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Device and method for preventing application of overcurrent

Abstract

Disclosed is an overcurrent application prevention device including a current sensor for measuring a charging current applied from a charging unit to a battery, a bypass unit, a 3-terminal switch having a first end connected to charging unit and a second end that is switched to be connected to the battery or the bypass unit, a comparator for receiving the measured charging current and controlling the 3-terminal switch on the basis of a result of a comparison between the received charging current and a preset value.

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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
6737756	12/2003	Gale	307/45	B60L 58/21
7068012	12/2005	Geren	320/136	H01M 50/581
2003/0048006	12/2002	Shelter, Jr. et al.	N/A	N/A
2014/0062387	12/2013	Kim	N/A	N/A
2014/0145506	12/2013	Lu	307/66	H02J 7/00304
2015/0244315	12/2014	Mcnamara	136/244	H01L 31/02021
2015/0346758	12/2014	Sakakibara	N/A	N/A
2016/0064979	12/2015	Huang et al.	N/A	N/A
2016/0094059	12/2015	Maetani	N/A	N/A
2018/0019590	12/2017	Morimoto	N/A	N/A
2018/0306845	12/2017	Yamaguchi	N/A	H02J 7/0047
2019/0229377	12/2018	Kim	N/A	B60L 50/64
2019/0393696	12/2018	Tada et al.	N/A	N/A
2020/0185784	12/2019	Yeom	N/A	N/A
2020/0203961	12/2019	Flowers	N/A	H02J 7/00304

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
51-37419	12/1975	JP	N/A
8-213055	12/1995	JP	N/A
8-272464	12/1995	JP	N/A
10-66251	12/1997	JP	N/A
2001-178009	12/2000	JP	N/A
2008-149177	12/2007	JP	N/A
2010-183679	12/2009	JP	N/A
2012-143114	12/2011	JP	N/A
2016-82800	12/2015	JP	N/A
2017-135074	12/2016	JP	N/A
2018-11482	12/2017	JP	N/A
10-2004-0068714	12/2003	KR	N/A
10-2005-0057693	12/2004	KR	N/A

10-2014-0028531	12/2013	KR	N/A
10-2015-0079747	12/2014	KR	N/A
10-2016-0044239	12/2015	KR	N/A
10-1740242	12/2016	KR	N/A
10-2017-0135265	12/2016	KR	N/A
10-2018-0017899	12/2017	KR	N/A
10-2018-0028240	12/2017	KR	N/A
10-1894970	12/2017	KR	N/A
10-2018-0119320	12/2017	KR	N/A
WO 2006/112501	12/2005	WO	N/A
WO 2019/246414	12/2018	WO	N/A

OTHER PUBLICATIONS

Extended European search report issued on Jun. 10, 2022 for the corresponding European patent application 20804979.1. cited by applicant
International Search Report for PCT/KR2020/005534 (PCT/ISA/210) mailed on Jul. 30, 2020. cited by applicant

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS
(1) This application claims the benefit of Korean Patent Application No. 10-2019-0057089, filed on May 15, 2019, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.
TECHNICAL FIELD
(2) The present invention relates to a device and method for preventing application of overcurrent.
BACKGROUND ART
(3) Recently, research and development of secondary batteries has been actively carried out. Here, the secondary batteries, which are rechargeable batteries, represent both conventional Ni/Cd batteries and Ni/MH batteries and up-to-date lithium ion batteries. The lithium ion batteries among the secondary batteries have the merit of high energy density compared to the conventional Ni/Cd batteries or Ni/MH batteries. Furthermore, the lithium ion batteries can be made small in size and light in weight, and are thus used as power sources of mobile devices. Moreover, since the scope of use of the lithium ion batteries extend to power sources of electric vehicles, the lithium ion batteries attract attention as next-generation energy storage media.
(4) A secondary battery is typically used as a battery rack including a battery module in which a plurality of battery cells are connected in series and/or in parallel. The state and operation of the battery rack are managed and controlled by a battery management system.
(5) A plurality of battery modules are connected in series or in parallel to constitute a battery rack, and a plurality of battery racks are connected in parallel to constitute a battery bank. Such a battery bank may be used as an energy storage system (ESS).
(6) Regarding ESSs that are used in underdeveloped countries, application of overcurrent to ESS packs frequently occurs according to a charging environment, causing a short circuit of an ESS pack fuse or continuous occurrence of an alarm. Thus, it is often difficult to operate ESSs normally.

(7) A normal charger charges an ESS by applying a current limited by a voltage suitable for an ESS pack. However, an abnormal charger causes a phenomenon in which overcurrent is applied from the charger to an ESS at the moment when the ESS is connected to the charger.
(8) Although this is a problem of a charger, ESS packs which can be operated normally in such an environment are required.

DETAILED DESCRIPTION OF THE INVENTION

Technical Problem

(9) An object of the present invention is to provide an overcurrent application prevention device and method for making it possible to safely charge a battery without being affected by instantaneous overcurrent even when an abnormal charger is connected.

Technical Solution

(10) An overcurrent application prevention device according to an embodiment is characterized by including a current sensor configured to measure a charging current applied from a charging unit to a battery; a bypass unit; a 3-terminal switch having a first end connected to charging unit and a second end that is switched to be connected to the battery or the bypass unit; a comparator configured to: receive the charging current from the current sensor and control the 3-terminal switch to be connected to the battery or to the bypass unit on the basis of a result of a comparison between the received charging current and a preset value.
(11) The overcurrent application prevention device according to an embodiment is characterized in that the current sensor is a Hall sensor.
(12) The overcurrent application prevention device according to an embodiment is characterized in that the 3-terminal switch is switched to be connected to the battery when the measured current value is smaller than the preset value, and is switched to be connected to the bypass unit when the measured current value is greater than the preset value.
(13) The overcurrent application prevention device according to an embodiment is characterized in that the bypass unit includes a first resistor having a first terminal connected to the 3-terminal switch, a capacitor connected to a second terminal of the first resistor, and a second resistor connected in parallel to the capacitor.
(14) The overcurrent application prevention device according to an embodiment is characterized in that when the 3-terminal switch is switched to be connected to the bypass unit by being controlled by the comparator, the charging current applied from the charging unit flows to the capacitor so that energy is stored in the capacitor.
(15) The overcurrent application prevention device according to an embodiment is characterized in that when the 3-terminal switch is switched to be connected to the battery by being controlled by the comparator, the current flows to the second resistor due to the energy stored in the capacitor.
(16) The overcurrent application prevention device according to an embodiment is characterized in that the bypass unit includes a first resistor having a first terminal connected to the 3-terminal switch, a battery cell connected to a second terminal of the first resistor, and a second resistor connected in parallel to the battery cell.
(17) The overcurrent application prevention device according to an embodiment is characterized in that when the 3-terminal switch is switched to be connected to the bypass unit by being controlled by the comparator, the charging current applied from the charging unit flows to the battery cell so that energy is stored in the battery cell.
(18) The overcurrent application prevention device according to an embodiment is characterized in that when the 3-terminal switch is switched to be connected to the battery by being controlled by the comparator, the current flows to the second resistor due to the energy stored in the battery cell.
(19) An overcurrent application prevention method according to an embodiment of the present invention is characterized by including the steps of: measuring a charging current applied from a charging unit to a battery; amplifying a value of the measured current; comparing the amplified value with a preset value; and controlling a 3-terminal switch so that the charging current is

bypassed when the amplified value is greater than the preset value, and controlling the 3-terminal switch so that the charging current flows to the battery when the amplified value is smaller than the preset value.
(20) The overcurrent application prevention method according to an embodiment of the present invention is characterized in that the step of measuring the current is performed by a Hall sensor.
(21) The overcurrent application prevention method according to an embodiment of the present invention is characterized in that when the 3-terminal switch is controlled so that the charging current applied from the charging unit is bypassed, the current flows to a capacitor so that energy is stored in the capacitor.
(22) The overcurrent application prevention method according to an embodiment of the present invention is characterized in that when the 3-terminal switch is controlled so that the charging current applied from the charging unit flows to the battery, the battery is charged, and the current flows to a resistor connected in parallel to the capacitor due to the energy stored in the capacitor.
(23) The overcurrent application prevention method according to an embodiment of the present invention is characterized in that when the 3-terminal switch is controlled so that the charging current applied from the charging unit is bypassed, the current flows to a battery cell so that energy is stored in the battery cell.
(24) The overcurrent application prevention method according to an embodiment of the present invention is characterized in that when the 3-terminal switch is controlled so that the charging current applied from the charging unit flows to the battery, the battery is charged, and the current flows to a resistor connected in parallel to the battery cell due to the energy stored in the battery call.
Effects of the Invention
(25) The present invention has the effect of safely charging a battery without being affected by instantaneous overcurrent even when an abnormal charger is connected.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is a configuration diagram illustrating an overcurrent application prevention device according to an embodiment of the present invention.
(2) FIG. **2** is a diagram illustrating an implementation example of an overcurrent application prevention device according to an embodiment of the present invention.
(3) FIG. **3** is a flowchart illustrating an overcurrent application prevention method according to an embodiment of the present invention.
(4) FIG. **4** is a diagram illustrating an installation example of an overcurrent application prevention device according to another embodiment of the present invention.
(5) FIG. **5** is a configuration diagram illustrating an overcurrent application prevention device according to another embodiment of the present invention.
(6) FIG. **6** is a configuration diagram illustrating an overcurrent application prevention device according to another embodiment of the present invention.
(7) FIG. **7** is a flowchart illustrating an overcurrent application prevention method according to another embodiment of the present invention.
MODE FOR CARRYING OUT THE INVENTION
(8) Hereinafter, various embodiments of the present invention will be described in detail with reference to the accompanying drawings. However, it should be understood that the present invention is not limited to specific embodiments, but rather includes various modifications, equivalents and/or alternatives of various embodiments of the present invention. Regarding description of the drawings, like reference numerals may refer to like elements.

(9) The terminology used herein is only used for describing specific embodiments and is not intended to limit the scope of other embodiments. The terms of a singular form may include plural forms unless otherwise specified. The terms used herein, including technical or scientific terms, have the same meanings as understood by those skilled in the art. Commonly-used terms defined in a dictionary may be interpreted as having meanings that are the same as or similar to contextual meanings defined in the related art, and should not be interpreted in an idealized or overly formal sense unless otherwise defined explicitly. Depending on cases, even the terms defined herein should not be such interpreted as to exclude various embodiments of the present invention.
(10) The terms "first", "second", "A", "B", "(a)", "(b)" and the like may be used herein to describe elements of the embodiments of the present invention. However, the terms are only used to distinguish one element from other elements, and the attributes or order of the elements are not limited by the terms. It will be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element, or other intervening elements may "connected" or "coupled" therebetween.
(11) FIG. **1** is a configuration diagram illustrating an overcurrent application prevention device according to an embodiment of the present invention.
(12) According to the prior art, a negative temperature coefficient (NTC) thermistor is connected to a charging path to consume energy by increasing a resistance value when overcurrent flows, thereby preventing abnormal overcurrent from being applied to an ESS. This configuration makes it possible to efficiently consume energy in an overcurrent situation, but causes a voltage drop and heat generation due to a resistance value of an NTC itself even in a normal operation state. In order to supplement this conventional configuration, the overcurrent application prevention device of the present invention monitors through a Hall sensor to bypass a current having at least a reference value when the current having at least the reference value is applied, so as to block overcurrent from being directly applied to an ESS pack.
(13) In detail, an overcurrent application prevention device **10** of the present invention includes a current sensor **100**, an amplifier **101**, a comparator **102**, a 3-terminal switch **104**, and a bypass unit **106**.
(14) The current sensor **100** measures a current flowing between one terminal of a charging unit **20** and the 3-terminal switch **104**.
(15) A current value measured by the current sensor **100** is transferred to the amplifier **101**. The amplifier **101** that has received the measured current value from the current sensor **100** amplifies the measured current value.
(16) The amplifier **101** transfers the amplified current value to the comparator **102**. Here, the amplifier **101** may be omitted, and the measured current value may be directly transferred to the comparator **102**.
(17) The comparator **102** receives the amplified current value from the amplifier and compares the amplified current value with a preset value. The comparator **102** may compare the amplified current value with the preset value to control the 3-terminal switch **104** to contact the bypass unit **106** when the amplified current value is greater than the preset value, and may compare the amplified current value with the preset value to control the 3-terminal switch **104** to contact one terminal side of a battery **30** when the amplified current value is smaller than the preset value.
(18) One end of the 3-terminal switch **104** is electrically connected to the charging unit **20**, and another end is connected to one end of the battery **30** or one end of the bypass unit **106** according to a result value from the comparator **102**.
(19) As described above, the 3-terminal switch **104** is connected to the side of the bypass unit **106** when the current value (or amplified value) measured by the current sensor is greater than the preset value, and is connected to the side of the battery **30** when the current value (or amplified value) measured by the current sensor is smaller than the preset value.
(20) When the 3-terminal switch **104** is connected to the side of the bypass unit **106**, a current

applied from the charging unit **20** flows to the bypass unit **106** and is thus not applied to the battery **30**, thereby protecting the battery **30** from overcurrent.
(21) When the 3-terminal switch **104** is connected to the side of the battery **30**, the current applied from the charging unit **20** is applied to the battery **30**, and thus the battery **30** is charged safely.
(22) FIG. **2** is a diagram illustrating an implementation example of an overcurrent application prevention device according to an embodiment of the present invention.
(23) The overcurrent application prevention device **10** includes a current sensor **204**, an amplifier **206**, a comparator **208**, a 3-terminal switch **210**, a first resistor **212**, a capacitor **214**, and a second resistor **216**.
(24) The current sensor **204** measures a current flowing between a first terminal **202** of a charging unit **200** and the 3-terminal switch **210**. The current sensor **204** may be a Hall sensor, which does not consume a current output from the charging unit **200** or does not cause a voltage drop due to resistance. A value of the current output from the charging unit **200** is measured by the Hall sensor **204**.
(25) The current value measured by the Hall sensor **204** is transferred to the amplifier **206**. The amplifier **206** that has received the measured current value from the Hall sensor **204** amplifies the current value. Here, the amplifier **206** may be omitted, and the measured current value may be directly transferred to the comparator **208**.
(26) The comparator **208** receives the amplified current value from the amplifier and compares the amplified current value with a preset value. The comparator **208** may compare the amplified current value with the preset value to control the 3-terminal switch **210** to contact the first resistor **212** when the amplified current value is greater than the preset value, and may compare the amplified current value with the preset value to control the 3-terminal switch **210** to contact one terminal side **218** of a battery **220** when the amplified current value is smaller than the preset value.
(27) One end of the 3-terminal switch **210** is connected to the first terminal **202** of the charging unit **200**, and another end is connected to the first terminal **218** of the battery **220** or the first resistor **212** according to a result value from the comparator **208**. Further, the charging unit **200** is also connected to a second terminal **222** of the battery and to the capacitor **214**.
(28) As described above, the 3-terminal switch **210** is connected to the side of the first resistor **212** when the current value (or amplified value) measured by the current sensor is greater than the preset value, and is connected to the side of the first terminal **218** of the battery **220** when the current value (or amplified value) measured by the current sensor is smaller than the preset value.
(29) When the 3-terminal switch **210** is connected to the first resistor **212**, the current applied from the charging unit **200** is applied to the first resistor **212** and dropped to a voltage suitable for a battery module for bypass, and energy is stored in the capacitor **214**. Further, the capacitor **214** may be replaced with a battery cell **214**.
(30) When the 3-terminal switch **210** is connected to the side of the first terminal **218** of the battery **220**, the current applied from the charging unit **200** is applied to the battery **220**, and thus the battery **220** is charged safely. Furthermore, when the 3-terminal switch **210** is connected to the first terminal **218** of the battery **220** or is not connected to the first resistor **212**, energy stored in the capacitor **214** is discharged by the second resistor **216**.
(31) Since the energy stored in the capacitor **214** is discharged as described above, when overcurrent is applied from the charging unit **200** thereafter, the current is applied and thus energy may be stored. That is, the capacitor **214** stores energy when overcurrent is applied, and discharges energy while overcurrent is not applied. Although the above descriptions are given using the capacitor as an example, a battery cell or a battery module rather than the capacitor may be used as the same corresponding configuration. The battery module or the battery cell may be replaced with a configuration having the same function as the capacitor in an embodiment of the present invention or another embodiment.
(32) FIG. **3** is a flowchart illustrating an overcurrent application prevention method according to an

embodiment of the present invention.
(33) A current applied from the charging unit **200** is measured by the Hall sensor **204** (S**300**). The hall sensor **204** may measure a current without consuming a current output from the charging unit **200** or causing a voltage drop due to resistance.
(34) The current value measured by the Hall sensor **204** is transferred to the amplifier **206**. The amplifier **206** that has received the measured current value from the Hall sensor **204** amplifies the current value (S**302**). Here, the amplifier **206** may be omitted, and the measured current value may be directly transferred to the comparator **208**.
(35) The comparator **208** receives the amplified current value from the amplifier and compares the amplified current value with a preset value (S**304**). The comparator **208** may compare the amplified current value with the preset value to control the 3-terminal switch **210** to contact the first resistor **212** when the amplified current value is greater than the preset value, and may compare the amplified current value with the preset value to control the 3-terminal switch **210** to contact one terminal side of the battery **220** when the amplified current value is smaller than the preset value.
(36) The comparator **208** compares the amplified current value with the preset value to determine whether the amplified current value is greater than the preset value (S**306**). When the amplified current value is greater than the preset value, the comparator **208** controls the 3-terminal switch **210** to contact the first resistor **212**. That is, the comparator **208** switches the 3-terminal switch to a bypass unit (S**308**).
(37) When the 3-terminal switch **210** is connected to the first resistor **212**, the current applied from the charging unit **200** is applied to the first resistor **212** and dropped to a voltage suitable for a battery module for bypass, and energy is stored in the capacitor **214** (S**310**).
(38) When the amplified current value is smaller than the preset value, the 3-terminal switch **210** is connected to the side of the first terminal **218** of the battery **220** (S**312**). When the 3-terminal switch **210** is connected to the side of the first terminal **218** of the battery **220**, the current applied from the charging unit **200** is applied to the battery **220**, and thus the battery **220** is charged safely (S**316**).
(39) Furthermore, when the 3-terminal switch **210** is connected to the first terminal **218** of the battery **220** or is not connected to the first resistor **212**, energy stored in the capacitor **214** is discharged by the second resistor **216** (S**314**).
(40) FIG. **4** is a diagram illustrating an installation example of an overcurrent application prevention device according to another embodiment of the present invention.
(41) An overcurrent application prevention device **402** is installed between a charging unit **400** and a battery **404**. A connected spring center axis of the overcurrent application prevention device **402** is configured with a fuse and is cut when a current increases, and thus the spring is compressed and a contact surface of a current transfer part increases, thus increasing resistance.
(42) Detailed descriptions will be given with reference to FIG. **5**.
(43) FIG. **5** is a configuration diagram illustrating the overcurrent application prevention device **402** according to another embodiment of the present invention.
(44) The overcurrent application prevention device **402** includes a current transfer part **502**, through which a current flows and which includes a plurality of metal (conductor) rods connected in a rail form so as to have a length that reduces or extends, a spring part **504** connected to the current transfer part, and a fuse part **506**, which supports the spring part **504** in an extended state. When a transferred current has at least a fixed reference value, the overcurrent application prevention device **402** generates heat, and thus the fuse part **506** is cut. When the fuse part **506** is cut, a support portion in which the fuse part supports between one ends of the spring part **504** disappears, and thus the spring part **504** restores to a compressed state, thus extending the current transfer part **502**.
(45) Any conductor that allows a flow of current may be used as the current transfer part **502**. Since a plurality of conductor rods are connected to each other by rail or the like in the current transfer

part **502**, the current transfer part **502** is capable of performing a motion of reducing and extending the length thereof. When an applied current has at least a fixed value, the overcurrent application prevention device **402** generates heat, and thus the fuse part **506** that supports the spring part **504** is cut. When the fuse part **506** is cut, the spring part **504** that was supported by the fuse part **506** restores to a compressed state, thus extending the current transfer part **502**. Since the current transfer part **502** is extended, the contact surface increases, thus increasing resistance. When the resistance of the current transfer part **502** increases, a current applied from a charging unit is transferred to a battery after consuming energy while passing through the current transfer part **502**, and thus the battery may be prevented from being damaged by overcurrent.
(46) FIG. **6** is a configuration diagram illustrating an overcurrent application prevention device according to another embodiment of the present invention.
(47) The overcurrent application prevention device includes a current sensor **602**, a capacitor **604**, an amplifier **606**, and a comparator **608**.
(48) The current sensor **602** may be a Hall sensor, which does not consume a current output from a charging unit **600** or does not cause a voltage drop due to resistance.
(49) The current sensor **602** measures a current which is output from the charging unit **600** and flows to the side of a battery **610**. The current value measured by the current sensor **602** is transferred to the amplifier **606**. The amplifier **606** that has received the measured current value from the current sensor **602** amplifies the measured current value.
(50) Here, the amplifier **606** may be omitted, and the measured current value may be directly transferred to the comparator **608**.
(51) The comparator **608** receives the amplified current value from the amplifier and compares the amplified current value with a preset value. The comparator **608** compares the amplified current value with the preset value to control a 3-terminal switch **609** to connect to a terminal **611** so as to connect the battery **610** and the capacitor **604** when the amplified current value is greater than the preset value, and compares the amplified current value with the preset value to control the 3-terminal switch **609** to connect to a terminal **612** so as to safely charge the battery **610** when the amplified current value is smaller than the preset value.
(52) FIG. **7** is a flowchart illustrating an overcurrent application prevention method according to another embodiment of the present invention.
(53) A current applied from the charging unit **600** is measured by the Hall sensor **602** (S**700**). The hall sensor **602** may measure a current without consuming a current output from the charging unit **600** or causing a voltage drop due to resistance.
(54) The current value measured by the Hall sensor **602** is transferred to the amplifier **606**. The amplifier **606** that has received the measured current value from the Hall sensor **602** amplifies the current value (S**702**). Here, the amplifier **606** may be omitted, and the measured current value may be directly transferred to the comparator **608**.
(55) The comparator **608** receives the amplified current value from the amplifier **606** and compares the amplified current value with a preset value (S**704**). Here, the amplifier **606** may be omitted, and the measured current value may be directly transferred to the comparator **608**.
(56) The comparator **608** determines whether the amplified current value from the amplifier **606** is greater than the preset value (S**706**). The comparator **608** controls the 3-terminal switch **609** to contact the terminal **611** when the amplified current value is greater than the preset value (S**712**), and controls the 3-terminal switch **609** to contact the terminal **612** when the amplified current value is smaller than the preset value (S**708**).
(57) When the 3-terminal switch **609** is connected to the terminal **612**, a current is applied from the charging unit **600** to charge the battery **610** (S**710**).
(58) In the present disclosure, the term “an embodiment” or various modified expressions thereof indicate that specific features, structures, and characteristics related to this embodiment are included in at least one embodiment of the principle of the present invention. Therefore, the term

“in an embodiment” and various modified expressions thereof should not be construed as indicating the same embodiment.

(59) All of the embodiments and conditional examples disclosed herein are intended to assist those skilled in the art with understanding the principle and concept of the present invention, and, thus, those skilled in the art could understand that the present invention can be implemented in modified forms without departing from the essential characteristics of the present invention. Therefore, the embodiments disclosed herein should be considered to be not limitative but illustrative. The scope of the present invention should be defined not by the above description but by the claims, and all differences that fall within the same scope as the claims should be construed as being covered by the present invention.

Claims

1. An overcurrent application prevention device, comprising: a current sensor configured to measure a current applied from a charging unit to a battery; a bypass unit; a 3-terminal switch having a first end connected to the charging unit and a second end that is switched to be connected to the battery or the bypass unit; and a comparator configured to: receive the current from the current sensor, and control the 3-terminal switch to be connected to the battery or to the bypass unit based on a result of a comparison between the current and a preset value, wherein the bypass unit comprises: a first resistor having a first terminal connected to the 3-terminal switch; a capacitor connected to a second terminal of the first resistor; and a second resistor connected in parallel to the capacitor, wherein the capacitor stores energy when the current is greater than the preset value, and the energy stored in the capacitor is discharged when the current is smaller than the preset value, and wherein, when the 3-terminal switch is connected to the battery, the energy stored in the capacitor is discharged by the second resistor.
2. The overcurrent application prevention device of claim 1, wherein the current sensor is a Hall sensor.
3. The overcurrent application prevention device of claim 1, wherein the 3-terminal switch is switched to be connected to the battery when the current is smaller than the preset value, and is switched to be connected to the bypass unit when the current is greater than the preset value.
4. The overcurrent application prevention device of claim 1, wherein, when the 3-terminal switch is switched to be connected to the bypass unit by being controlled by the comparator, the current applied from the charging unit flows to the capacitor so that energy is stored in the capacitor.
5. The overcurrent application prevention device of claim 4, wherein, when the 3-terminal switch is switched to be connected to the battery by being controlled by the comparator, the current flows to the second resistor due to the energy stored in the capacitor.
6. The overcurrent application prevention device of claim 1, wherein the first resistor is connected in series with a circuit including the capacitor and the second resistor.
7. An overcurrent application prevention method comprising: measuring a current applied from a charging unit to a battery; amplifying a value of the current; comparing the amplified value with a preset value; controlling a 3-terminal switch so that the current is bypassed through a bypass unit when the amplified value is greater than the preset value; and controlling the 3-terminal switch so that the current flows to the battery when the amplified value is smaller than the preset value, wherein the bypass unit comprises: a first resistor having a first terminal connected to the 3-terminal switch, a capacitor connected to a second terminal of the first resistor, and a second resistor connected in parallel to the capacitor, wherein the capacitor stores energy when the current is greater than the preset value, and the energy stored in the capacitor is discharged when the current is smaller than the preset value, and wherein, when the 3-terminal switch is connected to the battery, the energy stored in the capacitor is discharged by the second resistor.
8. The overcurrent application prevention method of claim 7, wherein the measuring the current is

performed by a current sensor, and wherein the current sensor is a Hall sensor.
9. The overcurrent application prevention method of claim 7, wherein, when the 3-terminal switch is controlled so that the current applied from the charging unit is bypassed, the current flows to the capacitor so that the energy is stored in the capacitor.
10. The overcurrent application prevention method of claim 9, wherein, when the 3-terminal switch is controlled so that the current applied from the charging unit flows to the battery, the battery is charged, and the current flows to the second resistor connected in parallel to the capacitor due to the energy stored in the capacitor.
11. The overcurrent application prevention method of claim 7, wherein, when the 3-terminal switch is controlled so that the current applied from the charging unit flows to the battery, the battery is charged, and the current flows to the second resistor connected in parallel to the capacitor due to the energy stored in the capacitor.