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Lin et al.

(54) **POWER CONTROL CIRCUIT AND BATTERY MODULE INCLUDING THE SAME**

(76) Inventors: **Chih-Hsiung Lin**, TAIPEI CITY (TW); **Shyh-Heh Hwang**, TAIPEI CITY (TW)

Correspondence Address:
NORTH AMERICA INTELLECTUAL PROPERTY CORPORATION
P.O. BOX 506
MERRIFIELD, VA 22116 (US)

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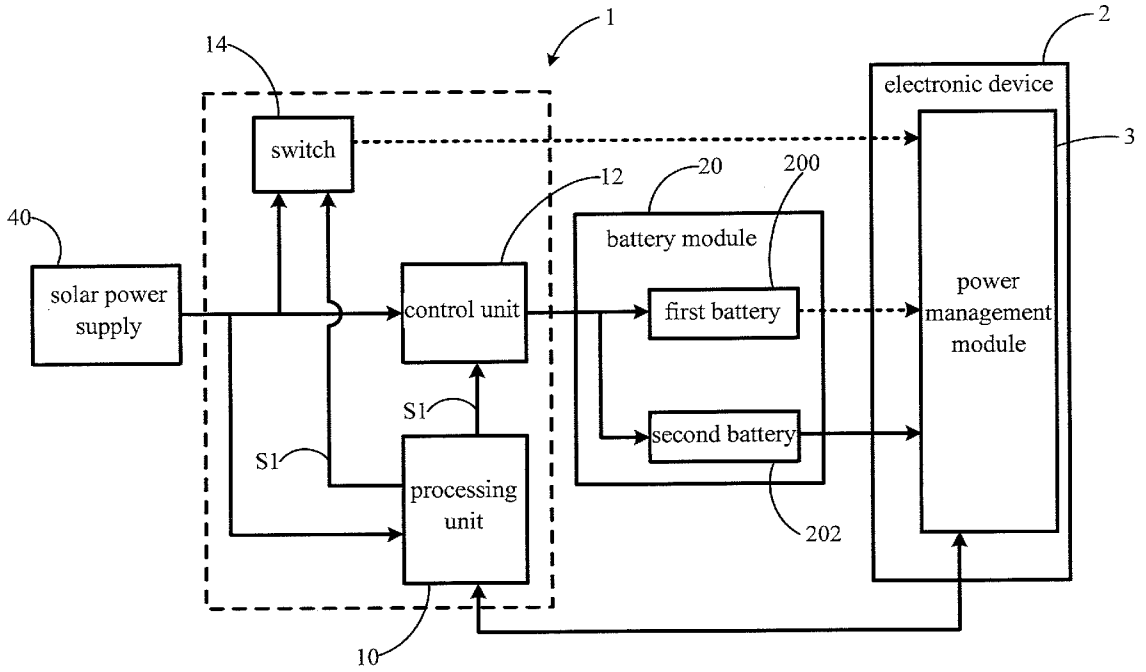
(57) **ABSTRACT**

This invention provides a power control circuit and a battery module including the same. The power control circuit is provided in an electronic device and is connected a solar power supply. The electronic device includes a first battery and a second battery. The power control circuit includes a processing unit and a control unit. When the processing unit is connected to the solar power supply, the processing unit outputs a first control signal. The control unit is connected to the processing unit, the first battery, and the second battery, respectively. Further, the control unit receives the first control signal to control the first battery and the second battery to alternately supply power to the electronic device and to control the first battery and the second battery to be alternately charged by the solar power supply.



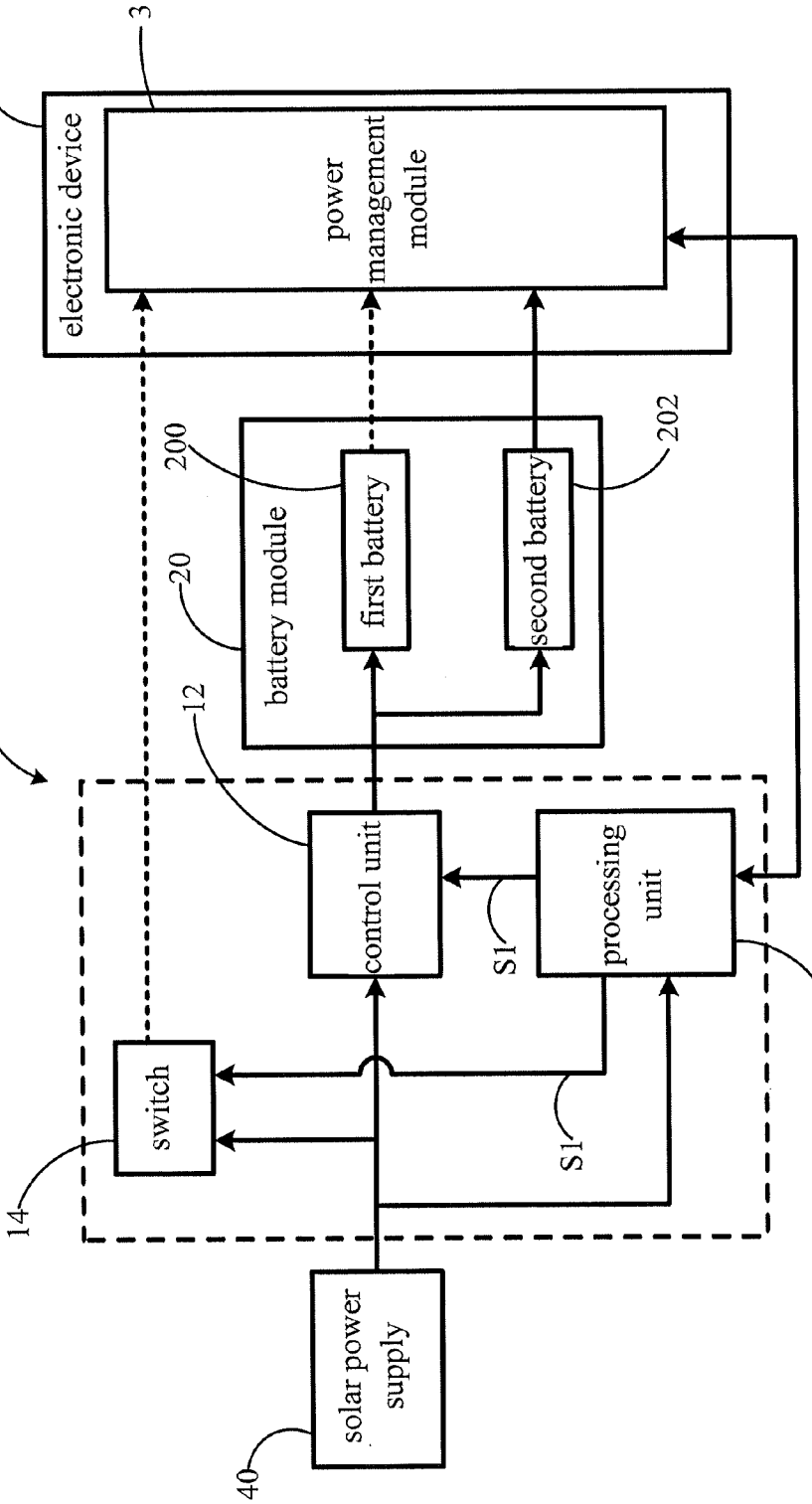

2
3
electronic device
power management module
200
202
20
battery module
first battery
second battery
1
12
control unit
processing unit
S1
S1
10
switch
14
solar power supply
40

FIG. 1A

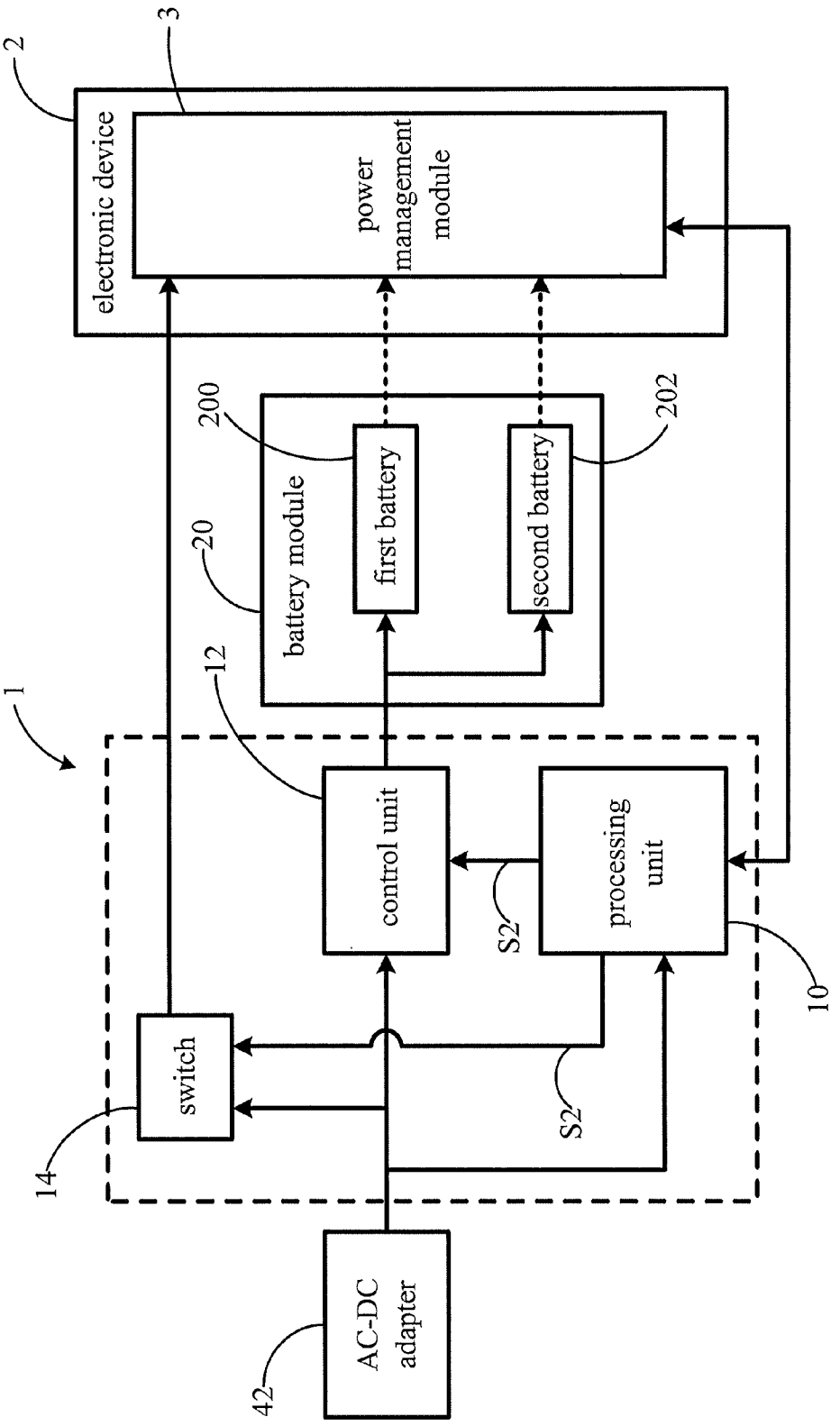

2
3
electronic device
power management module
200
202
battery module
first battery
second battery
20
12
1
control unit
processing unit
S2
S2
10
switch
14
AC-DC adapter
42

FIG. 1B

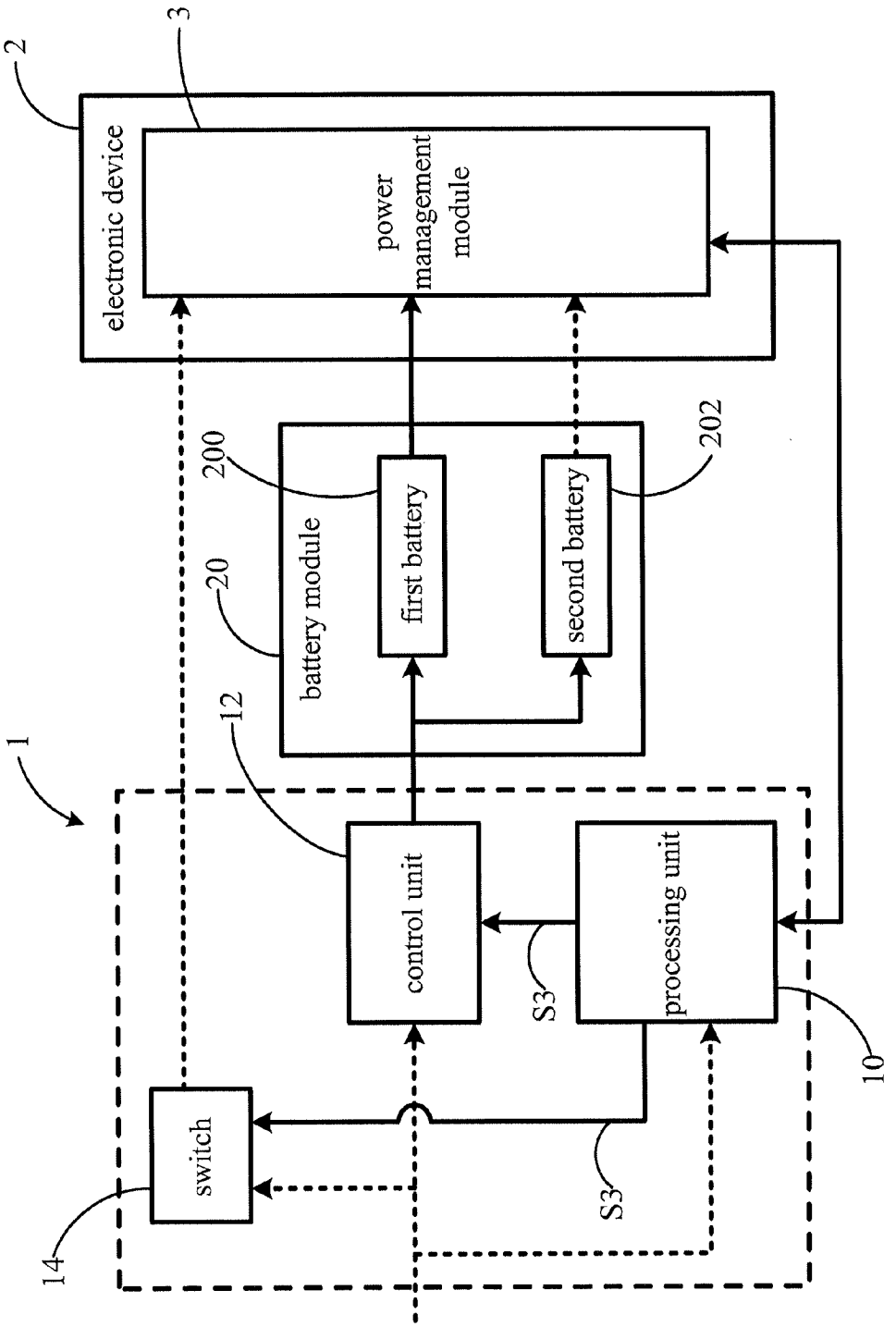

2
3
electronic device
power management module
200
202
first battery
second battery
20
battery module
12
1
control unit
processing unit
S3
S3
10
switch
14

FIG. 1C

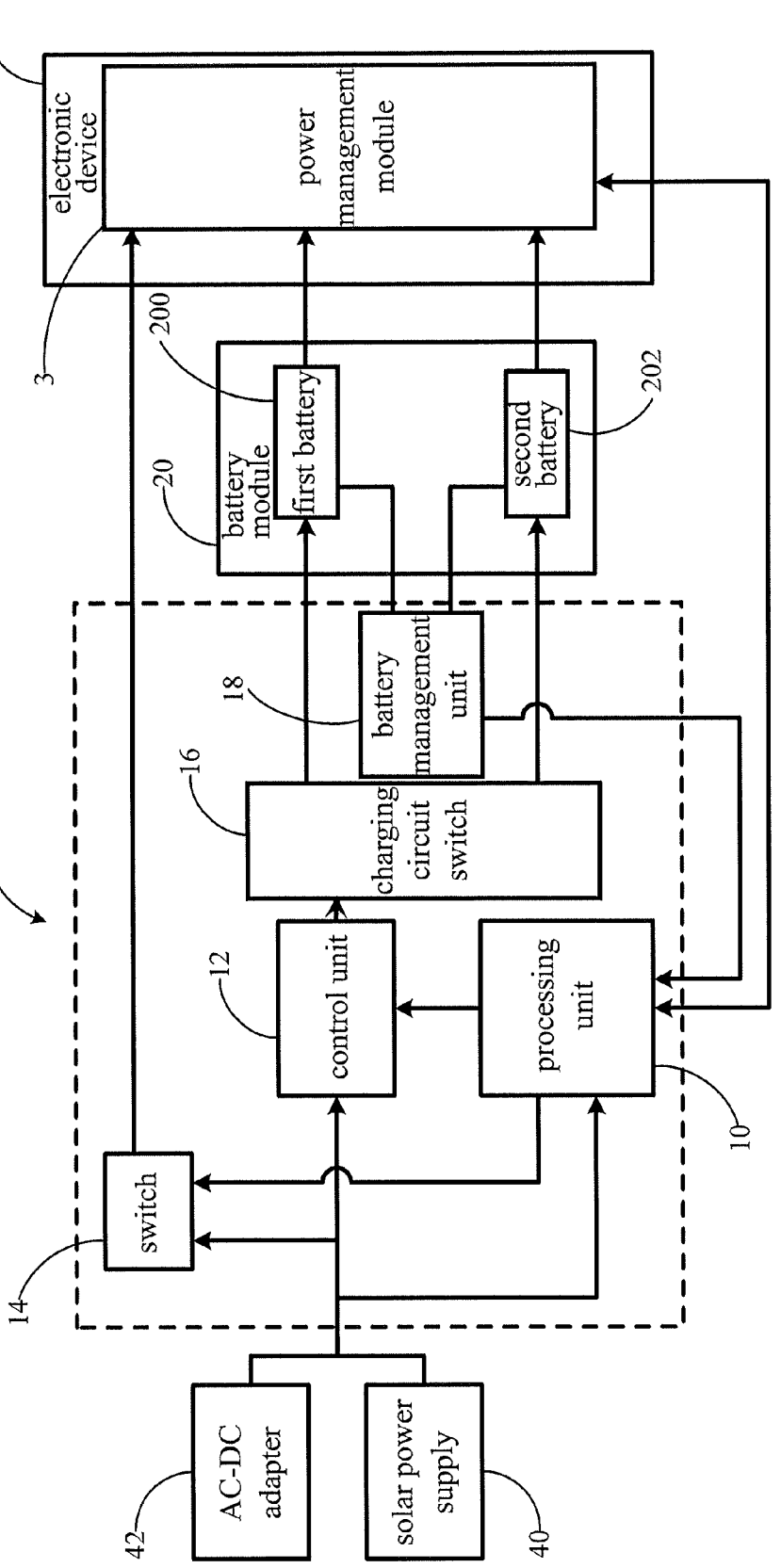

2
electronic device
power management module
3
200
battery module
first battery
second battery
202
20
18
battery management unit
16
charging circuit switch
1
12
control unit
processing unit
10
switch
14
AC-DC adapter
42
solar power supply
40

FIG. 2

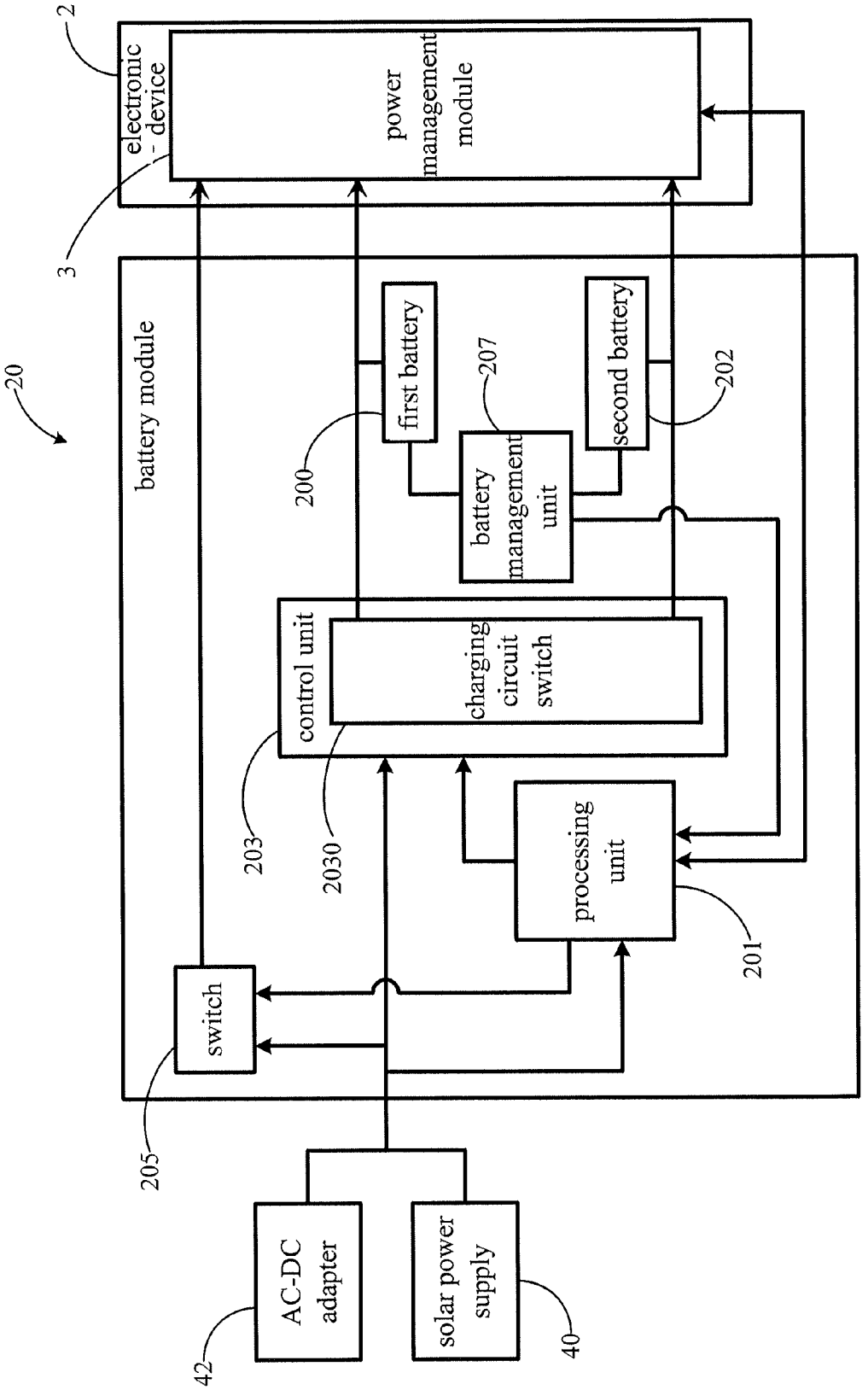

2
electronic device
power management module
3
20
battery module
first battery
200
207
second battery
202
battery management unit
control unit
charging circuit switch
203
2030
processing unit
201
switch
205
AC-DC adapter
42
solar power supply
40

FIG. 3

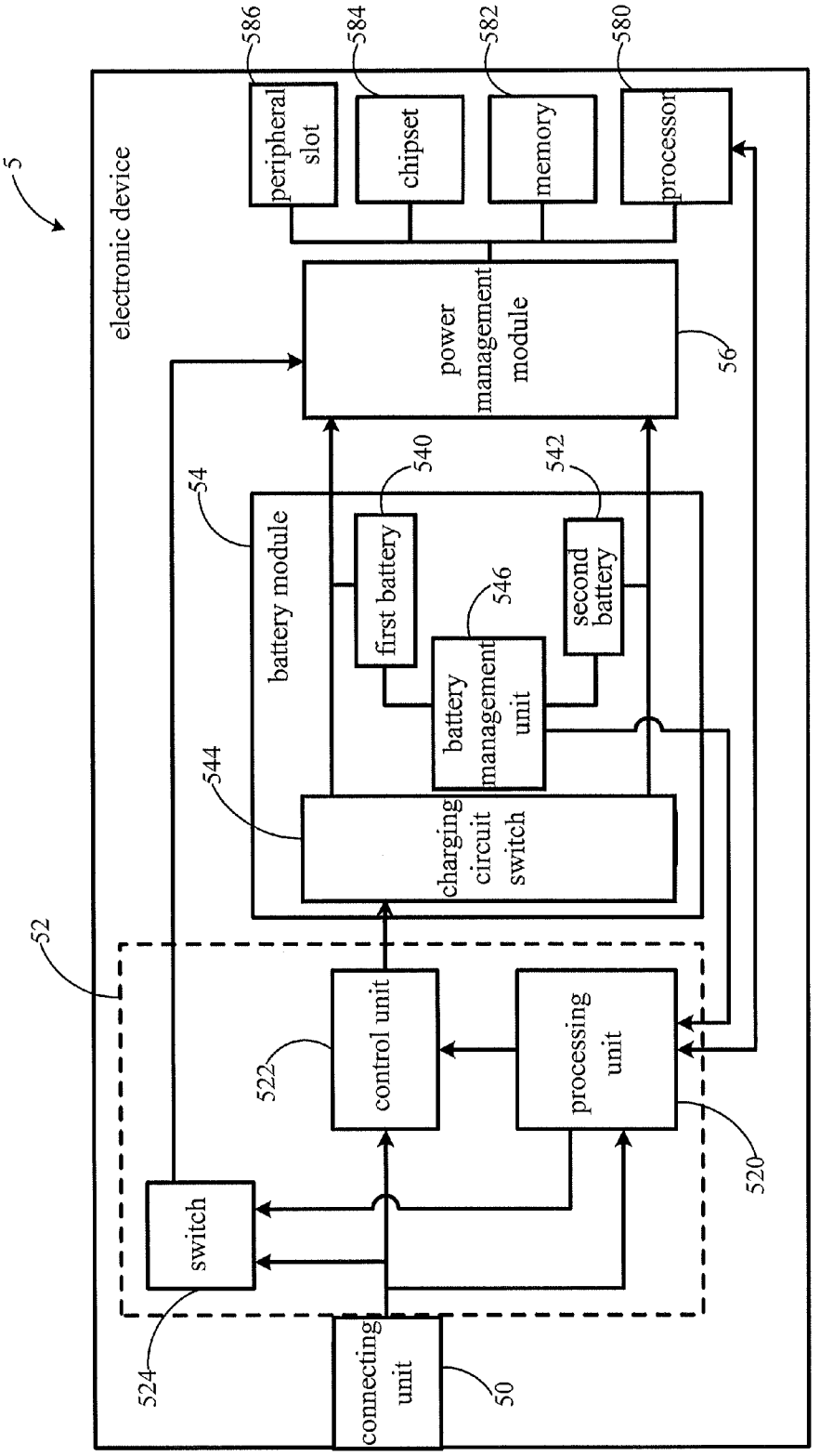

5
electronic device
peripheral slot
586
chipset
584
memory
582
processor
580
power management module
56
54
battery module
540
first battery
542
second battery
546
battery management unit
544
charging circuit switch
52
control unit
522
processing unit
520
switch
524
connecting unit
50

FIG. 4

POWER CONTROL CIRCUIT AND BATTERY MODULE INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This Non-provisional application claims priority under 35 U.S.C. §119(a) on Patent Application No(s). 098118023 filed in Taiwan, Republic of China on Jun. 1, 2009, the entire contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates to a power control circuit and a battery module including the same.

[0004] 2. Description of the Related Art

[0005] With development of technology and increase of users' needs, a plurality of electronic devices are designed to be thinner and thinner thus to facilitate carrying by the users. Most of portable electronic devices, such as a notebook computer, a tablet computer, a mobile phone, a personal digital assistant, a multimedia player, a digital camera and so on, can selectively obtain power from batteries or commercial power.

[0006] When the portable electronic device obtains the power from the commercial power, an AC-DC adapter is usually needed to adjust voltage and current of the commercial power to be within an acceptable range of the portable electronic device. The AC-DC adapter also provide stable voltage and current for the portable electronic device thus to maintain stability of each component in the portable electronic device.

[0007] In addition, a universal serial bus (USB) widely used at present can transmit about 5V power. Therefore, some portable electronic devices with lower power consumption, such as a mobile phone, a multimedia player and so on, can be connected to the commercial power or data processing systems, such as a computer, via USB cables thus to receive the power from the commercial power or the data processing systems.

[0008] With improvement of environmental consciousness, natural energy, such as solar energy, is used to generate power thus to prevent energy from being exhausted in a long time and being monopolized.

[0009] However, currently, efficiency of converting the solar energy to power energy is still low, and in one day, intensity of the solar energy changes with positions of the sun and weather at any time, which limits an application range of the solar energy. At present, products using the power supplied by the solar energy on a market are mainly the products with lower power, such as a lamp, a watch, a calculator and so on, or the products still using the commercial power or the batteries as the main power source.

BRIEF SUMMARY OF THE INVENTION

[0010] One objective of this invention is to provide a power control circuit. Particularly, the power control circuit in the invention can adjust power configuration modes according to different power sources thus to prolong using time of an electronic device by efficiently using power energy converted from solar energy.

[0011] A power control circuit in the invention is provided in an electronic device and is connected to a solar power supply. The electronic device includes a first battery and a second battery. The power control circuit includes a processing unit and a control unit.

[0012] When the processing unit is connected to the solar power supply, the processing unit outputs a first control signal. The control unit is connected to the processing unit, the first battery, and the second battery, respectively. The control unit receives the first control signal to control the first battery and the second battery to alternately supply power to the electronic device and to control the first battery and the second battery to be alternately charged by the solar power supply.

[0013] Another objective of the invention is to provide a battery module for supplying power to an electronic device.

[0014] A battery module in the invention includes a first battery, a second battery, and a power control circuit. The power control circuit is connected to a solar power supply for controlling operation of the first battery and the second battery. The power control circuit includes a processing unit and a control unit.

[0015] When the processing unit is connected to the solar power supply, the processing unit outputs a first control signal. The control unit is connected to the processing unit, the first battery, and the second battery, respectively. The control unit receives the first control signal to control the first battery and the second battery to alternately supply the power to the electronic device and to control the first battery and the second battery to be alternately charged by the solar power supply.

[0016] To sum up, when the power control circuit is connected to the solar power supply, the power control circuit in the invention can control the first battery and the second battery in the battery module to alternately supply the power to the electronic device and can control the first battery and the second battery to be alternately charged by the solar power supply. Therefore, the power energy converted from the solar energy can be efficiently used to prolong using time of the electronic device.

[0017] These and other features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. **1**A is a functional block diagram showing a power control circuit connected to a solar power supply according to one embodiment of the invention.

[0019] FIG. **1**B is a functional block diagram showing a power control circuit connected to an AC-DC adapter according to one embodiment of the invention.

[0020] FIG. **1**C is a functional block diagram showing a power control circuit according to one embodiment of the invention.

[0021] FIG. **2** is a functional block diagram showing a power control circuit according to one embodiment of the invention.

[0022] FIG. **3** is a functional block diagram showing a battery module according to one embodiment of the invention.

[0023] FIG. **4** is a functional block diagram showing an electronic device according to one embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0024] This invention provides a power control circuit and a battery module including the same. A plurality of embodiments about the power control circuit and the battery module in the invention are described hereinbelow.

[0025] An electronic device in the invention can refer to any device needing power for operation and, more particularly, to a data processing device such as a computer. In addition, the data processing device particularly refers to a portable data processing device such as a notebook computer, a tablet computer, an image capturing device, a multimedia player, a mobile communication device, or a personal digital assistant. However, the invention is not limited thereto.

[0026] In one embodiment, the power control circuit can control charge and discharge of the battery module. In an actual application, the battery module can be connected to the electronic device, and the battery module includes a first battery and a second battery. Further, the power control circuit can be selectively connected to different power supplies and can adjust power configuration modes according to different power sources. A solar power supply and an AC-DC adapter as the power supplies are taken for example, and an application mode of the power control circuit according to one preferred embodiment of the invention is described hereinbelow.

[0027] Please refer to FIG. **1**A to FIG. **1**C. FIG. **1**A is a functional block diagram showing a power control circuit **1** connected to a solar power supply **40** according to one preferred embodiment of the invention. FIG. **1**B is a functional block diagram showing a power control circuit **1** connected to an AC-DC adapter **42** according to one preferred embodiment of the invention. FIG. **1**C is a functional block diagram showing a power control circuit **1** free from connecting any power supply according to one preferred embodiment of the invention.

[0028] According to the embodiment, the power control circuit **1** includes a processing unit **10**, a control unit **12**, and a switch **14**. Further, the power control circuit **1** can control charge and discharge of a battery module **20**. The battery module **20** is connected to an electronic device **2**, and the battery module **20** includes a first battery **200** and a second battery **202**. The electronic device **2** includes a power management module **3**. The power management module **3** can be connected to the first battery **200**, the second battery **202**, and the switch **14** in a plugging mode or a soldering mode thus to receive power supplied by the first battery **200**, the second battery **202**, or the power supply (that is, the solar power supply **40** or the AC-DC adapter **42**). In other embodiments, the power control circuit **1** may be disposed in the electronic device **2** for connecting the solar power supply **40**. In addition, the electronic device **2** may further include the first battery **200** and the second battery **202**. However, the invention is not limited thereto.

[0029] In FIG. **1**A, when the processing unit **10** determines that the connected power supply is the solar power supply **40**, that is, when the processing unit **10** is connected to the solar power supply **40** and determines that the connected device is the solar power supply **40**, the processing unit **10** outputs a first control signal S**1**.

[0030] The control unit **12** is connected to the solar power supply **40**, the processing unit **10**, and the battery module **20**, respectively. The control unit **12** receives the first control signal S**1** from the processing unit **10**. According to the first control signal S**1**, the control unit **12** controls the first battery **200** and the second battery **202** to alternately supply power to the power management module **3** in the electronic device **2**. Then, the power management module **3** distributes the power to each electronic component in the electronic device **2**. The control unit **12** controls the first battery **200** and the second battery **202** to be alternately charged by the solar power supply **40**.

[0031] That is, when the control unit **12** controls the first battery **200** to be charged by the solar power supply **40**, the control unit **12** controls the second battery **202** to supply the power to the electronic device **2**; when the control unit **12** controls the second battery **202** to be charged by the solar power supply **40**, the control unit **12** controls the first battery **200** to supply the power to the electronic device **2**. In other words, when the power control circuit **1** according to the preferred embodiment of the invention is connected to the solar power supply **40**, the control unit **12** controls the batteries **200**, **202** in the battery module **20** respectively to be charged and discharge.

[0032] The switch **14** is connected to the solar power supply **40**, the electronic device **2**, and the processing unit **10**, respectively. The switch **14** receives the first control signal S**1** and is turned off according to the first control signal S**1**, such that the solar power supply **40** fails to supply power to the electronic device **2** via the switch **14**. In other words, the solar power supply **40** only charges the battery module **20**, and then the first battery **200** or the second battery **202** in the battery module **20** supplies the power to the electronic device **2**. The solar power supply **40** does not directly supply the power to the electronic device **2**.

[0033] In FIG. **1**B, when the processing unit **10** determines that the connected power supply is the AC-DC adapter **42**, the processing unit **10** outputs a second control signal S**2**. At that moment, the control unit **12** receives the second control signal S**2** and controls to the first battery **200** and the second battery **202** to be charged by the AC-DC adapter **42** according to the second control signal S**2**. In addition, the switch **14** receives the second control signal S**2** and is turned on according to the second control signal S**2**, such that the AC-DC adapter **42** can directly supply power to the power management module **3** of the electronic device **2** via the switch **14**. Then, the power management module **3** distributes the power to each electronic component in the electronic device **2**.

[0034] In other words, when the power control circuit **1** in the preferred embodiment of the invention is connected to the AC-DC adapter **42**, the power control circuit **1** controls the AC-DC adapter **42** to directly supply the power to the electronic device **2** and controls the first battery **200** and the second battery **202** to be charged by the AC-DC adapter **42** in the battery module **20**. In addition, the power control circuit **1** can also control the first battery **200** and the second battery **202** not to supply the power to the electronic device **2**.

[0035] In FIG. **1**C, when the power control circuit **1** in the embodiment is not connected to any power supply, the processing unit **10** outputs a third control signal S**3**, and the control unit **12** controls the first battery **200** and the second battery **202** to supply the power to the electronic device **2** according to the third control signal S**3**. In an actual application, the first battery **200** and the second battery **202** may simultaneously or alternately supply the power to the power management module **3** of the electronic device **2**, and then the

power management module **3** may distribute the power to each electronic component in the electronic device **2**.

[0036] Please refer to FIG. **2**. FIG. **2** is a functional block diagram showing a power control circuit **1** according to another embodiment of the invention. In FIG. **2**, besides the aforementioned processing unit **10**, the control unit **12**, and the switch **14**, the power control circuit **1** in the embodiment further includes a charging circuit switch **16** and a battery management unit **18**.

[0037] The charging circuit switch **16** is connected to the control unit **12**, a first battery **200**, and a second battery **202**, respectively, thus to switch connection states between a power supply (a solar power supply **40** or an AC-DC adapter **42**) and the first battery **200** and the second battery **202**.

[0038] For example, when the power control circuit **1** in the embodiment is in the state shown in FIG. **1**A, the charging circuit switch **16** allows the circuit between the control unit **12** and the first battery **200** to be turned on and the circuit between the control unit **12** and the second battery **202** to be turned off. Thus, the solar power supply **40** can charge the first battery **200** instead of the second battery **202** via the control unit **12** and the charging circuit switch **16**.

[0039] Further for example, when the power control circuit **1** in the embodiment is in the state shown in FIG. **1**B, the charging circuit switch **16** simultaneously allows the circuits between the control unit **12** and the first battery **200** and between the control unit **12** and the second battery **202** to be turned on. Thus, the first battery **200** and the second battery **202** can be simultaneously charged by the AC-DC adapter **42** via the control unit **12** and the charging circuit switch **16**. Certainly, in an actual application, operation of the charging circuit switch **16** may be adjusted according to other mechanisms. The invention is not limited to thereto.

[0040] In addition, the battery management unit **18** is connected to the processing unit **10**, the first battery **200**, and the second battery **202**. The battery management unit **18** can regularly detect states of the first battery **200** and the second battery **202** to obtain a state value, such as remaining capacity, a temperature, a discharge voltage, a discharge current and so on. However, the invention is not limited thereto. Further, the battery management unit **18** can feed back the state value to the processing unit **10**.

[0041] According to the state value, the processing unit **10** outputs a proper instruction signal at any time thus to drive the control unit **12** to control charge and discharge of the first battery **200** and the second battery **202**. For example, when the processing unit **10** is connected to the solar power supply **40** and the battery management unit **18** detects that the state value of the second battery **202** is abnormal, the processing unit **10** may output a switch signal according to the abnormal state value, and according to the switch signal, the control unit **12** may control the second battery **202** to stop supplying power to the electronic device **2** and control the first battery **200** to supply power to the electronic device **2**.

[0042] The power control circuit **1** in the embodiment may be integrated into a single circuit board and may be disposed in a proper device or module such as the aforementioned electronic device **2** or the battery module **20**; according to different conditions, the power control circuit **1** may also be separately disposed in different devices or modules. For example, the control unit **12**, the charging circuit switch **16**, and the battery management unit **18** may be disposed in the battery module **20**, and the processing unit **10** and the switch **14** may be disposed in the electronic device **2**.

[0043] In an actual application, the processing unit **10**, the control unit **12**, and the switch **14** may be components having proper functions according to different conditions. For example, the processing unit **10** may be a micro processor; the switch **14** may be a field effect transistor (FET). However, the invention is not limited thereto.

[0044] The invention further provides a battery module including the aforementioned power control circuit for supplying power to an electronic device.

[0045] Please refer to FIG. **3**. FIG. **3** is a functional block diagram showing a battery module **20** according to one embodiment of the invention. In FIG. **3**, the battery module **20** in the embodiment includes a first battery **200**, a second battery **202**, a processing unit **201**, a control unit **203**, a switch **205**, and a battery management unit **207**.

[0046] As described above, the processing unit **201** can be connected to a solar power supply **40** or an AC-DC adapter **42**. In some case, the processing unit **201** may be not connected to any power supply. The control unit **203** can be connected to the solar power supply **40** or the AC-DC adapter **42**, or the control unit **203** is not connected to any power supply. Further, the control unit **203** is connected to the processing unit **201**. In addition, as shown in FIG. **3**, the control unit **203** further includes a charging circuit switch **2030** connected to the first battery **200** and the second battery **202**, respectively.

[0047] The switch **205** can be connected to the solar power supply **40** or the AC-DC adapter **42**, or the switch **205** is not connected to any power supply. Further, the switch **205** is connected to the processing unit **201**. In addition, the battery management unit **207** is connected to the processing unit **201**, the first battery **200**, and the second battery **202**.

[0048] When the power supply is the solar power supply **40**, the processing unit **201** outputs a first control signal. According to the first control signal, the control unit **203** controls the charging circuit switch **2030** to turn on such that power from the solar power supply **40** can be supplied to the first battery **200**, thereby the first battery **200** being charged. At the same time, according to the first control signal, the control unit **203** controls the second battery **202** to supply power to the power management module **3** of the electronic device **2**, and then the power management module **3** distributes the power to each electronic component in the electronic device **2**. In addition, the switch **205** is turned off according to the first control signal, such that the solar power supply **40** fails to supply the power to the power management module **3** of the electronic device **2** via the switch **205**.

[0049] In addition, when the power supply is the AC-DC adapter **42**, the processing unit **201** outputs a second control signal. According to the second control signal, the control unit **203** controls the charging circuit switch **2030** to turn on, such that power from the AC-DC adapter **42** can be supplied to the first battery **200** and the second battery **202** to charge the first battery **200** and the second battery **202**. Further, the switch **205** is turned on according to the second control signal, such that the AC-DC adapter **42** can supply the power to the power management module **3** of the electronic device **2** via the switch **205**, and then the power management module **3** distributes the power to each electronic component in the electronic device **2**.

[0050] When the processing unit **201** is not connected to any power supply, the processing unit **201** outputs a third control signal. According to the third control signal, the control unit **203** controls the first battery **200** and the second battery **202** to supply the power to the power management

module **3** of the electronic device **2**, and then the power management module **3** distributes the power to each electronic component in the electronic device **2**.

[0051] As described above, the battery management unit **207** can regularly detect states of the first battery **200** and the second battery **202** and feeds back a state value to the processing unit **201**. According to the state value, the processing unit **201** outputs a proper instruction signal at any time thus to drive the control unit **203** and the charging circuit switch **2030** to control charge and discharge of the first battery **200** and the second battery **202**.

[0052] In one embodiment, a power control circuit in the embodiment can be disposed in an electronic device. Please refer to FIG. **4**, FIG. **4** is a functional block diagram showing an electronic device **5** according to one embodiment of the invention. In FIG. **4**, the electronic device **5** in the embodiment includes a connecting unit **50**, a power control circuit **52**, a battery module **54**, a power management module **56**, and a plurality of electronic components including units or modules, such as a processor **580**, a memory **582**, a chipset **584**, a peripheral device slot **586** and so on, needed in operation of the electronic device **5**.

[0053] The connecting unit **50**, such as a plugging hole, can allow different kinds of power supplies as mentioned above to be connected by a user. The power control circuit **52** includes a processing unit **520**, a control unit **522**, and a switch **524**. Further, the processing unit **520**, the control unit **522**, and the switch **524** are connected to the connecting unit **50**, respectively. In addition, the battery module **54** includes a first battery **540**, a second battery **542**, a charging circuit switch **544**, and a battery management unit **546**.

[0054] The power management module **56** can be connected to the first battery **540**, the second battery **542**, and the switch **524** in a plugging mode or a soldering mode thus to receive power supplied by the first battery **540**, the second battery **542**, or the power supply. In addition, the operating units or functional modules, such as the processor **580**, the memory **582**, the chipset **584**, the peripheral device slot **586** and so on, are connected to the power management module **56**, respectively, thus to receive the power needed by operation from the power management module **56**.

[0055] In the embodiment, connections and functions of each unit included in the power control circuit **52** and the battery module **54** are the same as that described above. Therefore, they are not described herein for a concise purpose.

[0056] To sum up, according to the preferred embodiments of the invention, the power control circuit can adjust power configuration modes according to different power sources. Particularly, when the power source is the solar power supply, the power control circuit in the preferred embodiments of the invention can control the first battery and the second battery in the battery module to alternately supply the power to the electronic device and control the first battery and the second battery to be alternately charged by the solar power supply. Further, the power control circuit in the preferred embodiments of the invention can switch between charge and discharge according to the state of each battery unit thus to prolong using time of the electronic device by efficiently using power energy converted from solar energy.

[0057] Although the present invention has been described in considerable detail with reference to certain preferred embodiments thereof, the disclosure is not for limiting the scope of the invention. Persons having ordinary skill in the art may make various modifications and changes without departing from the scope and spirit of the invention. Therefore, the scope of the appended claims should not be limited to the description of the preferred embodiments described above.

What is claimed is:

1. A power control circuit provided in an electronic device and connected to a solar power supply, the electronic device including a first battery and a second battery, the power control circuit comprising:

a processing unit for outputting a first control signal when the processing unit is connected to the solar power supply; and

a control unit connected to the processing unit, the first battery, and the second battery, respectively,

wherein the control unit receives the first control signal to control the first battery and the second battery to alternately supply power to the electronic device and to control the first battery and the second battery to be alternately charged by the solar power supply.

2. The power control circuit according to claim **1**, further comprising:

a switch connected to the solar power supply, the electronic device, and the processing unit, respectively, the switch receiving the first control signal and being turned off according to the first control signal, such that the solar power supply fails to supply power to the electronic device via the switch.

3. The power control circuit according to claim **1**, wherein when the processing unit is connected to an AC-DC adapter, the processing unit outputs a second control signal, and the control unit controls the first battery and the second battery to be charged by the AC-DC adapter according to the second control signal.

4. The power control circuit according to claim **3**, further comprising:

a switch connected to the AC-DC adapter, the electronic device, and the processing unit, respectively, the switch receiving the second control signal and being turned on according to the second control signal, such that the AC-DC adapter supplies power to the electronic device via the switch.

5. The power control circuit according to claim **1**, wherein when the first battery is charged by the solar power supply, the second battery supplies the power to the electronic device, and when the second battery is charged by the solar power supply, the first battery supplies the power to the electronic device.

6. The power control circuit according to claim **1**, further comprising:

a battery management unit connected to the processing unit, the first battery, and the second battery for detecting a state value related to the first battery and the second battery and feeding back the state value to the processing unit.

7. The power control circuit according to claim **6**, wherein when the second battery supplies the power to the electronic device and the state value of the second battery is abnormal, the processing unit outputs a switch signal, and according to the switch signal, the control unit controls the second battery to stop supplying the power to the electronic device and controls the first battery to supply the power to the electronic device.

8. The power control circuit according to claim **6**, wherein the state value is selected from the group consisting of remaining capacity, a temperature, a discharge voltage, and a discharge current.

9. A battery module for supplying power to an electronic device, the battery module comprising:

a first battery;

a second battery; and

a power control circuit connected to a solar power supply for controlling operation of the first battery and the second battery, the power control circuit including:

a processing unit, outputting a first control signal when the processing unit is connected to the solar power supply; and

a control unit connected to the processing unit, the first battery, and the second battery, respectively,

wherein the control unit receives the first control signal to control the first battery and the second battery to alternately supply the power to the electronic device and to control the first battery and the second battery to be alternately charged by the solar power supply.

10. The battery module according to claim **9**, further comprising:

a switch connected to the solar power supply device, the electronic device, and the processing unit, respectively, the switch receiving the first control signal and being turned off according to the first control signal, such that the solar power supply fails to supply power to the electronic device via the switch.

11. The battery module according to claim **9**, wherein when the processing unit is connected to an AC-DC adapter, the processing unit outputs a second control signal, and the control unit controls the first battery and the second battery to be charged by the AC-DC adapter according to the second control signal.

12. The battery module according to claim **11**, further comprising:

a switch connected to the AC-DC adapter, the electronic device, and the processing unit, respectively, the switch receiving the second control signal and being turned on according to the second control signal, such that the AC-DC adapter supplies power to the electronic device via the switch.

13. The battery module according to claim **9**, wherein when the first battery is charged by the solar power supply, the second battery supplies the power to the electronic device, and when the second battery is charged by the solar power supply, the first battery supplies the power to the electronic device.

14. The battery module according to claim **9**, further comprising:

a battery management unit connected to the processing unit, the first battery, and the second battery for detecting a state value related to the first battery and the second battery and feeding back the state value to the processing unit.

15. The battery module according to claim **14**, wherein when the second battery supplies the power to the electronic device and the state value of the second battery is abnormal, the processing unit outputs a switch signal, and according to the switch signal, the control unit controls the second battery to stop supplying the power to the electronic device and controls the first battery to supply the power to the electronic device.

16. The battery module according to claim **14**, wherein the state value is selected from the group consisting of remaining capacity, a temperature, a discharge voltage, and a discharge current.

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