

source. A rectifier circuit is connected between the transformer and the output circuit, the rectifier circuit including a two diode rectifying circuit for producing a full wave voltage output positive pulse having an RF content.

**5633576**

**BATTERY CHARGING METHOD WITH  
STEPPED CURRENT PROFILE WITH  
OPERATING PARAMETER  
COMPENSATION AND ASSOCIATED  
CHARGER**

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Engineered Products Inc

A method and apparatus is provided to charge a battery including a DC charge current supply having a variable output. The charging current is varied in accordance with several sensed parameters in the circuit so that battery voltage is accurately controlled. Initially, constant charging current is applied, and upon detecting that battery voltage increases to the gassing voltage, an incremental step reduction in charging current is triggered. The step reduction causes a decrease in battery voltage, dropping it below the gassing voltage. The step reduced charging current is then applied to increase battery voltage back up to the gassing voltage, thereby triggering another step reduction in charging current. This process is repeated multiple times providing a stepped current profile, i.e., each battery voltage increase to the gassing voltage triggering a step reduction in charging current, and in turn a corresponding voltage reduction. The battery voltage, with the alternating increases and decreases, is thus defined by a saw-tooth profile with peaks at the gassing voltage. When the charging current is finally reduced to a minimum level, the sensed battery voltage triggers a termination of the stepped current reduction. Upon the battery reaching full charge, the application of charging current is terminated. In the alternative embodiment, the slope of the voltage curve is detected and analyzed to control a step up profile of the current during the initial phase of charging. The rising temperature of the battery controls a decrease in the gassing or target voltage.

**5635813**

**ELECTRONIC APPARATUS, BATTERY  
MANAGEMENT SYSTEM, AND BATTERY  
MANAGEMENT METHOD**

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JAPAN assigned to Mitsubishi Denki Kabushiki Kaisha

Methods and apparatus to enable electronic apparatuses to display the remaining power of exchangeable batteries at any given time. A battery pack having a battery and an ID generator is attached to an electronic apparatus. The accumulated consumption hours of the battery is stored in a battery information memory for each battery ID. A remaining power detector determines the remaining battery power on the basis of the accumulated consumption hours and displays it on a display unit. Because the remaining battery power is determined based on the consumption hours of a battery, the running hours of a battery can be displayed at any given time.

**5635816**

**METHOD AND APPARATUS FOR  
CONTROLLING BATTERY CHARGING  
CURRENT**

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An automatic photovoltaic controller provides a fixed frequency, pulse width modulated charging current to charge and regulate a battery, the duty cycle of the charging current being controlled by the difference between the sensed battery voltage and a desired regulated voltage. Modulation is achieved by controlling the on and off states of plural parallel-connected FET switches placed in series between the photovoltaic array and the battery. The duty cycle is adjustable in discrete steps over the entire range of 0% to 100% and is updated numerous times per second with new battery voltage measurements to provide highly accurate regulation. The charge current pulse rise time is selected to match the response time of the photovoltaic array. The fixed frequency of the charge current is within the preferred range of 100 Hz to 600 Hz to provide sufficient time for the chemical reaction within the battery cells to be

substantially completed between charge pulses during the regulation mode. Automatic protection of the controller and the load is achieved by rapidly disconnecting the battery and/or load in response to specified conditions. The photovoltaic array is disconnected from the battery at night to prevent battery discharge into the array. Equalization of the battery is performed automatically, at a voltage level slightly higher than the regulated voltage, after a predetermined number of days or if the battery voltage falls below a predetermined level.

**5635817**

### **VEHICLE BATTERY CHARGING SYSTEM**

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An emergency vehicle battery charging device is utilized to charge a depleted battery of a first vehicle from the engine system of a running second vehicle at a predetermined maximum charging current above that used for a trickle charge and below the typical starting current of either vehicle. The battery charging device includes a control housing having a first pair of cables extending therefrom which is rigidly connected to the battery terminals of one of the vehicles and a second pair of cables extending therefrom for being selectively connected to the battery terminals of the other of the vehicles. The cables include a current limiting device to prevent any exceeding of the predetermined maximum charging current which is preferably with in a range of about 40 to 60 amps. The control housing includes a polarity detecting device to verify the correct polarity of the connection of the terminals of the two batteries and to electrically disconnect the two batteries of there was an incorrect polarity. When using the emergency vehicle battery charging device, the dead battery of a first vehicle, which is not started or running, should be charged through the engine system of the second vehicle, which is running, in about three to five minutes.

**5635819**

### **METHOD OF CHARGING A BATTERY**

Ryberg Bertil Torslanda, SWEDEN assigned to AB Volvo Penta

PCT No. PCT/SE93/00411 Sec. 371 Date Dec. 14, 1994 Sec. 102(e) Date Dec. 14, 1994 PCT Filed May 11, 1993 PCT Pub. No. WO93/23906 PCT Pub. Date Nov. 25, 1993. A method and a device for charging a rechargeable battery by means of a generator which delivers regulating voltage from a voltage regulator receiving a value indicative of the battery voltage in order to regulate the generator in response to the voltage in relation to predetermined nominal charging voltage. A voltage drop may be introduced between the battery and the regulator in dependence of the operational condition of the battery, the voltage drop reducing the battery the voltage value received by the regulator. In accordance with the invention, the voltage drop is introduced between the positive terminal of the battery and the regulator by connection of a diode which is forward biased. The voltage drop is introduced in dependence of the battery voltage.

**5635820**

### **BATTERY CHARGING CONTROL DEVICE AND METHOD FOR ACCURATELY DETECTING A CHARGING END STATE**

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The present invention discloses a controlling device and a method for charging a battery for an electric vehicle which improves the battery consumption ratio and its stability. The charge controlling device includes a battery temperature sensing member, a battery voltage sensing member, a current sensing member, a charging mode switch, a charge control device. When the predetermined charging mode is a constant current/constant voltage method, if the battery temperature is above the maximum predetermined temperature, a charging end signal is produced. If the battery temperature is below the minimum predetermined temperature, the full-charging state is determined in accordance with the measured current value and the charging end signal is produced. On the other hand, when the predetermined charging mode is a constant current charging mode, if the battery temperature is below the minimum predetermined temperature, the battery voltage drop state is determined. If the battery voltage drop occurs below the predetermined voltage, the charging end signal is