electrolyte plate, an anode terminal electrode connected to the anode electrically, the anode terminal electrode being placed along an edge of the cell structure to be perpendicular with respect to a layered direction in which the cathode, the electrolyte plate, and the anode are layered, a cathode terminal electrode connected to the cathode electrically, the cathode terminal electrode being placed along another edge of the cell structure to be perpendicular with respect to the layered direction, a first gas channel for supplying a reactant gas to the anode in the layered direction, and a second gas channel for supplying the reactant gas to the cathode in the layered direction.

**5547776**

### ELECTROCHEMICAL FUEL CELL STACK WITH CONCURRENTLY FLOWING COOLANT AND OXIDANT STREAMS

Fletcher Nicholas J; Chow Clarence; Pow Eric G; Wozniczka Boguslav; Voss Henry H; Hornburg Gerald Vancouver, CANADA assigned to Ballard Power Systems Inc; Daimler-Benz

A fuel cell assembly within an electrochemical fuel cell stack has a cooling jacket disposed adjacent the cathode layer. The cooling jacket comprises a coolant stream inlet, a coolant stream outlet, and at least one channel for directing a coolant stream from the coolant stream inlet to the coolant stream outlet. The coolant stream channels extend such that the coolest region of the cooling layer substantially coincides with the region of the adjacent cathode layer having the highest concentration of oxygen (and also the lowest water content), and the warmest region of the cooling layer substantially coincides with the region of the adjacent cathode layer having the lowest concentration of oxygen (and also the highest water content).

**5547777****FUEL CELL HAVING UNIFORM  
COMPRESSIVE STRESS DISTRIBUTION  
OVER ACTIVE AREA**

Richards William R Springfield, VA, UNITED STATES assigned to Richards Engineering

Uniform compressive stress distribution is applied over the active area of a PEMFC stack to increase the contact area between the electrically conductive components of the stack. This increases fuel cell stack efficiency. Fuel cell stack is constructed as a modular component readily connected with like modules for providing fuel cell stack configurations capable of meeting a wide range of power generation for application to vehicles, including submersible vehicles up to utility power requirements.

**5549983****COFLOW PLANAR FUEL CELL STACK  
CONSTRUCTION FOR SOLID  
ELECTROLYTES**

Yamanis Jean Morristown, NJ, UNITED STATES assigned to Allied Signal Inc

A fuel cell stack is based on solid electrolytes, such as the oxygen-ion conducting solid oxide fuel cells and the proton conducting ceramic or polymer membrane fuel cells. The fuel cell has a radial, coflow planar stack with an integral, internal manifold and tubular porous elements for controlling the rate and uniformity of the radial fuel and oxidant fluid flows. Such construction minimizes the extent of sealing that may be required and provides for easy manifolding of stack arrays. In addition, the fuel cell construction has the potential for high mass and volume specific power densities and low fabrication costs.

**BATTERY MATERIALS****5536279****METHOD OF COVERING AN  
ELECTRODE FOR ELECTROCHEMICAL  
CELLS**

Nesselbeck Neal N; Spaulding Joseph; Muffoletto Barry Lockport, NY, UNITED STATES assigned to Wilson Greatbatch Ltd

In an alkali metal-halogen or oxyhalide electrochemical cell wherein an alkali metal anode, preferably lithium, has a surface in operative contact with a halogen-containing or oxyhalide cathode/electrolyte including a solvent if necessary, an electrode covering, preferably applied on the anode surface comprising a non-fabric, continuous and solid film of substrate material having a uniform unit weight, is described. The substrate material is perforated to provide for ion flow therethrough and coated with organic electron donor material, or other suitable coating material. The film substrate material preferably comprises a mechanically perforated synthetic polyester film material, and the film is prepared by contacting with a solution of the organic material and solvent followed by drying. The resulting coated film is flexible and is applied to the operative surface of the electrode thereby covering the same, preferably adhered to the surface by pressing. The flexible film can be applied equally well to electrode surfaces which are either smooth and flat or irregular.

**5536596****METHOD OF FORMING A BUTTON-TYPE  
BATTERY AND BUTTON-TYPE BATTERY**

Lake Rickie Eagle, ID, UNITED STATES assigned to Micron Communications Inc

A button-type battery includes, a) a conductive first terminal housing member; b) a conductive second terminal housing member; c) an anode, a cathode and an electrolyte between the anode and cathode; the anode, the cathode and the electrolyte being collectively received intermediate the first and second terminal

housing members; the first and second terminal housing members forming an enclosed housing which holds and protects the anode, the cathode and the electrolyte; and d) the anode having an operative surface within the enclosed housing which faces the cathode, the operative anode surface having been roughened prior to final assembly of the button-type battery. A method of forming a button-type battery comprising the following includes, a) providing an anode within a first terminal housing member, the anode having an outer exposed surface; b) preferably with the anode within the first terminal housing member, roughening the outer exposed anode surface to increase its surface area from that prior to the toughening; and c) assembling the first terminal housing member with the toughened anode therein with a cathode, electrolyte and second terminal housing member to form an enclosed housing which holds and protects the anode, the cathode and the electrolyte. Alternately, the outer exposed anode surface comprises a passivation barrier film, and the toughening includes penetrating through the outer exposed barrier film and anode surface to roughen such surface to increase its surface area from that prior to the penetrating and to expose anode material therebeneath.

**5536598**

### **BIPOLAR BATTERY CELLS, BATTERIES AND METHODS**

LaFollette Rodney Provo, UT, UNITED STATES  
assigned to Bipolar Technologies Corporation

Bipolar battery cells, bipolar batteries, and related methods are disclosed. The disclosed bipolar plate comprises a composite of long carbon fibers and a filler of carbon particles and a fluoroelastomer. A fluoroelastomeric sealant for placement between adjacent cells is also disclosed.

**5538811**

### **IONIC CONDUCTIVE POLYMER ELECTROLYTE**

Kanbara Teruhisa; Takeyama Kenichi; Tsubaki Yuichiro Ikeda, JAPAN assigned to Matsushita Electric Industrial Co Ltd

An ionic conductive polymer electrolyte including a polymer having ether type oxygen in the structure and a plasticizer is provided. The plasticizer is at least one selected from the group consisting of compounds represented by the following general Formulas IV and V: Formula IV: (\*See Patent for Tabular Presentation\*) PS wherein  $n+m$  is 2, 3, 4 or 5, and  $R_1=CH_3$ ,  $C_2H_5$ ,  $C_3H_7$  or  $C_4H_9$ ; and Formula V: (\*See Patent for Tabular Presentation\*) PS wherein  $n+m$  is 2, 3, 4, or 5 and  $R_1=R_2=CH_3$ .

**5538812**

### **ELECTROLYTE MATERIALS CONTAINING HIGHLY DISSOCIATED METAL ION SALTS**

Lee Hung-Sui; Geng Lin; Skotheim Terje A East  
Setauket, NY, UNITED STATES assigned to Moltech  
Corporation

The present invention relates to metal ion salts which can be used in electrolytes for producing electrochemical devices, including both primary and secondary batteries, photoelectrochemical cells and electrochromic displays. The salts have a low energy of dissociation and may be dissolved in a suitable polymer to produce a polymer solid electrolyte or in a polar aprotic liquid solvent to produce a liquid electrolyte. The anion of the salts may be covalently attached to polymer backbones to produce polymer solid electrolytes with exclusive cation conductivity.

**5543245**

### **SYSTEM AND METHOD FOR MONITORING BATTERY AGING**

Andrieu Xavier; Rocher Michel; Guillaume Philippe;  
Poignant Philippe Bretigny Sur Orge, FRANCE  
assigned to Alcatel Converters

A system for monitoring aging of a battery comprising a plurality of cells connected in series and able to be fully discharged comprises a discharger which discharges one of the previously charged cells at a time to an end of discharge value. The quantity of electricity supplied by each discharged cell during discharging is



measured. The quantity of electricity supplied by at least one discharged cell is processed to detect excessive aging of the battery. Excessive aging of the battery results in a residual capacity which is less than a fraction of the nominal capacity of the battery.

**5543247**

**HIGH TEMPERATURE CELL  
ELECTRICAL INSULATION**

Pulley Christopher J; Specht Steven J; Barlow Geoffrey  
Shaker Hts, OH, UNITED STATEE assigned to  
Northrop Grumman Corporation

An insulator for use in a monopolar cell battery is provided in which the battery includes a first electrode in contact with the case and a second electrode which is not in contact with case. The insulator is a plate which is formed from a higher melting point salt which is provided adjacent the edges of the second electrode. The plate insulates the second electrode from the case. The salt used for the insulator has a melting point that is greater than the operating temperature of the battery.

**5543249**

**AQUEOUS BLENDED ELECTRODE  
MATERIAL FOR USE IN  
ELECTROCHEMICAL CELLS AND  
METHOD OF MANUFACTURE**

Takeuchi Esther; Pyszczek Michael East Amherst, NY,  
UNITED STATES assigned to Wilson Greatbatch Ltd

A method for preparing an electrode component comprises mixing an electrode active material in a water-based environment with the aid of surfactants. A preferred embodiment of this process comprises combining a high surface area carbonaceous cathode active material with a water/surfactant mixture, and then adding a fluoro-polymer as the binder material to the slurry. The resulting paste is processed and formed into the cathode material. This process replaces the use of isopropyl alcohol with the water/surfactant mixture as the solvent. Preferred surfactants include those of the polyglycol family.

**5543250**

**ELECTRODE FOR STORAGE BATTERY  
AND METHOD FOR PRODUCING THE  
SAME**

Yanagihara Nobuyuk; Kawano Hiroshi; Hayashi Takayuki; Tsuji Masato Hirakata, JAPAN assigned to Matsushita Electric Industrial Co Ltd

The electrode comprises a metal substrate and a coated layer of an active material provided on one or both faces of the substrate. The metal substrate is a metal sheet having a plurality of punched holes. The punched holes have burrs along their peripheries so that the apparent thickness including the burrs is at least twice the original thickness of the metal sheet. The burrs improve the engagement between the metal substrate and the coated layer.

**5545496**

**PROCESS FOR PRODUCING  
FILAMENT-LIKE VANADIUM OXIDE  
FOR USE IN SOLID STATE  
RECHARGEABLE ELECTROCHEMICAL  
CELLS AND THE USE THEREOF AS A  
CATHODE IN ELECTROCHEMICAL  
CELLS**

Chang On-Kok; Saidi M Yazid San Jose, CA,  
UNITED STATES

The present invention provides a novel process for synthesizing vanadium oxide V<sub>6</sub>O<sub>13</sub> with a filament-like morphology by thermally decomposing ammonium metavanadate NH<sub>4</sub>VO<sub>3</sub> in the presence of a compound which sublimates upon heating. The reaction is carried out in an inert gas flow. The V<sub>6</sub>O<sub>13</sub> synthesized according to this invention can be used as cathode active material in electrochemical batteries.

**5545497****CATHODE MATERIAL FOR  
NONAQUEOUS ELECTROCHEMICAL  
CELLS**

Takeuchi Esther S; Leising Randolph East Amherst, NY, UNITED STATES assigned to Wilson Greatbatch Ltd

A new cathode material for use in a high energy density electrochemical cell, preferably comprising silver and vanadium, is described. The new cathode material has the general formula  $Ag_xV_2O_y$  and can comprise a beta-phase silver vanadium oxide having in the general formula  $x=0.35$  and  $y=5.18$  and a gamma-phase silver vanadium oxide having in the general formula  $x=0.74$  and  $y=5.37$  or a mixture of the phases. This new cathode material exhibits reduced voltage delay during high rate applications, such as when the cathode mixture is incorporated into a primary lithium electrochemical cell powering an implantable cardiac defibrillator.

**5548055****SINGLE-ION CONDUCTING SOLID  
POLYMER ELECTROLYTES**

Narang Subhash; Ventura Susanna C Redwood City, CA, UNITED STATES assigned to SRI International

Novel single-ion conducting polymer electrolytes (SPEs) are provided. A first group of polymers are polysiloxanes substituted with fluorinated poly(alkylene oxide) side chains having associated ionic species, while a second group are copolymers containing mer units having the following structures (\*See Patent for Chemical Structure\*) (II)  $(O)_x3(CH_2)y3R_6R_7C(CH_2)z_3$  (III) in which  $R_4$  through  $R_8$ ,  $x_2$ ,  $x_3$ ,  $y_2$ ,  $y_3$ ,  $z_2$ , and  $z_3$  are as defined herein. Also provided are conductive compositions containing these novel polymers, particularly film compositions, and batteries formulated with such films.

**5547911****PROCESS OF IMPRINTING  
CATALYTICALLY ACTIVE PARTICLES  
ON MEMBRANE**

Grot Walther G Chadds Ford, PA, UNITED STATES assigned to E I Du Pont de Nemours and Company

A membrane and electrode structure is formed by surface hydrolyzing an ion exchange membrane and then applying electrode ink of catalytically active particles on the surface of the membrane. The membrane and electrode structure of the present invention is particularly useful in fuel cells and batteries. The inventive process prevents the membrane from swelling or distorting following application of the electrode ink and also improves adhesion between the electrode ink layer and the surface of the membrane.

**5549988****POLYMER ELECTROLYTES AND  
ELECTROCHEMICAL CELLS USING  
SAME**

Reichert Veronica R; Venugopal Ganes; Eschbach Florence O Sunrise, FL, UNITED STATES assigned to Motorola Inc

An electrolyte system for use in connection with an electrochemical cell. The cell includes a positive and a negative electrode, and an electrolyte system disposed therebetween. The electrolyte system includes a polymer matrix fabricated of a polyacrylic acid or polyacrylic acid derivative polymeric material. The polymer material is adapted to engage in electroactive species. Examples of electroactive species may be either an acid or a base electrolyte, such as KOH or  $H_2SO_4$ .

## **LITHIUM BATTERIES**

**5536278**

### **PROCESS FOR ASSEMBLING LPB BATTERIES**

St-Amant Guy; Duval Michel Trois RiviWest, CANADA assigned to Hydro-Quebec

Before laminating the electrolyte with the positive electrode, the electrolyte is heated at a temperature higher than its softening temperature or the melting temperature of its crystallites, and the heated electrolyte is allowed to return to room temperature before laminating the positive electrode to the electrolyte at room temperature. This enables to prevent the formation of wrinkles on the collector of the positive electrode.

**5536597**

### **LITHIUM SECONDARY BATTERY EMPLOYING A NON-AQUEOUS ELECTROLYTE**

Takahashi Yuzuru; Yoshimura Masatosh; Yamada Hideo Tsukuba, JAPAN assigned to Mitsubishi Gas Chemical Company

A lithium secondary battery employing a non-aqueous electrolyte in which the anode material is prepared by calcining a precursor organic compound obtained from the reaction of at least one polycyclic organic compound with a compound containing nitrogen and sulfur.

**5536599**

### **SOLID POLYMER ELECTROLYTE BATTERIES CONTAINING METALLOCENES**

Alamgir Mohamed; Abraham Kuzhikalail M Dedham, MA, UNITED STATES assigned to EIC Laboratories Inc

This invention pertains to the use of ferrocenes to

provide both overcharge protection and Li dendrite-growth suppression in solid polymer electrolyte-based, rechargeable batteries having anodes of Li and Li-containing compounds. In particular, this invention pertains to the use of acetylferrocene and ferrocene carboxaldehyde in solid polymer electrolyte-based rechargeable batteries with anodes of Li and Li-containing compounds.

**5536600**

### **LI-ALLOY ELECTRODE FOR LI-ALLOY/METAL SULFIDE CELLS**

Kaun Thomas D New Lenox, IL, UNITED STATES

A method of making a negative electrode, the electrode made thereby and a secondary electrochemical cell using the electrode. Lithium, silicon and nickel is alloyed in a prescribed proportion forming an electroactive material, to provide an improved electrode and cell.

**5536601**

### **CURRENT COLLECTORS FOR ELECTROCHEMICAL CELLS AND BATTERIES**

Koksbang Rene; Olsen Ib I San Jose, CA, UNITED STATES

In an electrochemical lithium cell having a negative electrode, a positive electrode and an electrolyte separator there is provided a positive electrode current collector which comprises a redox active conductive polymer.

**5538814**

### **LITHIUM SECONDARY BATTERY**

Kamauchi Masahiro; Soejima Hiroshi; Kubota Shuji; Sasaki Kouzou Amagasaki, JAPAN assigned to Mitsubishi Cable Industries Ltd

A lithium secondary battery comprising a positive electrode composed of a positive electrode active

material comprising at least one member selected from the group consisting of lithium phosphate, lithium-cobalt phosphate, cobalt oxide, and lithium-cobalt oxide, such that the molar ratio of cobalt:phosphorus: lithium is more than 0.1:more than 0.2:1, a negative electrode, and an electrolyte. The lithium secondary battery of the invention has high energy density leading to high discharge capacity, high electromotive force, and high discharge voltage, and excellent cycle properties.

**5540741**

**LITHIUM SECONDARY BATTERY  
EXTRACTION METHOD**

Gozdz Antoni S; Schmutz Caroline N; Tarascon Jean-Marie; Warren Paul C Tinton Falls, NJ, UNITED STATES assigned to Bell Communications Research Inc

The present invention is a method of fabricating a rechargeable battery structure by extracting plasticizer from plastic battery preforms to render them insensitive to water while maintaining the homogeneous characteristics of the plastic materials to allow subsequent activation of the batteries through the introduction of an electrolyte solution. These battery preforms need not be maintained under anhydrous conditions and can be activated immediately preceding use thereof.

**5542959**

**METHOD OF FORMING BUTTON-TYPE  
BATTERY LITHIUM ELECTRODES**

Tuttle Mark E Boise, ID, UNITED STATES assigned to Micron Communications Inc

A method of forming a plurality of button-type electrodes includes: a) providing a release liner sheet having elemental lithium adhered thereto in the form of a series of discrete patterns having a size and shape of the lithium electrodes being formed; b) providing an electrically conductive sheet having an exposed surface which is divisible into a plurality of areas; c) laminating the release liner sheet with the conductive sheet to adhere the series of discrete elemental lithium patterns onto the respective sheet areas; d) pulling the release liner sheet from the conductive sheet and discrete

lithium patterns, leaving the discrete lithium patterns adhering to the conductive sheet; and e) cutting and forming a plurality of discrete battery terminal housing members from the areas of the sheet, with each of the discrete battery terminal housings bearing one of the discrete lithium patterns.

**5545468**

**RECHARGEABLE LITHIUM CELL AND  
PROCESS FOR MAKING AN ANODE FOR  
USE IN THE CELL**

Koshiba Nobuharu; Takata Kenichi; Asaka Emi; Nakanishi Makoto Nara ken, JAPAN assigned to Matsushita Electric Industrial Co Ltd

A rechargeable lithium cell comprises a cathode having a discharge potential not less than 2 V relative to a Li/Li<sup>+</sup> anode, an anode capable of doping and un-doping lithium and made of a material comprising a lithium titanate having a spinel structure and represented by the general formula, Li<sub>x</sub>Ti<sub>y</sub>O<sub>4</sub> wherein 0.8 < or = x < or = 1.4 and 1.6 < or = y < or = 2.2, a separator separating the cathode and the anode from each other, and an electrolytic solution impregnated at least in the separator and dissolving a lithium salt in a non-aqueous solvent. When subjected to X-ray diffraction analysis, the material has peaks at least at 4.84 +/- 0.02 angstroms, 2.53 +/- 0.02 angstroms, 2.09 +/- 0.02 angstroms and 1.48 +/- 0.02 angstroms and a ratio of a peak intensity at 4.84 +/- 0.02 angstroms and a peak intensity at 1.48 +/- 0.02 angstroms of 100:30 +/- 10. The material may consist of the lithium titanate or mixed crystals of the lithium titanate and rutile-type titanium dioxide. A process for making the anode is also described.

**5547778**

**CAVITAND ELECTROLYTIC CELL AND  
ELECTROLYTIC PROCESS**

Fauteux Denis G; Van Buren Martin; Shi Jie Acton, MA, UNITED STATES assigned to Arthur D Little Inc

An electrolytic cell, such as a rechargeable lithium battery, having cavitands associated with a metal ion source-electrode and an electrolyte. The cavitands,

which are anchored to the electrode by a polymer leash, are capable of releasably attracting particular ions, such as lithium ions, which are migrating from the electrolyte, toward the surface of the electrode during electrodeposition. The polymer leash serves to continuously maintain the cavitands at a predetermined distance away from the surface of the electrode, regardless of surface area fluctuations, typically caused during deposition and dissolution of the particular ions. Accordingly, the cavitands facilitate substantially uniform electrodeposition of the particular ions, which, in turn, substantially suppresses and/or controls the formation and growth of a passive film or layer, on the electrode surface, which may otherwise promote the formation of dendrites.

**5547782**

### **CURRENT COLLECTOR FOR LITHIUM ION BATTERY**

Dasgupta Sankar; Jacobs James K Toronto, Ont, CANADA

An improved lithium ion battery is described wherein corrosion of the current collector in contact with the electrode face is greatly reduced. In one embodiment an electrically conductive, ceramic layer is inserted between the current collector and the corresponding major face of the lithium ion battery. In another embodiment the metallic current collector plate is replaced by an electrically conductive laminated organic polymer having electrically conductive particles dispersed therein.

**5547785**

### **LITHIUM CELL**

Yumiba Hideaki; Matsumoto Kazunobu; Kawakami Akira Suita, JAPAN assigned to Hitachi Maxell Ltd

There is provided a lithium cell comprising a negative electrode made of lithium or a lithium containing material, an electrolytic solution based on an organic solvent, and a positive electrode active material which comprises a copper compound oxide and an atomic ratio of a number of lithium atoms (Li) which react with one molecule of the copper compound oxide during

discharge of the lithium cell to a number of oxygen atoms (O) contained in one molecule of the copper compound oxide, which ratio is expressed as Li/O, is at least 1.

**5549880**

### **METHOD OF MAKING LITHIUM-VANADIUM-OXIDE ACTIVE MATERIAL**

Koksbang Ren San Jose, CA, UNITED STATES

A method of making an electrode active material of the nominal general formula  $\text{LiVyOz}$  where  $y$  is greater than 0 and up to about 3 and  $z$  is greater than 0 and up to about 8, comprises a series of steps. In the first step, lithium hydroxide is dispersed in an alcohol of the general formula  $\text{C}_n\text{H}_{2n+1}\text{OH}$ . The alcohol and the hydroxide are each in an amount sufficient to provide a lithium alkoxide of the general formula  $\text{LiOC}_n\text{H}_{2n+1}$ . Next, progressive amounts of an oxide of vanadium having the general formula  $\text{V}_2\text{O}_5$  (vanadium pentoxide) are added while stirring the mixture. The amount of vanadium pentoxide in the mixture is sufficient to provide about 3 moles of vanadium for each mole of lithium present in the alkoxide. Then, the mixture is heated to an elevated temperature for a time sufficient to change the color of the oxide of vanadium and provide a solid precipitate. The solid precipitate is separated from the mixture and dried to obtain a powder of an oxide of vanadium having the nominal general formula  $\text{LiVyOz}$ ,  $0 < y < \text{or} = 3$  and  $0 < z < \text{or} = 8$ .

**5549985**

### **METHOD OF ASSEMBLING ELECTROCHEMICAL CELLS OF NOVEL CONSTRUCTION**

Heller Bernard; Schmidt Craig; Nutzman Thomas; Lessar Joseph Fridley, MN, UNITED STATES assigned to Medtronic Inc

A lithium halide button cell formed of simplified sub-assemblies including one such subassembly in which molten cathode material is poured into a retaining ring and allowed to solidify therein before incorporation into the cell.

**5552238****STABILIZED RECHARGEABLE CELL IN  
MSE AND METHOD THEREFOR**

Carlin Richard T; Fuller Joan Colorado Springs, CO, UNITED STATES assigned to The United States of America as represented by the Secretary of the Air Force

Method is provided for preparing a stabilized rechargeable cell having a negative electrode and a molten salt electrolyte (MSE) while avoiding problems of chloroaluminate cell system which are not air stable. The cell of the present invention thus employs an LiBF<sub>4</sub>/EMIBF<sub>4</sub> MSE and a negative electrode of an inert substrate. On charging such cell, Li metal plates out on the electrode, which metal would immediately be attacked by such MSE. However a small amount of water is added to the MSE which, forms a lithium salt on the surface of such metal and protects it from attack by the MSE. However such protective film is permeable to Li<sup>+</sup> ions. This means that on continuing to charge such cell, the Li<sup>+</sup> ions flow from the MSE through the protective film and build up as more Li metal on the negative electrode, under the protective film. On discharge of such cell, the Li metal becomes Li<sup>+</sup> ions which can pass through the protective lithium salt film. Accordingly employing a suitable cathode, the rechargeable cell of the invention can operate at high voltage, with a cycling efficiency of over 60%. Also the electrolyte of such cell has a variable temperature range, a high inherent conductivity and is air stable.

**5552239****RECHARGEABLE BATTERY  
STRUCTURE AND METHOD OF MAKING  
SAME**

Gozdz Antoni; Schmutz Caroline; Tarascon Jean-Mari; Warren Paul C Tinton Falls, NJ, UNITED STATES assigned to Bell Communications Research Inc

A rechargeable battery comprises a laminate electrolytic cell in which a flexible plasticized polymer hybrid electrolyte/separator layer is interposed between positive and negative electrode layers of lithium-ion intercalating polymeric matrix compositions bearing respective current collector foils. An elongate laminar cell is

formed into a unified battery by means of an initial transverse fold disposing one electrode/collector within the structure and with subsequent sequential folds spiralling the cell, without need for interposed insulation, outwardly toward the electrode ends where the collectors accommodate battery terminals. Immersion of the structure in a solvent extracts the polymer plasticizer which is subsequently replaced by contact with lithium salt solution electrolyte to activate the battery.

**5554459****MATERIAL AND METHOD FOR LOW  
INTERNAL RESISTANCE LI-ION  
BATTERY**

Gozdz Antoni S; Warren Paul C Tinton Falls, NJ, UNITED STATES assigned to Bell Communications Research Inc

An electrically-conductive collector element in a polymeric laminate lithium ion rechargeable battery is cleaned of surface oxides and coated with an adherent conductive polymer film which is substantially inert to battery electrolyte components and prevents recurrent formation of insulative collector surface oxides, thereby maintaining effective electrode/collector electrical conductivity and significantly reducing internal battery resistance.

**5554462****CARBON ANODE FOR A LITHIUM  
RECHARGEABLE ELECTROCHEMICAL  
CELL AND A PROCESS FOR ITS  
PRODUCTION**

Flandrois Serge; Fevrier Annie; Biensan Philippe; Simon Bernard Pessac, FRANCE assigned to Saft

The present invention concerns a carbon anode for a lithium rechargeable electrochemical cell, comprising a graphite-containing carbon-containing material which includes, prior to electrical cycling, at least a first phase constituted by graphite having a rhombohedral crystal structure and comprising a fraction of more than 10%.

**5556721**

**NON-AQUEOUS ELECTROLYTE  
SECONDARY BATTERY AND  
PRODUCTION METHOD OF THE SAME**

Sasaki Tomio; Sakai Tsugio; Tahara Kensuke Tokyo, JAPAN assigned to Seiko Instruments Inc; Seiko Electronic Components

A non-aqueous electrolyte secondary battery comprises at least a negative electrode, a positive electrode and a non-aqueous electrolyte. The negative electrode has an active material comprised of silicon or a silicon alloy containing lithium represented by composition formula  $\text{Li}_x\text{Si}$  where  $x$  satisfies  $0 < x \leq 5$ . The positive electrode has an active material comprised of a transition metal oxide. The non-aqueous electrolyte is a lithium ion-conductive non-aqueous electrolyte having at least one lithium compound comprised of one of an organic solvent and a solid polymer. The negative electrode active material is formed by absorption of lithium ions into the silicon resulting from an electrochemical reaction between the negative electrode and a lithium metal and/or a material containing lithium. A secondary battery having high voltage, high energy density, high reliability, improved current charge and discharge characteristics and a long cycle life is obtained.

**5556723**

**NEGATIVE ELECTRODE FOR USE IN A  
SECONDARY BATTERY**

Ohsaki Takahisa; Takami Norio; Nishimura Yoshiyuki; Tamaki Toshio Yokohama, JAPAN assigned to Kabushiki Kaisha Toshiba; Petoca Ltd

A negative electrode for use in a secondary battery is disclosed, comprising milled carbon fibers derived from mesophase pitch wherein the milled carbon fibers each has a fiber cut surface and a fiber axis intersecting with each other at cross angles, the smaller one thereof being at least  $65^\circ$  on the average. This negative electrode does not suffer from property deterioration, irrespective of multiple repetitions of charge and discharge, from which a nonaqueous-electrolyte-loaded lithic secondary battery having excellent cycle characteristics can be fabricated.

**NICKEL METAL HYDRIDE BATTERIES**

**5536591**

**ELECTROCHEMICAL HYDROGEN  
STORAGE ALLOYS FOR NICKEL METAL  
HYDRIDE BATTERIES**

Fetcenko Michael A; Ovshinsky Stanford; Chao Benjamin S; Reichman Benjami Rochester Hills, MI, UNITED STATES assigned to Ovonic Battery Company Inc

A disordered electrochemical hydrogen storage alloy comprising: (\*See Patent for Tabular Presentation\*) PS where the Base Alloy comprises 0.1 to 60 atomic percent Ti, 0.1 to 40 atomic percent Zr, 0 to 60 atomic percent V, 0.1 to 57 atomic percent Ni, and 0 to 56 atomic percent Cr; b is 0 to 7.5 atomic percent; c is 13 to 17 atomic percent; d is 0 to 3.5 atomic percent; e is 0 to 1.5 atomic percent; and  $a+b+c+d+e=100$  atomic percent.

**5537023**

**CHARGING METHOD FOR STORAGE  
BATTERIES**

Hanselmann Diете; Mayer Bernd; Nutz Karl-Diethe; Weller Stefan-Peter GERMANY assigned to Temic Telefunken microelectronic GmbH

The invention relates to a charging method for storage batteries, in particular for NiCd and NiMH cells. According to the invention, the rise in the charging voltage during each of a number of consecutive charging cycles of a specified duration is measured in the form of a unit corresponding to a certain voltage. The number of these units is transmitted in the form of a counting pulse to two up-down counters during the period of the charging cycle, whereby one counter functions in the down mode and is set at the beginning of a charging cycle to a number corresponding to the number of units established in the preceding charging cycle. In the following charging cycle, the roles of the two counters are reversed, so that the up-counter is now set to the down mode and the other counter to the up mode, whereby the latter is set to a Certain starting counting status. At the end of each charging cycle, the final status

of the down counter is compared with the specified starting status, from which a switch-off criterion is derived for the charging process. According to the invention, this process enables both positive and negative changes in the  $dU/dt$  value of the charging curve to be detected with a high voltage resolution and, at the same time, minimal cost.

**5537733**

**METHOD OF MANUFACTURING A  
NICKEL-METAL HYDRIDE SECONDARY  
CELL**

Kozawa Hideaki; Kojima Kazuo; Ono Tomoyuki; Yanagawa Hirofumi; Kitazume Hideaki; Taguchi Kouji  
Yokohama, JAPAN assigned to Toshiba Battery Co Ltd

A rectangular nickel-metal hydride secondary cell permits improving the air-tightness and also permits preventing a metal case from being deformed in a step unfolding an open end portion of the metal case. The rectangular nickel-metal hydride secondary cell, includes a rectangular cylindrical metal case having a bottom, an electrode group housed in the metal case, an alkali electrolyte contained in the metal case, a rectangular sealing plate mounted near the open end portion of the metal case. An insulating gasket is interposed in a compressed state between the inner wall near the open end of the metal case and the sealing plate. The metal case comprises a folded portion formed by inwardly folding the open end portion of the metal case and an inwardly projecting stepped portion formed along the inner surface of the metal case below the folded portion. The sealing plate is fixed to the metal case at the portion between the folded portion and the stepped portion of the metal case with the insulating gasket interposed therebetween, the folded portion at a corner portion of the open end portion of the metal case has an angle of 80 degrees to 100 degrees. Such a secondary cell can be formed by a process which includes charging-discharging cycles, an aging step, and a full charging step.

**5541496**

**APPARATUS AND METHOD OF RAPIDLY  
CHARGING NICKEL-CADMIUM  
BATTERIES**

Simmonds Stewart Port Coquitlam, CANADA  
assigned to 4C Technologies Inc; Datalink Corporation

PCT No. PCT/JP92/00955 Sec. 371 Date Feb. 14, 1994  
Sec. 102(e) Date Feb. 14, 1994 PCT Filed Jul. 28, 1992  
PCT Pub. No. WO93/19496 PCT Pub. Date Sep. 30,  
1993. A method and apparatus for charging  
nickel-cadmium batteries with a current greater than 2C  
rate. The cell temperature or both the temperature and  
voltage thereof are monitored, and the charging  
operation is halted upon detection of a moment when the  
rate of temperature increase of the cell became at least  
twice as great as the rate of temperature increase that  
was measured just before, or of a moment at which the  
above phenomenon took place and a moment at which  
the rate of voltage increase has declined immediately  
following a period during which the rate of voltage  
increase has continually risen.

**5545392**

**PROCESS FOR PRODUCING NICKEL  
HYDROXIDE FROM ELEMENTAL  
NICKEL**

Babjak Juraj; Ettl Victor A Mississauga, CANADA  
assigned to Inco Limited

The invention provides a method of producing nickel hydroxide from elemental metal. Elemental nickel is first introduced into an aqueous ammonia or ammonia/ammonium salt solution capable of dissolving nickel. The potential, as measured by a standard calomel electrode, is allowed to reach a negative or reducing level. Oxygen is added to the aqueous solution at a rate that maintains the negative potential to facilitate the conversion of elemental nickel to nickel hydroxide. Nickel hydroxide may be readily precipitated from the aqueous solution.



**5549992**

**PREPARING METHOD FOR A NICKEL  
HYDROXIDE FOR A NICKEL  
ELECTRODE, A MANUFACTURING  
METHOD FOR THE NICKEL  
ELECTRODE, AND AN ALKALINE  
SECONDARY BATTERY  
INCORPORATING THE NICKEL  
ELECTRODE THEREIN**

Iwane Noriyas; Sawa Harauo Tokyo, JAPAN assigned to Furukawa Denchi Kabushiki Kaisha

Provided are a method for preparing a nickel hydroxide for a nickel electrode, which comprises solidly dissolving ions of other metals than nickel in a nickel hydroxide, and eluting a partial amount of the metal, a method for manufacturing a nickel electrode, which comprises filling a porous current collector with an active material paste consisting mainly of the resulting nickel hydroxide, and an alkaline secondary battery which incorporates the nickel electrode as a positive electrode therein. This nickel hydroxide restrains deformation or expansion of the nickel electrode and lowering of the discharge capacity of the battery despite repeated charge/discharge cycles of the battery.

**5552243**

**BIPOLAR ELECTROCHEMICAL  
BATTERY OF STACKED WAFER CELLS**

Klein Martin Brookfield, CT, UNITED STATES assigned to Electro Energy Inc

The subject invention relates to electrode structures that are adaptable for primary and electrically rechargeable electrochemical wafer cells. A flat wafer cell is disclosed that includes conductive, carbon-filled polymeric outer layers that serve as electrode contacts and as a means of containment of the cell. Multi-cell, higher voltage batteries may be constructed by stacking individual cells. Specially formulated electrodes and processing techniques that are compatible with the wafer cell construction are disclosed for a nickel-metal hydride battery system. The cell design and electrode formulations provide for individual operation of a vented or low pressure sealed cell and/or for operation of these

cells in a stacked array in an outer battery housing.

**5552246**

**MATERIALS FOR HYDROGEN STORAGE,  
HYDRIDE ELECTRODES AND HYDRIDE  
BATTERIES**

Hong Kuochih Troy, MI, UNITED STATES

The present invention discloses four main groups of hydrogen storage/hydride electrode materials for electrochemical applications as the active material of the negative electrode of a hydride battery. The compositions of these four groups are represented by the formulas: (1)  $Ti_aNb_bNi_cR_xDyQp$ , (2)  $Ti_aHf_bNi_cR_xDyQp$ , (3)  $Ti_aTa_bNi_cR_xDyQp$ , (4)  $Ti_aVbNi_cR_xDyQp$ , and its hydride thereof; where R is at least one element selected from the group consisting of B, Hf, Sc, Zn, Sb, W, Sn, N, O, Ge, Ga, P, S, and the alkali metals; D is at least one element selected from the group consisting of Mn, Cu, Si, Cr, and Mm, where Mm is the mischmetal; Q is at least one element selected from the group consisting of C, Mg, Ca, Sr, Ba, Al, Si, V, Cr, Mn, Fe, Co, Cu, Zr, Mo, Ag, Pd, Y, Ta, La, Ce, and Mm, where Mm is the mischmetal; and where the atomic mole ratios: a, b, c, x, y and p are defined by:  $0.10 < a < 0.85$ ,  $0.001 < b < 0.50$ ,  $0.02 < c < 0.85$ ,  $0 < x < 0.30$ ,  $0 < y < 0.30$ ,  $0 < p < 0.45$ ,  $b + y < 0.62$ , and  $a + b + c + x + y + p = 1.00$ ; and if present,  $Mm < 12$  at. %; preferably,  $0.15 < a < 0.63$ ,  $0.01 < b < 0.38$ ,  $0.15 < c < 0.60$ ,  $0 < x < 0.15$ ,  $0 < y < 0.15$  and  $0 < p < 0.30$ .

**COMPONENTS AND/OR CHARGERS**

**372455**

**BATTERY CHARGER**

Tiefenthal James L; Goldhardt Donald J; Morrow James Dublin, OH, UNITED STATES assigned to Abbott Laboratories

The ornamental design for a battery charger is described.

**372456****BATTERY CHARGER**

Cooper Stephen; Salvatori Phillip; Andrews Jonathan; Brink Gregory D; Bledsoe James D; Blumberg-Dominguez Wendy; Burton David L Amity, OR, UNITED STATES assigned to Hewlett-Packard Company

The ornamental design for a battery charger is described.

**5536977****BIDIRECTIONAL CURRENT BLOCKING MOSFET FOR BATTERY DISCONNECT SWITCHING**

Williams Richard K Cupertino, CA, UNITED STATES assigned to Siliconix incorporated

A bidirectional current blocking switch is disclosed. The switch includes a four-terminal MOSFET in which there is no source-body short. The voltages applied to the source and drain terminals are both higher than the voltage applied to the body terminal (for an N-channel) device so that the source-body and drain-body junction of the MOSFET never become forward-biased. The switch of this invention is particularly useful for switching a cascaded set of batteries in a portable computer.

**5536979****CHARGER FOR HAND-HELD RECHARGEABLE ELECTRIC APPARATUS WITH SWITCH FOR REDUCED MAGNETIC FIELD**

McEachern Alexander; Haverstock Thomas Oakdale, CA, 94618, UNITED STATES

A system transfers electric power between two devices using a magnetic coupling and no electrical connections. Each device incorporates a magnetic core surrounded by a coil. When properly aligned the cores form a closed magnetic circuit whereby stray magnetic fluxes are

substantially reduced. In the preferred embodiment, a base unit incorporates a substantially C shaped magnetic core surrounded by its respective coil. A portable detachable device, such as an electric toothbrush, incorporates a substantially linear shaped magnetic core surrounded by its coil. The linear shaped magnetic core and the portable device are configured to fit within a gap formed in the C shaped magnetic core forming a substantially closed magnetic circuit thereby. Stray magnetic fluxes are thus significantly reduced. Additionally, an apparatus deactivates the power to the coil in the base unit when the portable device is removed from the base unit or when the battery within the portable device is charged to a predetermined level.

**5537042****METHOD AND SYSTEM FOR UNOBTRUSIVELY MEASURING PHYSICAL PROPERTIES IN ELECTROCHEMICAL PROCESSES**

Beutler Jon F; Burreson Bernard J; Van Schalkwijk Walter A; Flagg Delbert F; Kromholtz Gregory; Green Jeffrey Arlington, WA, UNITED STATES assigned to ELDEC Corporation

Disclosed is a method and system for unobtrusively measuring physical properties in electrochemical processes occurring in a predefined volume, such as the state of charge in an electrochemical battery. The invention provides for a coil or positioned relative to the predefined volume to minimize the reluctance path between the coil and the electrochemical process, with the winding axis of the coil generally transverse to a surface bounding the predefined volume. In this position, an alternating current is applied to the coil to generate an oscillatory magnetic field. Preferably, the coil includes a core or a backing plate for concentrating the magnetic field in a direction towards the process in the predefined volume. The physical properties are determined based upon a measurement of the electrical complex impedance of the coil, and data correlating the physical properties of the process with the electrical complex impedance of the coil.

**5538809****AUTOMATIC COUPLING SYSTEM FOR TRACTION BATTERIES**

Bittihn Rainer; Woeffler Friedrich; Sziksnus Dieter; Rinke Hubert Halver, GERMANY assigned to Varta Batterie Aktiengesellschaft

A coupling for connecting a battery to a battery charger of a replacement station for electric road vehicles equipped with exchangeable batteries receivable upon a roller conveyor associated with the replacement station, or to a battery charger of the owner of the vehicle, includes corresponding terminal strips associated with the battery and with the battery charger having plugs and sockets for electrical connection, and optionally for connection with an air supply and a water refilling device. The plugs and sockets are suitably connected to the battery with cables and hoses. The correspondingly adjusted terminal strip arranged at the charging position in the replacement station is provided with corresponding sockets and plugs, and has additional guide pins for engaging corresponding guide openings in the battery terminal strip. These various structures are automatically connected when the battery is advanced along the roller conveyor.

**5539296****METHOD AND SYSTEM OF CHARGING A PROPULSION BATTERY OF AN ELECTRICALLY POWERED VEHICLE**

Ito Makoto Kariya, JAPAN assigned to Kabushiki Kaisha Toyota Jidoshokki Seisakusho

A battery charging method and system are provided which are applicable to battery-powered vehicles. According to the charging system of the invention, there is provided a primary charger including a primary winding which is connectable with a source of charging alternating current at a charging station. There are also provided at least two secondary chargers each connected with a battery on each vehicle and including a secondary winding having a number of winding turns which is different from that of the winding of the other secondary charger. Transfer of electrical energy from the primary charger to the secondary chargers is accomplished by

inductively coupling the primary winding with any selected one of the secondary windings, as a result of which a voltage, the magnitude of which is dependent on the turns ratio between the primary and secondary windings, is produced across the selected secondary winding.

**5539297****CHARGING DEVICE FOR CHARGING A PLURALITY OF BATTERIES BASED ON PARAMETER PRIORITY**

Fiebig Arnim Leinfeldten Echterdingen, GERMANY assigned to Robert Bosch GmbH

PCT No. PCT/DE93/00350 Sec. 371 Date Oct. 17, 1994 Sec. 102(e) Date Oct. 17, 1994 PCT Filed Apr. 22, 1993 PCT Pub. No. WO93/23905 PCT Pub. Date Nov. 25, 1993. The charging device for charging a plurality of rechargeable batteries according to the invention includes at least two sensors associated with each rechargeable battery for measuring a measurable parameter, e.g. voltage, temperature, etc., of the rechargeable battery associated therewith; switchable devices for electrically connecting one or more rechargeable batteries at a time for charging; a control device for selecting rechargeable batteries for charging in an order determined by measured values of the measurable parameters obtained from the sensors associated with each rechargeable battery. The control device includes a device for weighting the measured parameters of each of the rechargeable batteries according to a priority factor to obtain weighted combined values, a device for comparing said weighted combined values to at least one predetermined limiting value to determine the order in which the rechargeable batteries are selected for charging and a device for controlling the switchable device to connect the rechargeable batteries for charging according to that order.

**5539298****PULSE CHARGE TECHNIQUE TO TRICKLE CHARGE A RECHARGEABLE BATTERY**

Perkins Dean P; Lin David S; Schneider Michael  
Tomball, TX, UNITED STATES assigned to Compaq  
Computer Corporation

A battery pack for a computer system including static memory to maintain battery operating parameters and charge information, a real time clock (RTC) for measuring periods of non-use of the battery and a communication means to exchange the battery information with a microcontroller located in the computer system. The static memory, RTC and communication means is preferably in the form of a single RAM/RTC chip. The battery pack also includes circuitry to maintain power to the RAM/RTC from the battery if AC power is not available. The microcontroller detects the presence of the battery and retrieves the present time from the RTC, a timestamp indicating time or removal of the battery and other operating parameters and charge information from the battery pack, and controls the charging functions of the battery accordingly. The microcontroller also updates the charge information of the battery pack while performing other housekeeping functions of a DC-DC converter. The microcontroller further controls a switch located in the charge path of the battery to control fast charging. Trickle charge is simulated by pulsing the switch at a predetermined duty cycle and period. The microcontroller may be placed in standby to conserve energy, while also monitoring the standby switch to pull the computer system out of standby mode if the standby switch is pressed. This allows the keyboard controller 21 to be shut off during standby mode to conserve energy.

**5539318****RESIDUAL CAPACITY METER FOR ELECTRIC CAR BATTERY**

Sasaki Torahiko Mishima, JAPAN assigned to Toyota  
Jidosha Kabushiki Kaisha

The voltage and current of a main battery used to drive a motor of an electric car is detected by a voltmeter and

ammeter. The V-I characteristic is detected by a V-I characteristic computing means by reading the voltage and current when the battery current is equal to or greater than 0.75 C and is increasing (high load state). The relation between the two is stored, and from the actually measured V-I characteristic and the stored relation, the residual capacity of the battery is computed. The SOC is also determined by a SOC computing means 20 according to the power integration method, and the degree of deterioration of the battery is computed from this SOC and the residual capacity. By correcting the full charge capacity from the power integration method based on this degree of deterioration in order to compute the SOC, errors arising in the power integration method are prevented and measurement precision is improved.

**5539399****DISPLAY DEVICE FOR ELECTRIC VEHICLE**

Takahira Yoshikazu; Ogawa Tomoko; Kanayama Shinichir Saitama, JAPAN assigned to Honda Giken Kogyo Kabushiki Kaisha

A display device for an electric vehicle, which display device is capable of displaying a possible running range from a current location of a vehicle with a detected residual battery charge on a road map indicated on the display device screen, considering the climbing power of the vehicle with that detected residual battery charge. The display device operates to indicate a current location of the vehicle on the road map shown on the display screen according to map information read from a storage medium according to a detected current location of the vehicle, to determine a possible running distance of the vehicle with a detected residual battery charge on the basis of electric energy consumption rate for each road on the road map in consideration of topographic features of each road, and then to display a possible running range of the vehicle starting from the current location of the vehicle on the road map.

**5541491****BATTERY CHARGING APPARATUS**

Yamazaki Yasuharu; Nakamura Shoichi Saitama, JAPAN assigned to Sony Corporation

A battery charging apparatus for charging a chargeable battery is disclosed. The apparatus comprises: a dc power source for generating a charging current; current control means connected between the dc power source and a chargeable battery to be charged; charging controller means connected to the current control means for controlling a flow of the charging current from the dc power source to the chargeable battery; and charging condition detecting means for detecting charging condition of the chargeable battery during charging operation. The charging controller means supplies control pulse to the current control means.

**5541492**

### **METHOD FOR CHARGING A MULTIPLE VOLTAGE ELECTROCHEMICAL CELL**

Fernandez Jose M; Meadows Vernon; Anani Anaba A Plantation, FL, UNITED STATES assigned to Motorola Inc

A method of charging a multiple voltage battery is disclosed. The multiple voltage battery is characterized by a preselected operating voltage and a charge profile curve having at least two occurrences of the slope thereof being substantially zero. The number of occurrences of the slope of the charge profile curve being substantially zero corresponds to the number of voltage levels the cell is adapted to operate in. The method recognizes the signature charging profile of the multiple voltage level battery and is thus capable of terminating battery charge at the level corresponding to the preselected operating voltage.

**5541495**

### **BATTERY POLARITY CONNECTION ADAPTION SOLID STATE SWITCH**

Gali Carl E Garland, TX, UNITED STATES

A bi-polar solid state battery switch is provided enabling the DC pulse output of battery reclaimer and charger circuits to be connected to a battery without regard to battery terminal polarity. The battery polarity bias itself determines bias to an conductive state of one of two sets of transistors through the respective resistors. This makes the battery connection conform to the same

polarity as the output DC of the reclaimer and charger.

**5543248**

### **THERMAL STABILIZATION SHIELD FOR STORAGE BATTERIES**

Dougherty Thomas; Inkmann Mark; Smith Debra; Reher Michael T Waukesha, WI, UNITED STATES assigned to Globe-Union Inc

A battery shield for a storage battery includes first and second members which are dimensioned to fit around the battery, forming a shield structure, that is open at its top and encloses the battery on all four sides and on the bottom, forming a heat shield for protecting the battery from hot temperatures, the first and second members being hinged to a common base and are adapted to be pivoted about respective hinges outwardly away from another to an open position to facilitate installation of a battery in the shield and to then be moved upwardly and toward one another, in the manner of a clamshell , to a closed position for enclosing the battery within the battery shield.

**5543701**

### **ELECTRICAL STORAGE CELL POLARIZATION CONTROLLER**

Leung Chiu F; O'Sullivan Thomas D East Hanover, NJ, UNITED STATES assigned to Bell Communications Research Inc

In order to extend the useful life of electrical storage battery cells under float voltage charge it is advisable to maintain the polarization of the positive plates of the cell relative to a reference electrode in the cell at a predetermined level. This invention provides a sensing and controller circuit which drains minute amounts of current from the positive cell plates when the polarization rises above the desired level and thereby prevents plate corrosion and loss of electrolyte. The present invention may be combined with a circuit for increasing cell polarization levels to provide a system for maintaining battery cells at optimum polarization levels over extended float charging periods.

**5543702****ALKALINE BATTERY CHARGING  
METHOD AND BATTERY CHARGER**

Pfeiffer John D Quebec, CANADA assigned to JDP Innovations Inc

A battery charger and method are disclosed for charging alkaline, Ni-Cad and zinc-based batteries, particularly sizes N, AAA, AA, C and D. For batteries rated at about 1.25 volts to about 1.5 volts, the battery charger and method provide a constant charging current of between about 0.28 ma to about 1.5 ma per gram weight of the battery. A substantially constant current is supplied to the battery while a reference voltage greater than the battery voltage is provided. Thereafter, as the battery voltage increases, the reference voltage is incremented up to a predetermined maximum reference voltage. Charging is terminated when the reference voltage reaches the predetermined maximum, or when the battery voltage does not increase during charging to be greater than a first or a subsequent reference voltage during a predetermined charging time period. The controller may also cause the constant current to be increased by from about 2.5% to about 25% for up to a predetermined testing time period, and terminate the supply of current to the battery if the battery voltage increases by greater than a predetermined amount. The battery charger may at the same time charge batteries of different sizes, and includes a separate constant current circuit for each battery in the battery charger. Each battery is continuously supplied with charging or testing current as determined by the controller, and the controller controls charging of each battery independently of the charge condition of any other battery. A separate controller may control each constant current circuit, or a microprocessor may control all of the constant current circuits.

**5545967****AUTOMATIC BATTERY MANAGEMENT  
SYSTEM**

Osborne Robert E; Garlow David Coral Springs, FL, UNITED STATES assigned to Precision Automation Systems Inc

A system for automatic loading, unloading and charging

of rechargeable batteries used in battery electric traction motor powered vehicles comprises a battery recharge station, a battery load and unload station adapted for positioning a battery powered vehicle in a preselected position, and a programmable battery transport apparatus programmed for automatically removing discharged batteries from the vehicle, transporting the discharged batteries to a battery recharge station, unloading the discharged batteries into the recharge station, retrieving charged batteries from the recharge station, transporting the charged batteries to the vehicle and loading the charged batteries onto the vehicle. The system may also include a battery water check station, the transport apparatus being programmed to transport batteries from the battery charging station to the water check station, load the charged batteries into the water check station and unload the batteries from the water check station upon completion of a check of the water level in each of the batteries by the water check station. The check station utilizes an elongate probe adapted for insertion into each cell of the battery through a cap positioned on the cell, the cap comprising a pair of elastomeric members having oppositely facing concave portions, each of the concave portions including a centrally positioned cut for allowing passage therethrough of the probe.

**5545969****BATTERY RESIDUAL CAPACITY  
DISPLAYING SYSTEM WITH  
DISCHARGED ELECTRICAL QUANTITY  
COMPUTATION SECTION**

Hasegawa Hirokazu Fujisawa, JAPAN assigned to Matsushita Electric Industrial Co Ltd

A system for displaying the residual capacity of a secondary battery so as to update the battery capacity when the battery discharges from its full charged condition to a predetermined voltage level, in which this predetermined voltage is selected to be sufficiently higher than the operation halting voltage of a portable electrical apparatus to be connected, and the quantity of electricity discharged until the predetermined voltage level is reached is suitably corrected to determine the newest battery capacity, so that the battery capacity can be accurately updated under the actual operating condition with a high frequency and high precision.

**5546003****MULTI-CELL BATTERY MONITORING SYSTEM WITH SINGLE SENSOR WIRE**

Noworolski Zbigniew; Sterescu Vlad; Lee Albert; Halton Pdraig; Noworolski Jan M North York, CANADA assigned to Polytronics Engineering Ltd

A method for detecting the condition of the individual cells of a bank of serially connected battery cells is provided. The method utilizes a single common sensing wire connected through respective non-linear component switching mechanisms to respective reference terminals. The reference terminals are located between adjacent batteries and at the end of the battery assembly. The method includes the step of detecting an instantaneous change of impedance at points of transition of the state of the individual switches provided.

**5546264****REVERSE VOLTAGE PROTECTION CIRCUIT**

Williamson Gregory L; Hoffman John P Metamora, IL, UNITED STATES assigned to Caterpillar Inc

An apparatus for providing reverse protection to an electronic circuit is provided. The electronic circuit has a positive input terminal and a negative input terminal. The positive input terminal is coupled to a positive battery terminal via the apparatus. The negative input terminal is connected to a negative battery terminal. The apparatus includes a MOSFET transistor having a gate terminal, a drain terminal and a source terminal. One of the drain terminal and the source terminal is connected to the positive battery terminal and an other of the drain terminal and the source terminal is connected to the positive input terminal. One end of a resistor is connected to the gate terminal. One end of a pair of Zener diodes is connected to the gate terminal. The other end is connected to the source terminal.

**5546317****SYSTEM FOR RECOGNIZING AND MANAGING ELECTROCHEMICAL CELLS**

Andrieu Xavier Bretigny sur Orge, FRANCE assigned to Alcatel Alsthom Compagnine Generale d'Electricite

The present invention provides a system for recognizing and managing electrochemical cells connected to an application, the system being characterized by the fact that it comprises an electronic memory associated with the cells, and circuitry for reading from the memory and writing in the memory, the read write circuitry being placed in the application, the electronic memory comprising a non-erasable first portion containing information enabling the cell to be identified, and a second portion which may be modified or erased, and which contains information about the operation and the state of the cell.

**5547775****CIRCUIT FOR PREVENTING OVERCHARGE AND OVERDISCHARGE OF SECONDARY BATTERIES**

Eguchi Yasuhito; Sato Masayuki; Narushima Toshio; Sanpei Akira; Murano Kanji Kanagawa, JAPAN assigned to Sony Corporation

Circuit for preventing overcharge and overdischarge of secondary batteries is disclosed. Overcharge detecting comparators COMP2 and COMP4 each having a hysteresis circuit 1 are connected between positive and negative electrodes of series-connected secondary batteries Abat and Bbat, and overdischarge detecting comparators COMP1 and COMP3 each having a hysteresis circuit 2 are connected also between the above electrodes. Transistors T1, T2 and a resistor R are connected between the batteries for overflow of overcharge and balance of overdischarge. Upon detection of any overcharge by the comparator COMP2 or COMP4, the charge current is interrupted by a transistor T6, and simultaneously the overcharge overflow is discharged by the hysteresis circuit until the battery voltage is lowered to the hysteresis voltage. And after the discharge, the transistor T6 is turned on to

resume recharging the batteries. Meanwhile, upon detection of any overdischarge by the comparator COMP1 or COMP3, the discharge current is interrupted by a transistor T5. Thus the overcharge and the overdischarge can be balanced by the hysteresis circuits 1 and 2 respectively.

**5548200**

**UNIVERSAL CHARGING STATION AND METHOD FOR CHARGING ELECTRIC VEHICLE BATTERIES**

Nor Jiri K; Soltys Josef V Oakville, CANADA assigned to Norvik Traction Inc

A method and apparatus for charging the battery of an electric vehicle are provided. When the electric vehicle is connected to a charging station, it is interrogated to determine the nature of the charge controller that is on board the vehicle; and logic decisions invoking the particular mode for charging the vehicle are made depending on the nature and type of charge controller that is on board the vehicle. Thus, delivery of charging energy to the battery in the vehicle may be entirely under the control of a charge controller on board the vehicle; or if the control module in the vehicle is less sophisticated then delivery of charging energy will be under the control of a charging module within the charging station. Parameters of initial charging current and voltage are therefore set either by the on board battery charging controller, or the charge controller in the charging station; alternatively, those parameters may be set manually or by insertion of a card into a data interface to establish initial charging conditions. Under controlled conditions, a plurality of vehicles may be charged at a single establishment having a plurality of charging stations, either sequentially or simultaneously, depending on the criteria to be established. The charging station may be privately owned, so as to charge a fleet of vehicles; or there may be a plurality of charging stations at a publicly accessible service station.

**5548201**

**BATTERY CHARGING METHOD AND APPARATUS WITH THERMAL MASS EQUALIZATION**

Grabon Robert J Cedar Rapids, IA, UNITED STATES assigned to Norand Corporation

A battery charging method in an environment of variable temperatures provides for a temperature correction to determine an onset of an overcharge phase which is detected by a discernible thermal energy output of a charging battery. The method comprises a precursory operation of determining time period required for effecting a temperature change in the battery in response to a temperature change of an ambient space about the battery. The temperature of the battery is then monitored throughout the charging process by measuring the temperature of the battery at timed, predetermined intervals. Over the same timed intervals the temperature of the ambience is measured. A measured difference in the temperature of the ambience with respect to a prior temperature of the ambience is applied to a measured temperature of the battery as modified by a predetermined time delay factor. The temperature is thereby corrected to reflect a change which would have occurred as a result of a temperature change of the ambient space about the battery. The corrected temperature, consequently, represents a temperature of the battery which is the result of the charging process. An apparatus for determining the onset of an overcharge phase of a battery charging cycle includes a control temperature sensor, a battery temperature sensor and a provision for determining when the battery temperature deviates from an anticipated temperature in response to a temperature change of the environment of the battery.

**5549443**

**BATTERY CHARGING AND TRANSFER SYSTEM**

Hammerslag Julius San Juan Capistrano, CA, UNITED STATES

A battery transfer and charging system for electric vehicles. A displacement station removes spent batteries of electric vehicles by forcing charged batteries into



position within the vehicles so as to laterally displace spent batteries. Spent batteries displaced from vehicles are received by a receiving station of the system. The receiving system includes an engagement device for engaging with engagement structures of the batteries, in order to assist the removal of spent batteries. Spent batteries removed from vehicles are tested and charged as they progress through the system in an assembly-line fashion. Following recharge, batteries are conveyed to the displacement station for installation within later vehicles. Batteries which cannot adequately be recharged are automatically removed from the system. In one embodiment of the system, vehicles drive through the system in sequential order, stopping at a specified location for battery installation/removal.

**5549717**

#### **METHOD OF MAKING PRISMATIC CELL**

Takeuchi Esther; Mead Ralph T Williamsville, NY, UNITED STATES assigned to Wilson Greatbatch Ltd

A solid cathode liquid organic electrolyte alkali metal high rate cell wherein a combination of an elongated alkali metal anode and elongated solid cathode with separator therebetween is wound to form an anode-cathode subassembly having a jellyroll type configuration and wherein the combination is shaped so that the resulting sub-assembly has a substantially rectangular cross-section, the shaping of the combination being done either simultaneously with or subsequent to the winding thereof. The anode-cathode sub-assembly is placed in a conductive cell casing of prismatic shape having opposed flat faces, a lead of either the anode or cathode is attached to the cell casing depending upon whether case positive or case negative electrical configuration is desired and a lead of the other of the anode or cathode is connected to an electrical connector means extending through the casing in an insulated manner. Liquid electrolyte is introduced to the anode-cathode sub-assembly in the casing whereupon the casing then is sealed closed. The foregoing provides a new and improved prismatic high rate battery which significantly reduces the time required to manufacture the cell stack assembly while maintaining the requisite performance, safety and reliability.

**5550452**

#### **INDUCTION CHARGING APPARATUS**

Shirai Ichiro; Yamagami Hitoshi; Hiroshige Eiichi; Kubo Koichi Kyoto, JAPAN assigned to Nintendo Co Ltd; Kyushu Hitachi Maxell Ltd

The induction charging apparatus has a power source unit and a device unit which can be detachably coupled to the power source unit. The power source unit has a first casing having one end opened, a primary coil provided in the first casing, an oscillator for supplying an alternating current to the primary coil to generate magnetic fluxes, and a depressible member movably provided and closing the open end of the first casing. The depressible member is movable between a lift position at which the magnetic fluxes are substantially located under the depressible member, and a depressed position at which portions of the magnetic fluxes are substantially located over the depressible member. The device unit has a second casing having one end detachable to the open end of the first casing, a secondary coil provided in the second casing and adjacent to the one end, and rechargeable battery provided in said second casing for receiving power from the secondary coil. When the second casing is attached to the first casing, the depressible member is moved to the depressed position to electromagnetically couple the primary and secondary coils.

**5550453**

#### **BATTERY CHARGING METHOD AND APPARATUS**

Bohne William C; Bergquist Eric Elgin, IL, UNITED STATES assigned to Motorola Inc

In a method and apparatus for battery charging, a battery charger charges a battery, preferably in a battery pack, by providing an initial battery charging current (I1) and terminating the initial charging current at a time t2 in response to a measured battery condition (for example, battery temperature rate of change;  $\Delta T/\Delta t$ ) exceeding a limit. A battery parameter, preferably battery voltage, is measured at the time t2 and stored as a limit (Vpeak). After t2, battery charging current is provided in accordance with a predetermined criteria and battery charging current is altered (to I3; or to I1) in

response to comparing a measured battery parameter, preferably battery voltage, after  $t_2$  to a threshold ( $V_{\text{peak}}$ ; or  $V_{\text{peak}} - \Delta V$ ) based on the stored limit ( $V_{\text{peak}}$ ). Preferably, rapid battery charging is implemented in response to a comparison of a measured battery parameter, preferably battery voltage, after the time  $t_2$  with respect to a threshold ( $V_{\text{peak}} - \Delta V$ ) determined in accordance with the stored limit ( $V_{\text{peak}}$ ).

**5550454**

### **CHARGING REGIME FOR SECONDARY LITHIUM BATTERIES**

Buckley James Cupertino, CA, UNITED STATES

A method for extending the cycle life of a solid, secondary lithium electrochemical cell is disclosed. The method increases the ability of an electrochemical cell to retain at least one-half of its initial charge capacity over many charge-discharge cycles. This objective is achieved by the use of certain non-uniform charging currents. In one aspect, the method relates to rapidly charging a discharged solid lithium secondary cell or battery, that has an active surface area  $S$  and that had an initial charge capacity  $Q_0$  and cycle life  $\eta_0$  prior to being discharged wherein  $Q_0$  was established by applying a constant current  $I_0$  over a length of time  $T_0$  such that  $Q_0 = SI_0T_0$ , which comprises the step of applying several charging currents,  $I_k$ , to the cell or battery wherein each  $I_k$  is applied for a time period,  $T_k < T_0$ , such that (\*See Patent for Mathematical Equation\*) where  $k$  is an integer from 1 to  $m$  representing the time serial order of charging steps in one charging one-half cycle, and  $m$  is an integer greater than one representing the charging steps in one charging one-half cycle.

**5550474**

### **BATTERY ELECTROLYTE-LEVEL AND ELECTROLYTE-STRATIFICATION SENSING SYSTEM**

Dahl Ernest A Ventura, CA, UNITED STATES

The device uses a sensor probe in which a plurality of electrolyte level sensor coils and/or specific gravity stratification indicators are stacked vertically in the walls of a hollow electrically insulating and chemically nonreactive elongated probe housing such that the sensor coils never come into contact with the electrolyte. Balanced transformers or series resonant coils are used to sense changes in electrolyte level and/or changes in specific gravity at various respective levels to indicate stratification of electrolyte. The fields of the sensors are changed by the amount of electrolyte in the area of the sensor coils. These changes operate to produce signals that are read as digital or analog outputs.

**5550475**

### **PROGRAMMABLE BATTERY CHARGE INDICATOR**

Shafer Timothy Yankton, SD, UNITED STATES

A programmable battery charge indicator including a pair of electrically-conductive terminals coupleable to a test battery; a user-actuated and timer-controlled power delivery mechanism coupled with the terminals for allowing transmission of electrical power from a test battery for a given period of time; a reference voltage generating mechanism coupled to the power delivery mechanism for generating a standard battery reference voltage and a user-programmed battery reference voltage; a comparator mechanism coupled to the reference voltage generating mechanism and power delivery mechanism for generating an overcharged designator signal representing an overcharged battery condition and for generating an undercharged designator signal representing an undercharged battery condition; and a display mechanism operatively coupled to the comparator mechanism and power delivery mechanism for indicating the charge condition on a test battery and displaying the optimum level of discharge state at which the test battery should be recharged to maximize battery life.

**5554455****RESEALABLE SAFETY VENT AND A SEALED ALKALINE RECHARGEABLE BATTERY PROVIDED WITH THE SAFETY VENT**

Inoue Hiroshi; Hamada Shinji; Matsuda Hiromu; Ikoma Munehisa; Yamasaki Hirosh Neyagawa, JAPAN assigned to Matsushita Electric Industrial Co Ltd

A safety vent body having a passage at the center of the bottom surrounded by a circular protrusion, a safety vent cover having a vent hole bonded to the safety vent body, and an elastic valve component consisting of valve seat and rubber pad bonded together into a one-piece structure and a coil spring, housed in a space provided by the safety vent body and the safety vent cover. A plastic container sealed alkaline rechargeable battery realizes a longer cycle life and high reliability by incorporating a resealable safety vent in accordance with the present invention.

**5554460****MULTI-LAYERED COATED MEMBRANE ELECTRODES FOR ELECTROCHEMICAL CELLS AND CELLS USING SAME**

Wu Han; Nerz John Barrington, IL, UNITED STATES assigned to Motorola Inc

An electrochemical cell includes an electrode having a microporous polymeric substrate upon which is deposited the first and second layers of an electrochemically material. Disposed between said first and second layers of electrochemically active materials is a current collecting layer adapted to electrically couple the electrode with a battery cell can. Two or more of such electrodes may be stacked one atop the other in order to affect a positive and negative electrode as used in conventional cylindrical cells.

**5554463****CURRENT COLLECTOR HAVING COINED SIDE EDGES FOR USE IN AN ELECTROCHEMICAL CELL, AND METHOD OF ITS PRODUCTION**

Marincic Nikola; Rabadjija Luka Winchester, MA, UNITED STATES assigned to Pacesetter Inc

An expanded screen current collector is provided with side edges coined inwardly to prevent sharp tines formed along the side edges from damaging adjacent components within the electrochemical cell. The expanded screen current collector is formed by cutting a thin flat sheet of current collector material, such as titanium or stainless steel, to have a height somewhat greater than a height required for use within the electrochemical cell. The current collector material is cut and expanded, then the side edges are coined inwardly by an amount sufficient to reduce the height of the resulting expanded screen current collector to a height appropriate for use within the electrochemical cell. An active cathode material, such as polycarbonmonoflouride, is coated onto side surfaces of the expanded screen current collector. An electrode structure employing the expanded screen current collector having the coined edges is also described. The improved expanded screen current collector is employed within an electrochemical cell adapted for use within an implantable device.

**5554464****HONEYCOMB BATTERY SEPARATOR**

Stempin John L; Stewart Ronald L; Wexell Dale R Beaver Dams, NY, UNITED STATES assigned to Corning Incorporated

An elongated, rigid, porous, ceramic separator for a rechargeable battery assembly, the separator having a honeycomb structure in which open cells are separated from adjacent cells by thin, porous, ceramic walls, the open cells and separating walls running lengthwise of the honeycomb, the cell walls being porous and the open cells and wall pores being adapted to be filled with an electrolyte to permit ion flow between electrodes in a battery.

## **OTHER BATTERIES**

**5536592**

### **GALVANIC BATTERY WITH REPLENISHABLE ELECTRODES AND/OR ELECTROLYTE FOR EXTENDED BATTERY OPERATION**

Celeste Salvatore; Cucinotta Anthony; Rossi Guy A Peabody, MA, UNITED STATES assigned to Biocybernetics Laboratories Inc

The galvanic battery of the present invention supplies the anode and/or cathode from an elongated strip of flexible tape preferably interconnected through a strip of inactive material functioning as a leader for said tape and for separating the tape entering the electrochemically active compartment of the battery housing from spent tape exiting the electrochemically active compartment. The battery is preferably constructed to include a supply reel having a rotatable core upon which said strip of tape is wound in a cylindrical configuration with the inner winding of tape extending from said core and being threaded through said electrochemically active compartment before being connected back into the electrochemically inactive compartment and wound as the outer winding around the core of the supply reel.

**5536593**

### **ELECTROCHEMICAL CELL**

Redey Laszlo I; Vissers Donald R; Prakash Jai Downers Grove, IL. UNITED STATES

PCT No. PCT/US92/08599 Sec. 371 Date Dec. 5, 1994 Sec. 102(e) Date Dec. 5, 1994 PCT Filed Oct. 8, 1992 PCT Pub. No. WO93/07650 PCT Pub. Date Apr. 15, 1993. An electrochemical cell having a bimodal positive electrode, a negative electrode of an alkali metal, and a compatible electrolyte including an alkali metal salt molten at the cell operating temperature. The positive electrode has an electrochemically active layer of at least one transition metal chloride at least partially present as a charging product, and additives of bromide

and/or iodide and sulfur in the positive electrode or the electrolyte. Electrode volumetric capacity is in excess of 400 Ah/cm<sup>3</sup>; the cell can be 90% recharged in three hours and can operate at temperatures below 160°C There is also disclosed a method of reducing the operating temperature and improving the overall volumetric capacity of an electrochemical cell and for producing a positive electrode having a BET area greater than 6\*10<sup>4</sup> cm<sup>2</sup>/g of Ni.

**5536594**

### **ELECTROCHEMICAL CELL**

Galloway Roy; Wright Michael L Park Nook, UNITED KINGDOM assigned to Programme 3 Patent Holdings

A method of making a cathode for a high temperature rechargeable electrochemical cell comprises impregnating a mixture, in granular form, of an alkali metal halide and a substance comprising a transition metal selected from the group consisting of iron, nickel, cobalt, chromium, manganese, and mixtures thereof, with an alkali metal aluminium halide molten salt electrolyte. The impregnated mixture is subjected to at least one charge cycle in a high temperature electrochemical cell in which the impregnated mixture forms the cathode and is located in a cathode compartment of the cell. The cathode compartment is separated from an anode compartment by a solid electrolyte separator. Alkali metal forms in the anode compartment during the charge cycle.

**5538808**

### **SODIUM SULFUR CELL AND PROCESS OF MANUFACTURING THE SAME**

Ohshima Masaaki; Kobayashi Akira; Yoshida Akihiko Tokyo, JAPAN assigned to The Tokyo Electric Power Co Inc; NGK Insulators Ltd

A sodium sulfur cell comprising an anode active material of metallic sodium, and a cathode active material of sulfur or sodium polysulfide, and a beta alumina solid electrolyte separator, the above active materials containing, as an impurity, calcium of at most 20 ppm and/or potassium of at most 200 ppm, by weight. The cell of the invention has excellent

characteristics, particularly prolonged electromotive life.

**5538813**

**ELECTROCHEMICAL STORAGE DEVICE  
HAVING ASYMMETRIC ELECTRODES**

Li Changming Vernon Hills, IL, UNITED STATES  
assigned to Motorola Inc

An electrochemical storage device is fabricated from two opposing asymmetric electrode assemblies and a solid polymer electrolyte. A first electrode is fabricated from a conducting polymer such as polyaniline, polypyrrole, or polythiothene. The second electrode is fabricated from a metal, metal hydroxides, metal oxides and combinations thereof. The solid polymer electrolyte is in intimate contact with and situated between the first and second electrodes. The solid polymer electrolyte may be made from a polymeric binder or support structure such as polyethylene oxide, polyvinyl alcohol, or other polymeric materials. Dispersed in the polymeric support structure may be either an acidic or basic material, such as KOH or H<sub>3</sub>PO<sub>4</sub>.

**5541016**

**ELECTRICAL APPLIANCE WITH  
AUTOMATIC VALVE ESPECIALLY FOR  
FLUID DEPOLARIZED  
ELECTROCHEMICAL BATTERY**

Schumm Brooke Bay Village, OH, UNITED STATES

The placement in an electrical appliance of one or more tiny electrically activated thermally responsive semiconductor microactuators (a valve-on-a-chip) disposed over the fluid entrance inlet(s) to regulate fluid flow to a gas depolarized electrochemical battery creates an efficient gas depolarized electrochemical power supply and appliance which permits the entrance of oxygen from air to the battery only when the battery is supplying electrical power to a load. Power for the valve is preferably derived from the battery itself but could be provided by a separate source within or without the battery. This tiny valve acts as a safety pressure vent and can act as a safety fuse as well. When electrical power is not required from the battery, the valve excludes entry of

harmful impurities and unneeded fluid reactants thereby increasing the life of the battery during storage or when the electrical appliance the battery is powering is idle. A resistance means in parallel to the actuator valve is useful to enhance the operation of the power supply. If the battery leaks, the corrosive fluid causes the valve and/or battery to cease to operate. The potential combination with a recharging apparatus is also useful. The appliance may be designed to regulate the flow of reactant.

**5541017**

**METHOD FOR MAKING HIGH CAPACITY  
RECHARGEABLE HYDRIDE BATTERIES**

Hong Kuochih; Hong Kuoshui; Hong Huiyim; Hong Kuoping Troy, MI, UNITED STATES

A method to make new improved high capacity rechargeable hydride batteries comprising steps of (1) preparing an improved hydrogen storage material represented by the composition formula: AaBbNicDyMxRz, where A is one or more element chosen from the group of Ti, Zr, Mg; B is one or more elements chosen from the group of Al, V, Mn, Nb, Si, Pd, and Ag; D is one or more elements chosen from the group of Cr, Mn, Fe, Co, Cu, Zn, Mo, W and Sn; R is one or more elements chosen from the group of C, B, Ca, Sb, Bi, Y, Hf, Ta, N, O, Ge, Ga and Mm, where Mm is mischmetal; M is one or more elements chosen from the group of Li, Na, K, Rb, Cs, P and S; and where a, b, c, y, x and z are defined by:  $0.10 < a < 0.85$ ,  $0.01 < b < 0.65$ ,  $0.02 < c < 0.75$ ,  $0 < y < 0.30$ ,  $0 < x < 0.30$ ,  $0 < z < 0.30$  and  $a+b+c+y+x+z=1.00$ ; (2) preparing a high capacity (1.15-2.4 AH/cc) hydrogen storage hydride electrode comprising the alloy material aforementioned; (3) preparing a high capacity (0.45-0.75 AH/cc) metal oxide positive electrode; (4) assembling a rechargeable hydride battery.

**5541019****METAL HYDRIDE ELECTROCHEMICAL CELL HAVING A POLYMER ELECTROLYTE**

Anani Anaba A; Reichert Veronica R; Massaroni Kenneth M Lawrenceville, GA, UNITED STATES assigned to Motorola Inc

An improved metal hydride hydrogen storage alloy electrochemical cell includes a positive electrode and a negative electrode having disposed therebetween, a polymer electrolyte. The polymer electrolyte comprises a polymer support structure fabricated of, for example, polyvinyl alcohol or polyvinyl acetate, and having dispersed therein an electrolyte active species such as, for example, KOH. The improved electrolyte for a metal hydride hydrogen storage alloy cell provides a battery cell free from electrolyte leakage, and having ionic conductivities which allow for an efficient use of the metal hydride electrodes.

**5541020****COMPOSITIONS AND METHODS FOR IMPROVING THE CUMULATIVE CAPACITY OF SOLID, SECONDARY ELECTROLYTIC CELLS**

Golovin Milton N; Moulton Russell; Shackle Dale R; Pradhan Bhuwon San Jose, CA, UNITED STATES

PCT No. PCT/US93/06894 Sec. 371 Date Feb. 4, 1994 Sec. 102(e) Date Feb. 4, 1994 PCT Filed Jul. 22, 1993 PCT Pub. No. WO94/02662 PCT Pub. Date Feb. 3, 1994. This invention is directed to solid electrolytes containing a solvent and, in particular, a solvent comprising a mixture of an organic carbonate and triglyme as well as electrolytic cells prepared from such solid electrolytes. The electrolyte also contains an inorganic ion salt, preferably an alkali metal salt, and most preferably LiPF<sub>6</sub>.

**5541021****ALKALINE CELL**

Watanabe Mitsutoshi; Ishiuchi Hiroshi Ibaraki, JAPAN assigned to Hitachi Maxell Ltd

There is provided an alkaline cell without mercury comprising zinc as a negative electrode active material and an electrolytic solution characterized in that a bismuth compound is added to the electrolytic solution.

**5541022****COMPOSITE ANODE FOR NONAQUEOUS SECONDARY BATTERY AND METHOD FOR PRODUCING THE SAME**

Mizumoto Mamoru; Honbo Hidetoshi; Horiba Tatsuo Katsuta, JAPAN assigned to Hitachi Ltd

A composite anode includes particles of an alkali metal alloy, a carbonaceous material powder and a binder and used for nonaqueous secondary batteries in which an alkali metal is used as an anode active material and a solution of an electrolyte in an organic solvent is used as an electrolyte solution, wherein the carbonaceous material powder contains oxygen atoms and the oxygen content is in the range of 1 to 5% by weight. A method for producing this composite anode includes the steps of mixing a solution of a binder comprising a copolymer of monomers mainly composed of olefins in an aromatic solvent with the alkali metal alloy particles and the carbonaceous material powder, coating the mixture on an electrode substrate and molding the coated substrate.

**5543244****ELECTROCHEMICAL STORAGE DEVICE**

Klink Rainer; German Johan Kernen im Remstal, GERMANY assigned to Deutsche Automobilgesellschaft mbH

An electrochemical storage device having a metallic, gas-tight storage device housing in which an electrode stack formed from a plurality of electrode plates stacked on one another is accommodated. Arranged between the storage device housing and the electrode stack is a box-like stack insulation which is made from an electrically insulating material and which surrounds the electrode stack on the sides which come to bear directly against the housing interior. For the purpose of reliable flow of the quantity of gas occurring during operation,

there are arranged on those circumferential sides of the stack insulation towards which the narrow sides of the electrode plates point material protuberances which cross over the narrow sides of the electrode plates and which are spaced apart from one another in order to form gas conduits.

**5545492**

**ELECTROCHEMICAL APPARATUS FOR  
POWER DELIVERY UTILIZING AN AIR  
ELECTRODE**

Zito Ralph Chapel Hill, NC, UNITED STATES  
assigned to National Power PLC

An electrochemical apparatus for power delivery employs an array of electrochemical cells which comprises an end +ve electrode and an end -ve electrode separated by one or more bipolar mid-electrodes each with a +ve side and a -ve side, the +ve side of each bipolar electrode comprising an electrically conductive substrate with a porous conductive surface. A bubbly dispersion of air/oxygen in an electrolyte is contacted with the +ve sides of the bipolar electrodes. The electrochemical apparatus of the invention may be used with an oxygen-sulfur couple with these reagents being provided for example as sodium salts in aqueous solutions, the overall reaction being: (\*See Patent for Tabular Presentation\*) PS The process is preferably carried out in an array of cells, comprising a plurality of bipolar electrodes, each having a +ve side 12A and a -ve side 14A spaced from one another by membranes which divide the cell into +ve and -ve chambers for posilyte and anolyte solutions which are circulated through the chambers.

**5547779**

**SEPARATOR FOR ALKALI-ZINC  
BATTERY**

Kishimoto Tomonori; Yamane Mitsuo; Bogauchi Takehito; Eguchi Yoshihiro Takatsuki, JAPAN  
assigned to Yuasa Corporation

A separator for alkali-zinc battery comprising a microporous membrane having alkali resistance, a part

of the porous membrane having highly persistent hydrophilic property and the remaining part having water repellent property. In the part having hydrophilic property, precipitation of ZnO can be controlled sufficiently because of its large persistency of hydrophilic property so that dendrite short-circuiting in the battery can be prevented satisfactorily. In the part having water repellent property, O<sub>2</sub> gas is permeable well through it so that a decrease in capacity of battery can be avoided.

**5547780**

**BATTERY PRECURSOR AND A BATTERY**

Kagawa Hiroshi; Kato Shiro; Murata Kazuo Takatsuki, JAPAN assigned to Yuasa Corporation

This invention provides a battery precursor for producing a battery through a cutting process, in which a large number of battery elements comprising positive active material layers, separators having electrolytes and negative active material layers are installed in parallel between a plate-like positive current collector plate and a negative current collector plate facing each other, and the respective battery elements are partitioned each other and sealed by insulators. According to this battery precursor, a battery having a voluntary shape can be obtained easily by cutting only.

**5547781**

**BUTTON-TYPE BATTERY WITH  
IMPROVED SEPARATOR AND GASKET  
CONSTRUCTION**

Blonsky Peter M; Tuttle Mark Boise, ID, UNITED STATES assigned to Micron Communications Inc

A button-type battery has an anode, a cathode, and an electrolyte encased with two terminal housing members. The terminal housing members have respective peripheries that are crimped together to form a fluid-tight seal. An insulating gasket is provided between the peripheries to electrically insulate the two terminal housing members. A porous separator physically separates the anode and cathode and extends

between the terminal housing member peripheries at least partially into the fluid-tight seal. According to one aspect, the separator overlaps the gasket in the seal. According to another aspect, the separator and gasket are formed of a single, integral piece of material.

**5547784**

**ALKALINE STORAGE BATTERY AND METHOD FOR PRODUCING THE SAME**

Okawa Takashi; Enokido Masashi; Tsuda Shingo; Akutsu Norikatsu Fujisawa, JAPAN assigned to Matsushita Electric Industrial Co Ltd

An alkaline storage battery made using a hydrogen-storing alloy for the negative electrode has suffered from the problems that the negative electrode is oxidized with oxygen gas generated from the positive electrode during overdischarge to cause increase of internal resistance and deterioration of charging and discharging cycle characteristics. Disclosed is a solution to the above problems which incorporates into the hydrogen-storing alloy negative electrode one of yttrium and yttrium compounds or a mixture thereof in such a state that it covers the surface of the hydrogen-storing alloy powder.

**5549981**

**ELECTROCHEMICAL STORAGE DEVICE**

Maly-Schreiber Martha; Huggins Robert A Ulm, GERMANY assigned to Daimler-Benz AG

The invention relates to an electrochemical storage device having a plurality of serially connected individual cells, each of the individual cells having two spatially separated electrodes, between which an electrolyte and an intermediate part ensuring the spacing of the electrodes is arranged. In the interior of the storage device, each individual cell has a protective element which is formed from a solid material having a nonlinear current/voltage characteristic curve, and which makes electrical contact with the positive and the negative electrode within the individual cell and provides a voltage-dependent electrical connection between said electrodes. The electrical resistance of the protective

element above a critical voltage is smaller, and below the critical voltage larger, than the resistance present between the electrodes at the respective voltages without the protective element. To protect the individual cells against overcharging, the critical voltage is smaller than the decomposition voltage of the associated individual cell.

**5549991**

**ALUMINUM PERMANGANATE BATTERY**

Licht Stuart; Marsh Catherine L Charlton City, MA, UNITED STATES assigned to The United States of America as represented by the Secretary of the Navy

A battery is provided comprising an aluminum anode, an aqueous solution of permanganate as the cathodic species and a second electrode capable of reducing permanganate. Such a battery system is characterized by its high energy density and low polarization losses when operating at high temperatures in a strong caustic electrolyte, i.e., high concentration of hydroxyl ions. A variety of anode and electrocatalyst materials are suitable for the efficient oxidation-reduction process and are elucidated.

**5552244**

**REVERSIBLE HIGH ENERGY CAPACITY METAL-SULFUR BATTERY AND METHOD OF MAKING SAME**

Griffin Eric B; Edling Jack V San Diego, CA, UNITED STATES assigned to Griffen Eric Blair

A reversible high energy capacity battery and method of making that battery. A cathode is formed by packing a mixture of from about 10 to 90 weight percent finely divided sulfur and from about 90 to 10 weight percent finely divided graphite about an electrically conductive electrode, preferably in a porous enclosure. This cathode and a reactive metal anode are placed in a case of suitable configuration which is non-reactive with other components. An electrolyte is prepared by mixing particles of an ion exchange resin system including a polyalkyl sulfide, a resin substrate and agent selected from the group consisting of H<sub>2</sub>S, HS<sup>-</sup>, S<sub>2</sub><sup>-</sup> and mixtures thereof in a polar solvent, such as water. Buffering agents, conditioners and complexing agents may be added to the electrolyte to improve battery life and performance.





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