Electric Car Drive System Provided with Hybrid Battery and Control Method

Inventor: Naito, Shotaro, Hitachinaki, JP
Assignee: Hitachi, Ltd. (03), Tokyo, JP
Hitachi Ltd JP (Code: 39224)
Examiner: Sircus, Brian (Art Unit: 217)
Law Firm: Antonelli, Terry, Stout & Kraus, LLP

Abstract:
In an electric car drive system having a car drive motor powered by a
mounted direct current power supply, a control system including a signal generating means is provided to generate signals which control motor speed. The direct current power supply is composed of a power battery having secondary cells connected to the motor and an energy battery formed by fuel cells connected in parallel to said power battery via an energy battery control switch. The electric car drive system is composed of a charge control means which charges the power battery using the energy battery if the charge of the power battery is below the specified value when said key switch is turned off, and suspends charging if the charge is equal to or greater than the specified value. A battery current and voltage control controls a voltage increasing circuit connected between the energy battery and the power battery based on the current or voltage of any one of the power battery, energy battery or motor and keeps the voltage of the direct current power supply within a specified range.

What is claimed is:

1. In an electric car drive system having a car drive motor powered by a mounted direct current power supply, and a control system including a signal generating means to generate signals which control said motor speed;
   wherein said direct current power supply comprises:
   a power battery having secondary cells connected to said motor;
   a voltage increasing circuit; and
   an energy battery comprising fuel cells connected in parallel to said power battery via said voltage increasing circuit;
   the electric car drive system further comprising:
   battery current and voltage control means which controls said voltage increasing circuit based on the current or voltage of any one of said power battery, said energy battery and said motor, and which keeps the voltage of said direct current power supply within a specified range, including charge control means which charges said power battery using said energy battery when the charge of said power battery is below a specified value, and suspends charging of said power battery when said charge is equal to or greater than the specified value (Main Claim)

2. In an electric car drive system having a car drive motor powered by a mounted direct current power supply, an inverter to convert the direct current power supply into an alternating power supply of variable voltage and frequency, a car driving three-phase alternating current motor, a signal generating means to generate signals for controlling said inverter, and a key switch;
   wherein said direct current power supply comprises:
   a power battery having secondary cells connected to said three-phase alternating current motor;
   a voltage increasing circuit; and
   an energy battery which comprises fuel cells generating substantially constant outputs at substantially all times and which is connected via the voltage increasing circuit to said power battery,
   the electric car drive system further comprising:
   battery current and voltage control means which controls said voltage increasing circuit based on the current or voltage of any one of said power battery, said three-phase alternating current motor and said inverter, and which keeps the voltage of said direct current power supply within a specified range, including charge control means which charges said power battery using said energy battery when the charge
of said power battery is below a specified value when said key switch is turned off, and suspends charging of said power battery when said charge is equal to or greater than the specified value.

3. An electric car drive control system provided with hybrid battery according to claim 1 or 2 characterized in that said voltage increasing circuit comprises a switching transistor to short-circuit said energy battery, a reactor and a reverse flow preventive diode.

4. An electric car drive control system provided with hybrid battery according to claim 1 or 2 characterized in that said battery current and voltage control means operates to turn off the operation of said voltage increasing circuit and to suspend charging of said power battery through said energy battery when the electric car is in a regenerative mode of recovering braking energy.

5. An electric car drive control system provided with hybrid battery according to claims 1 or 2, characterized in that said electric car has auxiliary equipment including an air conditioner motor, a power steering motor and a vacuum motor, and said auxiliary equipment is driven by said energy battery as a power source.

6. An electric car drive system comprising:
   an inverter to convert a direct current power supply from a mounted main power supply into an alternating power supply of variable voltage and frequency;
   a car driving three-phase alternating current motor;
   a current sensor and a speed sensor to sense current and speed, respectively, of said three-phase alternating current motor;
   alternating current command generating means to generate a three-phase alternating current command, based on a value of accelerator opening and an output from said speed sensor;
   a PWM signal generating means to generate a signal to control said inverter based on said three-phase alternating current command and current flowing to said three-phase alternating current motor; and
   a key switch;
wherein said main power supply comprises:
   a main contactor;
   a power battery having secondary cells connected to said three-phase alternating current motor via said main contactor and said inverter;
   a voltage increasing circuit; and
   an energy battery which comprises fuel cells and which is connected to said power battery via said voltage increasing circuit;
the electric car drive system further comprising:
   a current sensor to detect the current of said power battery and said energy battery; and
   battery current and voltage control means which controls said voltage increasing circuit, based on the current or voltage of any one of said power battery, said three-phase alternating current motor and said inverter and which keeps the voltage of said direct current power supply within a specified range, including charge control means which charges said power battery using said energy battery when the charge of said power battery is below a specified value and when said key switch is turned off, and which suspends charging of said power battery when said charge is equal to or greater than the specified value.

7. A drive control method for an electric car drive control system, wherein said electric car has a car drive motor powered by a mounted direct current power supply, a signal generating means to generate signals for the control of motor speed; wherein said direct current power supply is composed of:
a power battery having secondary cells connected to said motor; a voltage increasing circuit; an energy battery which comprises fuel cells generating constant outputs at all times and which is connected to said power battery via said voltage increasing circuit; and a key switch to control turning on or off of the power and energy batteries;

the drive control method for the electric car drive control system comprising the steps of:

controlling said voltage increasing circuit, based on the current or voltage of any one of said power battery, said energy battery and said motor, to charge the power battery using said energy battery while keeping the voltage of said direct current power supply within a specified range by: i) charging said power battery using said energy battery when the charge of said power battery is below a specified value while said key switch is turned off; and ii) suspending charging of said power battery when said charge is equal to or greater than the specified value.

8. A drive control method for an electric car drive control system according to claim 7, characterized in that said electric car has auxiliary equipment including a pump to supply fuels and discharge reaction products, an air condition motor, a power steering motor and a vacuum motor, and further comprising the steps of driving said auxiliary equipment by said energy battery as a power source.

9. A drive control method for an electric car drive control system provided with hybrid battery according to claim 7 or 8, further comprising the steps of: turning off the operation of said voltage increasing circuit to suspend charging of said power battery through said energy battery when the electric car is in a regenerative mode of recovering braking energy.

10. A drive control method for an electric car drive control system according to claim 7 characterized in that said electric car has an auxiliary battery to supply power to a pump to supply fuels to said energy battery and discharge reaction products therefore, further comprising the steps of charging said auxiliary battery via a DC/DC converter from said energy battery.

11. An electric car drive control system provided with hybrid battery according to claim 3, characterized in that said battery current and voltage control means operates to turn off the operation of said voltage increasing circuit and to suspend charging of said power battery through said energy battery when the electric car is in a regenerative mode of recovering braking energy.

12. An electric car drive control system provided with hybrid battery according to claim 3, characterized in that said electric car has auxiliary equipment including an air conditioner motor, a power steering motor and a vacuum motor, and said auxiliary equipment is driven by said energy battery as a power source.

13. An electric car drive control system provided with hybrid battery according to claim 4, characterized in that said electric car has auxiliary equipment including an air conditioner motor, a power steering motor and a vacuum motor, and said auxiliary equipment is driven by said energy battery as a power source.

14. A drive control method for an electric car drive control system according to claim 8, characterized in that said electric car has an auxiliary battery to supply power to said pump, further comprising the steps of charging said auxiliary battery via a DC/DC converter from said energy battery.