(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 952 049 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
18.10.2023 Bulletin 2023/42

(21) Application number: **20217937.0**

(22) Date of filing: **30.12.2020**

(51) International Patent Classification (IPC):
H02J 7/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
H02J 7/0048; H02J 7/00711; H02J 7/007186

(54) UNIVERSAL CHARGING DEVICE AND UNIVERSAL CHARGING METHOD THEREOF

UNIVERSELLE LADEVORRICHTUNG UND UNIVERSELLES LADEVERFAHREN DAFÜR

DISPOSITIF DE CHARGEMENT UNIVERSEL ET PROCÉDÉ DE CHARGEMENT UNIVERSEL ASSOCIÉ

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **06.08.2020 CN 202010780425**

(43) Date of publication of application:
09.02.2022 Bulletin 2022/06

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Description

[0001] This application claims priority of Application No. 202010780425.4 filed in Mainland China on 6 August 2020;

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to the charging technology, particularly to a universal charging device and a universal charging method thereof.

Description of the Related Art

[0003] Unlike lithium batteries for one-time use, lithium-ion batteries are rechargeable batteries that can work by moving lithium ions between positive and negative electrodes. At present, lithium-ion batteries have been widely used in the field of consumer electronics, especially portable electronic products, including mobile phones, smart phones, unicycles, etc. Users can repeatedly charge lithium-ion batteries to supply power to portable electronic products. The advantages of lithium-ion batteries include high energy density, which have 250-530 watt-hours per liter (Wh/L) in a unit volume, and high open-circuit voltage and large output power, allowing lithium-ion batteries to be widely used in different electronic products.

[0004] At present, lithium-ion batteries are widely used in our lives. Many devices use rechargeable lithium-ion batteries as the charging structure. However, there is no universal wide-range charging device for consumers to choose from. Lithium-ion batteries introduced by various manufacturers do not have uniform voltage specifications but have their own charging devices. Therefore, consumers must purchase corresponding charging devices to charge lithium-ion batteries. If you use the wrong charging device, you may not be able to charge the battery, or causing damage to the battery. In severe cases, it will cause the battery to explode and cause industrial safety problems. In addition, every time you must repurchase the charging device for a different battery, so that the life of the charging device is actually the same as that of the battery. The behavior wastes the cost and resources. Even if the charging device is not damaged, it can no longer be used.

[0005] To overcome the abovementioned problems, the present invention provides a universal charging device and a universal charging method thereof, so as to solve the afore-mentioned problems of the prior art.

[0006] Patent application publication US 2009/0091298 A1 teaches to adapt the DC charging voltage and the DC charging current in such manner during the charging process that the rated voltage is never exceeded, to which end the battery charger device comprises a voltage regulator. The DC charging voltage is adjusted such that at the beginning of the charging cycle the voltage increases rapidly and the then the voltage is maintained at a constant voltage level, while the charging current is high at the beginning of the charging cycle and then decreases rapidly and approaches zero at the end of the charging cycle. In this latter part of the charging cycle a trickle current is applied in order to charge the battery to 100 % state of charge without overcharging the batteries.

[0007] According to patent application publication US 2014/0266068 A1 the voltage applied to the battery during a charging cycle consists of pulses between which the voltage drops to the level of the instantaneous open-circuit voltage, i.e. between two pulses the charging process is not proceeded but paused. This, however, is the exact opposite of what is done according to the invention, where between two pulses the DC charging voltage is applied to the battery in order to charge the same, and serves a different purpose because according to the invention the pulses are not for charging the battery, but for determining its state of charge, thereby preventing overcharging the battery. Also, it is taught to adapt the height of the voltage pulses during the charging cycle according to the maximum voltage V_{max} of the specific battery, "taking into account battery chemistry, the details of construction, the likely charge/discharge regime in use and the consequences of failure", wherein "the value of V_{max} can be determined according to battery supplier specifications, regulations and standards, and other product development considerations".

SUMMARY OF THE INVENTION

[0008] One objective of the present invention is to provide a universal charging device and a universal charging method thereof, which charge various batteries without knowing the rated voltages of the batteries. This way, users can use one charging device to charge various batteries, avoid using the wrong charging device to charge the battery and cause damage to batteries, reduce the probability of endangering work safety, and save costs. When replacing the battery, the user does not need to replace the charging device to avoid unnecessary waste.

[0009] The present invention provides a universal charging device having the features of claim 1. Further embodiments are subject-matter of the dependent claims. The universal charging device according to the invention includes a charger and a power control detector. The charger is coupled to at least one battery and configured to receive an alternating-current (AC) voltage and convert the AC voltage into a direct-current (DC) charging voltage. The at least one battery has a terminal voltage less than a rated voltage of the at least one battery. The power control detector is coupled to the at least one battery and the charger. After the charger and the power control detector determines that the at least one battery is a battery to be charged, the charger and the

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power control detector sequentially perform at least two first charging processes. In each of the at least two first charging processes, the power control detector detects the terminal voltage, controls the charger to adjust the DC charging voltage to be larger than the terminal voltage based on the terminal voltage, and controls the charger to generate at least one pulse voltage based on the DC charging voltage. The charger cooperates with the DC charging voltage to charge the at least one battery and respectively generates a direct-current (DC) charging current and at least one pulse current by applying the DC charging voltage and the at least one pulse voltage to at least one battery until the power control detector determines that the terminal voltage is equal to the DC charging voltage based on the DC charging current. The at least one pulse current flows through the at least one battery to establish a first detected voltage across the at least one battery. When the power control detector determines that the first detected voltage satisfies a charged condition and the terminal voltage is equal to the DC charging voltage. The power control detector controls the charger to convert the DC charging current into a decreasing trickle current until the value of the trickle current is decreased to a triggered current value. The triggered current value divided by the value of the corresponding DC charging current is equal to a fixed ratio less than 1 and larger than 0. Before the charger and the power control detector sequentially perform the at least two first charging processes, the power control detector detects the terminal voltage and drives the charger to provide an initial voltage for the at least one battery and generate an initial current. The initial current flows through the at least one battery. The power control detector is configured to receive the initial current and determine that the at least one battery is the battery to be charged according to the initial current, the terminal voltage, and a charging voltage range.

[0010] In an embodiment of the present invention, the at least one pulse current has a pulse period, an initial time point, and a final time point. The at least one pulse current establishes a first open-circuit voltage across the at least one battery at the initial time point. The at least one pulse current establishes a second open-circuit voltage across the at least one battery at the final time point. The charged condition defines that an absolute value of a difference between the first open-circuit voltage and the second open-circuit voltage divided by the pulse period is equal to or less than a given positive value.

[0011] In an embodiment of the present invention, the DC charging current establishes a first battery voltage across the at least one battery. The at least one pulse current establishes a second battery voltage across the at least one battery. The charged condition defines that the absolute value of a difference between the first battery voltage and the second battery voltage divided by the absolute value of a difference between the DC charging current and the at least one pulse current is equal to or less than a given positive value.

[0012] In an embodiment of the present invention, after the charger and the power control detector perform the at least two first charging processes, the charger and the power control detector perform a second charging process. In the second charging process, the power control detector detects the terminal voltage, controls the charger to adjust the DC charging voltage to be larger than the terminal voltage based on the terminal voltage, and controls the charger to generate the at least one pulse voltage in response to the DC charging voltage. The charger cooperates with the DC charging voltage to charge the at least one battery, respectively generates the DC charging current and the at least one pulse current by applying the DC charging voltage and the at least one pulse voltage to the at least one battery. The at least one pulse current establishes a second detected voltage across the at least one battery. When the power control detector determines the second detected voltage satisfies a full condition, the power control detector controls the charger to stop generating the DC charging voltage, the at least one pulse voltage, the DC charging current, and the at least one pulse current.

[0013] In an embodiment of the present invention, the at least one pulse current has a pulse period, an initial time point, and a final time point. The at least one pulse current establishes a first open-circuit voltage across the at least one battery at the initial time point. The at least one pulse current establishes a second open-circuit voltage across the at least one battery at the final time point. The full condition defines that the absolute value of a difference between the first open-circuit voltage and the second open-circuit voltage divided by the pulse period is larger than a given positive value.

[0014] In an embodiment of the present invention, the DC charging current establishes a first battery voltage across the at least one battery. The at least one pulse current establishes a second battery voltage across the at least one battery. The full condition defines that the absolute value of a difference between the first battery voltage and the second battery voltage divided by the absolute value of a difference between the DC charging current and the at least one pulse current is larger than a given positive value.

[0015] In an embodiment of the present invention, the at least one pulse current includes a plurality of pulse currents. When the power control detector determines that the second detected voltage established by each of the plurality of pulse currents satisfies the full condition, the power control detector controls the charger to stop generating the DC charging voltage.

[0016] In an embodiment of the present invention, in each of the at least two first charging processes, a period when the terminal voltage is equal to the DC charging voltage is less than a period when the DC charging voltage is larger than the terminal voltage.

[0017] In an embodiment of the present invention, the at least two first charging processes include a previous first charging process and a next first charging process.

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Periods corresponding to the DC charging current and the trickle current in the previous first charging process are respectively larger than periods corresponding to the DC charging current and the trickle current in the next first charging process.

[0018] In an embodiment of the present invention, the pulse period of the at least one pulse current is less than the period of the corresponding DC charging current.

[0019] In an embodiment of the present invention, the charger controls the DC charging voltage to be larger than the terminal voltage, a difference between the DC charging voltage and the corresponding terminal voltage is a given value. The given values corresponding to the at least two first charging processes are equal.

[0020] In an embodiment of the present invention, the at least two first charging processes comprise a previous first charging process and a next first charging process. When the charger adjusts the DC charging voltage to be larger than the terminal voltage, a difference between the DC charging voltage and the corresponding terminal voltage is a given value. The given value corresponding to the previous first charging process is larger than the given value corresponding to the next first charging process.

[0021] In an embodiment of the present invention, the at least two first charging processes comprise a previous first charging process and a next first charging process. Periods corresponding to the DC charging current and the trickle current in the previous first charging process are respectively less than periods corresponding to the DC charging current and the trickle current in the next first charging process.

[0022] In an embodiment of the present invention, the charger includes an input rectifier, a resonate converter, and a synchronous rectifier. The input rectifier is configured to receive the AC voltage and convert the AC voltage into an input direct-current (DC) voltage. The resonate converter is coupled to the input rectifier and the power control detector. The resonate converter is configured to receive the input DC voltage and convert the input DC voltage into a resonate voltage. The synchronous rectifier is coupled to the resonate converter and the at least one battery. The synchronous rectifier is configured to receive the resonate voltage and convert the resonate voltage into the DC charging voltage. The power control detector is configured to control the resonate converter and the synchronous rectifier to adjust the DC charging voltage to be larger than the terminal voltage based on the terminal voltage. The power control detector is configured to control the resonate converter and the synchronous rectifier to generate the at least one pulse voltage in response to the DC charging voltage. The resonate converter and the synchronous rectifier are configured to respectively generate the DC charging current and the at least one pulse current by applying the DC charging voltage and the at least one pulse voltage. When the terminal voltage is equal to the DC charging voltage, the power control detector controls the resonate converter and the synchronous rectifier to convert the DC charging current into the trickle current.

[0023] In an embodiment of the present invention, the power control detector includes a voltage feedback circuit, a feedback resistor, a current feedback circuit, an isolator, and a controller. The voltage feedback circuit is coupled to the synchronous rectifier and the at least one battery. The voltage feedback circuit is configured to receive the terminal voltage and a voltage across the at least one battery established by the at least one pulse current, and respectively generate a first feedback voltage and at least one pulse feedback voltage based on the terminal voltage and a voltage across the at least one battery established by the at least one pulse current. The feedback resistor is connected between the synchronous rectifier and the at least one battery in series. The DC charging current, the trickle current, and the at least one pulse current flow through the feedback resistor, so as to generate a first responsive voltage, a trickle voltage, and at least one second responsive voltage across the feedback resistor. The current feedback circuit is coupled to two ends of the feedback resistor, the synchronous rectifier, and the at least one battery. The current feedback circuit is configured to receive the first responsive voltage, the trickle voltage, and the at least one second responsive voltage and respectively generate a second feedback voltage, a trickle feedback voltage, and at least one pulse responsive voltage based on the first responsive voltage, the trickle voltage, and the at least one second responsive voltage. The isolator has a primary side and a secondary side. The secondary side is coupled to the voltage feedback circuit and the current feedback circuit. The controller is coupled to the primary side and the resonate converter. The controller is configured to receive the first feedback voltage, the second feedback voltage, the trickle feedback voltage, the at least one pulse feedback voltage, and the at least one pulse responsive voltage through the isolator. The controller is configured to control the resonate converter and the synchronous rectifier to adjust the DC charging voltage to be larger than the terminal voltage based on the first feedback voltage. The controller is configured to control the resonate converter and the synchronous rectifier to generate the at least one pulse voltage in response to the DC charging voltage. The controller is configured to obtain the DC charging current according to the second feedback voltage. The controller is configured to obtain the DC charging voltage according to the DC charging current. The controller is configured to obtain the at least one pulse current according to the at least one pulse responsive voltage. The controller is configured to obtain the trickle current according to the trickle feedback voltage. The controller is configured to determine that the at least one pulse feedback voltage satisfies the charged condition. When the terminal voltage is equal to the DC charging voltage, the controller controls the resonate converter and the synchronous rectifier to convert the DC charging current into the trickle current until the value

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of the trickle current is decreased to the triggered current value.

[0024] In an embodiment of the present invention, the fixed ratio is 90% or 85%.

[0025] In an embodiment of the present invention, the initial value of the terminal voltage divided by the rated voltage is less than or equal to 97%.

[0026] In an embodiment of the present invention, the at least one battery is a lithium-ion battery.

[0027] In an embodiment of the present invention, the lithium-ion battery is a nickel-cobalt-lithium battery, a nickel-lithium battery, or a $LiFePO_4$ battery.

[0028] In an embodiment of the present invention, the rated voltage has a range of 9-72 volts.

[0029] In an embodiment of the present invention, the at least one battery comprises 10-20 batteries connected in series.

[0030] The present invention provides also a universal charging method having the features of claim 22. Further embodiments are subject-matter of the dependent claims. The universal charging method charges at least one battery. The at least one battery has a terminal voltage less than a rated voltage of the at least one battery. The universal charging method includes: determining that the at least one battery is a battery to be charged; converting an alternating-current (AC) voltage into a direct-current (DC) charging voltage; and sequentially performing at least two first charging processes, wherein each of the at least two first charging processes comprising steps:

adjusting the DC charging voltage to be larger than the terminal voltage based on the terminal voltage, cooperating with the DC charging voltage to charge the at least one battery, generating at least one pulse voltage based on the DC charging voltage, respectively generating a direct-current (DC) charging current and at least one pulse current by applying the DC charging voltage and the at least one pulse voltage until the terminal voltage is equal to the DC charging voltage, the DC charging current and the at least one pulse current flowing through the at least one battery, the at least one pulse current flowing through the at least one battery to establish a first detected voltage across the at least one battery, and the first detected voltage satisfying a charged condition;

when the terminal voltage is equal to the DC charging voltage, converting the DC charging current into a decreasing trickle current until a value of the trickle current is decreased to a triggered current value, and the triggered current value divided by a value of a corresponding the DC charging current is equal to a fixed ratio less than 1 and larger than 0; and

wherein in the step of determining that the at least one battery is the battery to be charged, the terminal voltage is detected, an initial voltage is provided to the at least one battery to generate an initial current that flows through the at least one battery, and the at least one battery is determined as the battery to be charged according to the initial current, the terminal voltage, and a charging voltage range.

[0031] In an embodiment of the present invention, the at least one pulse current has a pulse period, an initial time point, and a final time point. The at least one pulse current establishes a first open-circuit voltage across the at least one battery at the initial time point. The at least one pulse current establishes a second open-circuit voltage across the at least one battery at the final time point. The charged condition defines that the absolute value of a difference between the first open-circuit voltage and the second open-circuit voltage divided by the pulse period is equal to or less than a given positive value.

[0032] In an embodiment of the present invention, the DC charging current establishes a first battery voltage across the at least one battery. The at least one pulse current establishes a second battery voltage across the at least one battery. The charged condition defines that the absolute value of a difference between the first battery voltage and the second battery voltage divided by the absolute value of a difference between the DC charging current and the at least one pulse current is equal to or less than a given positive value.

[0033] In an embodiment of the present invention, after the step of performing the at least two first charging processes, performing a second charging process, and the second charging process comprises steps: adjusting the DC charging voltage to be larger than the terminal voltage based on the terminal voltage, cooperating with the DC charging voltage to charge the at least one battery, generating the at least one pulse voltage in response to the DC charging voltage, respectively generating the DC charging current and the at least one pulse current by applying the DC charging voltage and the at least one pulse voltage, and the DC charging current and the at least one pulse current flowing through the at least one battery; and the at least one pulse current establishing a second detected voltage across the at least one battery, and when the second detected voltage satisfies a full condition, stopping generating the DC charging voltage, the at least one pulse voltage, the DC charging current, and the at least one pulse current.

[0034] In an embodiment of the present invention, the at least one pulse current has a pulse period, an initial time point, and a final time point. The at least one pulse current establishes a first open-circuit voltage across the at least one battery at the initial time point. The at least one pulse current establishes a second open-circuit voltage across the at least one battery at the final time point. The full condition defines that the absolute value of a difference between the first open-circuit voltage and the second open-circuit voltage divided by the pulse period is larger than a given positive value.

[0035] In an embodiment of the present invention, the DC charging current establishes a first battery voltage

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across the at least one battery. The at least one pulse current establishes a second battery voltage across the at least one battery. The full condition defines that the absolute value of a difference between the first battery voltage and the second battery voltage divided by the absolute value of a difference between the DC charging current and the at least one pulse current is larger than a given positive value.

[0036] In an embodiment of the present invention, the at least one pulse current includes a plurality of pulse currents. When the second detected voltage established by each of the plurality of pulse currents satisfies the full condition, the DC charging voltage stops being generated.

[0037] In an embodiment of the present invention, in each of the at least two first charging processes, a period when the terminal voltage is equal to the DC charging voltage is less than a period when the DC charging voltage is larger than the terminal voltage.

[0038] In an embodiment of the present invention, the at least two first charging processes include a previous first charging process and a next first charging process. Periods corresponding to the DC charging current and the trickle current in the previous first charging process are respectively larger than periods corresponding to the DC charging current and the trickle current in the next first charging process.

[0039] In an embodiment of the present invention, the pulse period of the at least one pulse current is less than the period of the corresponding DC charging current.

[0040] In an embodiment of the present invention, in the step of adjusting the DC charging voltage to be larger than the terminal voltage, a difference between the DC charging voltage and the corresponding terminal voltage is a given value. The given values corresponding to the at least two first charging processes are equal.

[0041] In an embodiment of the present invention, the at least two first charging processes include a previous first charging process and a next first charging process. In the step of adjusting the DC charging voltage to be larger than the terminal voltage, a difference between the DC charging voltage and the corresponding terminal voltage is a given value. The given value corresponding to the previous first charging process is larger than the given value corresponding to the next first charging process.

[0042] In an embodiment of the present invention, the at least two first charging processes include a previous first charging process and a next first charging process. Periods of the DC charging current and the trickle current corresponding to the previous first charging process are respectively less than periods of the DC charging current and the trickle current corresponding to the next first charging process.

[0043] In an embodiment of the present invention, the fixed ratio is 90% or 85%.

[0044] In an embodiment of the present invention, the initial value of the terminal voltage divided by the rated voltage is less than or equal to 97%.

[0045] Below, the embodiments are described in detail in cooperation with the drawings to make easily understood the technical contents, characteristics and accomplishments of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046]

Fig.1 is a diagram schematically illustrating a universal charging device according to an embodiment of the present invention;

Fig.2 is a flowchart of a universal charging method according to an embodiment of the present invention;

Fig.3 is a diagram schematically illustrating waveforms of a terminal voltage of a battery, a DC charging voltage, a DC charging current, and a trickle current according to an embodiment of the present invention;

Fig.4 is a diagram schematically illustrating waveforms of a negative pulse voltage and a negative pulse current according to an embodiment of the present invention;

Fig.5 is a diagram schematically illustrating waveforms of a positive pulse voltage and a positive pulse current according to an embodiment of the present invention;

Fig.6 is a flowchart of a second charging process according to an embodiment of the present invention; and

Fig.7 is a diagram schematically illustrating a charger and a power control detector according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0047] Reference will now be made in detail to embodiments illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts. In the drawings, the shape and thickness may be exaggerated for clarity and convenience. This description will be directed in particular to elements forming part of, or cooperating more directly with, methods and apparatus in accordance with the present disclosure. It is to be understood that elements not specifically shown or described may take various forms well known to those skilled in the art. Many alternatives and modifications will be apparent to those skilled in the art, once informed by the present disclosure.

[0048] Unless otherwise specified, some conditional sentences or words, such as "can", "could", "might", or "may", usually attempt to express that the embodiment in the present invention has, but it can also be interpreted as a feature, element, or step that may not be needed. In other embodiments, these features, elements, or steps

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may not be required.

[0049] Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, the appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment.

[0050] Certain terms are used throughout the description and the claims to refer to particular components. One skilled in the art appreciates that a component may be referred to as different names. This disclosure does not intend to distinguish between components that differ in name but not in function. In the description and in the claims, the term "comprise" is used in an open-ended fashion, and thus should be interpreted to mean "include, but not limited to." The phrases "be coupled to," "couples to," and "coupling to" are intended to compass any indirect or direct connection. Accordingly, if this disclosure mentioned that a first device is coupled with a second device, it means that the first device may be directly or indirectly connected to the second device through electrical connections, wireless communications, optical communications, or other signal connections with/without other intermediate devices or connection means.

[0051] Referring to Fig. 1 and Fig.2, an embodiment of the universal charging device of the present invention is introduced as follows. The universal charging device includes a charger 10 and a power control detector 12. The charger 10 is coupled to at least one battery 14. The battery 14 may be a lithium-ion battery, such as a nickel-cobalt-lithium battery, a nickel-lithium battery, or a $LiFePO_4$ battery, but the present invention is not limited thereto. The rated voltage of the battery 14 is not limited. The rated voltage of the battery 14 may be 9-72 volts. The present invention also uses 10-20 batteries 14 connected in series. In an embodiment of the present invention, one battery 14 is used. Lithium-ion batteries can be used in many consumer electronics, especially the application of portable electronics. The portable electronics include electric bicycles, unicycles, two-wheeled balanced bikes, skateboard balanced bikes, electric motorcycles, electric carts, electric patrol cars, electric golf carts, hand-held electric drills, electric wrenches, electric hammers, movable electric lawn mowers, grinders, high-pressure cleaners, remote control helicopters, remote control model cars, aerial cameras, remote control boats, handling robots, warehousing logistics handling trucks, forklifts, etc. The battery 14 has a terminal voltage VT. The terminal voltage VT is less than the rated voltage of the battery 14. Preferably but not limitedly, the initial value of the terminal voltage VT divided by the rated voltage is less than or equal to 97%. In Step S8, the charger 10 and the power control detector 12 determines that the battery 14 is a battery to be charged. In some embodiments of the present invention, the charger 10 receives an alternating-current (AC) voltage AV. The power control detector 12 may detect the terminal voltage VT and drive the charger 10 to provide an initial voltage IV for the battery 14 in response to the AC voltage AV, thereby generating an initial current IA. The initial current IA flows through the battery 14. The power control detector 12 receives the initial current IA and determines that the battery 14 is a battery to be charged according to the initial current IA, the terminal voltage VT, and a charging voltage range. For example, when the terminal voltage VT is higher than or lower than the charging voltage range, the power control detector 12 determines that the battery 14 is not a battery to be charged, such that the subsequent charging processes cannot be performed. When the terminal voltage VT is within the charging voltage range and the value of the initial current IA is less than a given current value, the power control detector 12 also determines that the battery 14 is not a battery to be charged, such that the subsequent charging processes cannot be performed. When the terminal voltage VT is within the charging voltage range and the value of the initial current IA is higher than or equal to a given current value, the power control detector 12 also determines that the battery 14 is a battery to be charged, such that the subsequent charging processes can be performed.

[0052] In Step S10, the charger 10 receives the AC voltage AV, such as mains electricity. The charger 10 converts the AC voltage AV into a direct-current (DC) charging voltage DV. The power control detector 12 is coupled to the battery 14 and the charger 10. The charger 10 and the power control detector 12 sequentially perform at least two first charging processes. Each first charging process includes Steps S12 and S14.

[0053] Refer to Fig.1, Fig.2, Fig.3, Fig.4, and Fig.5. In Step S12, the power control detector 12 detects the terminal voltage VT. The power control detector 12 controls the charger 10 to adjust the DC charging voltage DV to be larger than the terminal voltage VT based on the terminal voltage VT. The power control detector 12 controls the charger 10 to generate at least one pulse voltage PV based on the DC charging voltage DV. The pulse voltage PV may be a positive pulse voltage or a negative pulse voltage. In some embodiments of the present invention, the number of the pulse voltage PV is one or more. The charger 10 cooperates with the DC charging voltage DV to charge the battery 14 and respectively generates a direct-current (DC) charging current DI and at least one pulse current PI by applying the DC charging voltage DV and the at least one pulse voltage PV to the battery 14 until the power control detector 12 determines that the terminal voltage VT is equal to the DC charging voltage DV based on the DC charging current DI. In some embodiments of the present invention, the number of the pulse current PI is one or more. When the pulse voltage PV is a positive pulse voltage, the pulse current PI is a positive pulse current. When the pulse voltage PV is a negative pulse voltage, the pulse current PI is a negative pulse current. The depth and the width of the pulse current PI are adaptable according to requirement. The

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pulse current PI cannot influence the charging processes. The pulse current PI flows through the battery 14 to establish a first detected voltage across the battery 14. The power control detector 12 determines that the first detected voltage satisfies a charged condition. In Step S14, when the terminal voltage VT is equal to the DC charging voltage DV, the power control detector 12 controls the charger 10 to convert the DC charging current DI into a decreasing trickle current TI until the value of the trickle current TI is decreased to a triggered current value. The triggered current value divided by a value of the corresponding DC charging current DI is equal to a fixed ratio less than 1 and larger than 0. The fixed ratio may be 90% or 85%. The fixed ratio is adaptable according to requirement.

[0054] The present invention performs at least two first charging processes on the battery 14 without knowing the rated voltage of the battery 14. The present invention uses the decreasing trickle current TI at least two times to avoid the overcharge phenomenon of the battery 14. The conventional charging device in the market charges a battery at a given constant voltage. Unlike the conventional charging device, the charging device of the present invention charges a battery during at least two steps. This way, users may use a single charging device to charge various batteries, avoid using the wrong charging device to charge the battery and cause damage to batteries, reduce the probability of endangering work safety, and save costs. When replacing the battery, the user does not need to replace the charging device to avoid unnecessary waste.

[0055] The present invention does not limit the charged condition. In some embodiments of the present invention, the pulse current PI has a pulse period T, an initial time point t1, and a final time point t2. The pulse current PI establishes a first open-circuit voltage O1 across the battery 14 at the initial time point t1. The pulse current PI establishes a second open-circuit voltage O2 across the battery 14 at the final time point t2. The pulse period T, the first open-circuit voltage O1, and the second open-circuit voltage O2 are transmitted to the power control detector 12. The charged condition defines that the absolute value of a difference between the first open-circuit voltage O1 and the second open-circuit voltage O2 divided by the pulse period T is equal to or less than a given positive value.

[0056] In some embodiments of the present invention, the DC charging current DI establishes a first battery voltage B1 across the battery 14. The pulse current PI establishes a second battery voltage B2 across the battery 14. The first battery voltage B1 and the second battery voltage B2 are transmitted to the power control detector 12.

[0057] The charged condition defines that the absolute value of a difference between the first battery voltage B1 and the second battery voltage B2 divided by the absolute value of a difference between the DC charging current DI and the pulse current PI is equal to or less than a given positive value. As mentioned above, the present invention can define the charged condition based on the internal resistance of the battery 14.

[0058] In some embodiments of the present invention, in each first charging process, a period when the terminal voltage VT is equal to the DC charging voltage DV is less than a period when the DC charging voltage DV is larger than the terminal voltage VT. Thus, the charging time is reduced. Preferably but not limitedly, periods corresponding to the DC charging current DI and the trickle current TI in the previous first charging process are respectively larger than periods corresponding to the DC charging current DI and the trickle current TI in the next first charging process. Thus, the total period T1 of the previous first charging process is larger than the total period T2 of the next first charging process. This is because the DC charging voltage DV will be higher and higher, so that the time of the first charging process will be shorter and shorter. It is noted that the period of the pulse current PI is very short. The period of the pulse current PI may be 30 seconds. That is to say, in the same first charging process, the pulse period T of the pulse current PI is less than the period of the corresponding DC charging current DI, but the present invention is not limited thereto. The pulse period T can allow the power control detector 12 to read the current value and the voltage value corresponding to the pulse current PI. If the pulse period T is very short, the power control detector 12 will not read the current value and the voltage value corresponding to the pulse current PI. In some embodiments of the present invention, the charger 10 controls the DC charging voltage DV to be larger than the terminal voltage VT. A difference between the DC charging voltage DV and the corresponding terminal voltage is a given value. The given values corresponding to all the first charging processes are equal.

[0059] For example, the given value may be 2 V. The charger 10 provides the DC charging voltage DV that can be 39 V. The terminal voltage VT is 37 V when the charger 10 starts to charge the battery 14. Simultaneously, the DC charging current DI is a fixed value, which is 100% of a full current. The terminal voltage VT gradually increases to 39 V. Afterwards, the trickle current TI starts to decrease. When the trickle current TI decreases to a triggered current value that can be 85% of the full current, the DC charging voltage DV is increased by 2 V. The abovementioned process is endlessly repeated until the battery 14 is full of power. Each increased voltage difference is adaptable according to requirement, such as resolution of the power control detector 12 and properties of the battery 14. The increased voltage difference may be 1 V or 3V. This experiment was conducted with a fully discharged battery 14. The times that the voltage increases depends on the rated voltage of the battery 14. The given value being the increased voltage difference may be preset in the power control detector 12. Alternatively, in some applications, the given value is inputted in a wired or wirelessly way. The power control detector 12 reads

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the given value being the increased voltage difference. The triggered current value is transmitted to the power control detector 12 in a wired or wirelessly way or preset in the power control detector 12.

[0060] Considering the cost, the power control detector 12 is sometimes implemented with a low-resolution control chip. Alternatively, the DC charging voltage DV is greatly larger than the terminal voltage VT, such that the feedback circuit cannot rapidly respond. In these situations, the following ways are used to adjust the given value and the total period of the first charging process. In some embodiments of the present invention, when the charger 10 adjusts the DC charging voltage DV to be larger than the terminal voltage VT, a difference between the DC charging voltage DV and the corresponding terminal voltage VT is a given value. The given value corresponding to the previous first charging process is larger than the given value corresponding to the next first charging process. In addition, periods corresponding to the DC charging current DI and the trickle current TI in the previous first charging process are respectively less than periods corresponding to the DC charging current DI and the trickle current TI in the next first charging process. As a result, the total period T3 of the previous first charging process is less than the total period T1 of the next first charging process. The speed of feedback response is insufficiently high, which is a relative concept. The concept can determine whether the hardware of the charging device has a capability to recognize the difference of voltage and current in unit time. If the charging device cannot recognize the difference of voltage and current, the speed of feedback response may be one of reasons.

[0061] Refer to Fig.1, Fig.2, Fig.3, Fig.4, Fig.5, and Fig.6. In some embodiments of the present invention, after performing all the first charging processes, the charger 10 and the power control detector 12 perform a second charging process. The second charging process includes Steps S16 and S18. In Step S16, the power control detector 12 detects the terminal voltage VT. The power control detector 12 controls the charger 10 to adjust the DC charging voltage DV to be larger than the terminal voltage VT based on the terminal voltage VT. The power control detector 12 controls the charger 10 to generate at least one pulse voltage PV in response to the DC charging voltage DV. The pulse voltage PV may be a positive pulse voltage or a negative pulse voltage. In some embodiments of the present invention, the number of the pulse voltage PV is one or more. The charger 10 cooperates with the DC charging voltage DV to charge the battery 14. The charger 10 respectively generates the DC charging current DI and at least one pulse current PI by applying the DC charging voltage DV and the pulse voltage PV to the battery 14. In some embodiments of the present invention, the number of the pulse current PI is one or more. When the pulse voltage PV is a positive pulse voltage, the pulse current PI is a positive pulse current. When the pulse voltage PV is a negative pulse voltage, the pulse current PI is a negative pulse current. The depth and the width of the pulse current PI are adaptable according to requirement. The pulse current PI cannot influence the charging processes. The pulse current PI establishes a second detected voltage across the battery 14. In Step S18, when the power control detector 12 determines the second detected voltage satisfies a full condition, the power control detector 12 controls charger 10 to stop generating the DC charging voltage DV, the pulse voltage PV, the DC charging current DI, and the pulse current PI, lest the DC charging voltage DV be endlessly increased to overcharge the battery 14. The present invention does not limit the full condition. In some embodiments of the present invention, the pulse current PI has a pulse period T, an initial time point t1, and a final time point t2. The pulse current PI establishes a first open-circuit voltage O1 across the battery 14 at the initial time point t1. The pulse current PI establishes a second open-circuit voltage O2 across the battery 14 at the final time point t2. The pulse period T, the first open-circuit voltage O1, and the second open-circuit voltage O2 are transmitted to the power control detector 12. The full condition defines that the absolute value of a difference between the first open-circuit voltage O1 and the second open-circuit voltage O2 divided by the pulse period T is larger than a given positive value.

[0062] In some embodiments of the present invention, the DC charging current DI establishes a first battery voltage B1 across the battery 14. The pulse current PI establishes a second battery voltage B2 across the battery 14. The first battery voltage B1 and the second battery voltage B2 are transmitted to the power control detector 12. The full condition defines that the absolute value of a difference between the first battery voltage B1 and the second battery voltage B2 divided by the absolute value of a difference between the DC charging current DI and the pulse current PI is larger than a given positive value. As mentioned above, the full condition depends on the internal resistance of the battery 14.

[0063] In some embodiments of the present invention, there is a plurality of pulse currents PI. When the power control detector 12 determines that the second detected voltage established by each of the plurality of pulse currents PI satisfies the full condition, the power control detector 12 controls the charger 10 to stop generating the DC charging voltage DV. The number of the pulse currents PI satisfying the full condition is adaptable according to hardware specifications.

[0064] Refer to Fig.1, Fig.3, Fig.4, Fig.5, and Fig.7. The circuit architecture of Fig.7 may be applied to the embodiment of Fig.1 or the other embodiments of the present invention, but the present invention is not limited thereto. The charger 10 may include an input rectifier 16, a resonate converter 18, and a synchronous rectifier 20. The input rectifier 16 may include an X capacitor, a Y capacitor, a bridge rectifier, and a power factor correction (PFC) circuit. The PFC circuit may be an interleave PFC circuit. The resonate converter 18 may be a topology formed by

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a transformer and power transistors, such as a LLC resonate converter. The synchronous rectifier 20 may be a rectifier formed by diodes. The input rectifier 16 receives the AC voltage AV and converts the AC voltage AV into an input direct-current (DC) voltage ID. The resonate converter 18 is coupled to the input rectifier 16 and the power control detector 12. The resonate converter 18 receives the input DC voltage ID and convert the input DC voltage ID into a resonate voltage RV. The synchronous rectifier 20 is coupled to the resonate converter 18 and the battery 14. The synchronous rectifier 20 receives the resonate voltage RV and convert the resonate voltage RV into the DC charging voltage DV. The power control detector 12 controls the resonate converter 18 and the synchronous rectifier 20 to adjust the DC charging voltage DV to be larger than the terminal voltage VT based on the terminal voltage VT. The power control detector 12 controls the resonate converter 18 and the synchronous rectifier 20 to generate the pulse voltage PV in response to the DC charging voltage DV. The resonate converter 18 and the synchronous rectifier 20 respectively generate the DC charging current DI and the pulse current PI by applying the DC charging voltage DV and the pulse voltage PV. When the terminal voltage VT is equal to the DC charging voltage DV, the power control detector 12 controls the resonate converter 18 and the synchronous rectifier 20 to convert the DC charging current DI into the trickle current TI.

[0065] The power control detector 12 may include a voltage feedback circuit 22, a feedback resistor 24, a current feedback circuit 26, an isolator 28, and a controller 30. For example, the voltage feedback circuit 22 and the current feedback circuit 26 may be comparators. The isolator 28 may be an optical coupler. The controller 30 is configured to control the duty cycle of the power transistor of the resonate converter 18. The voltage feedback circuit 22 is coupled to the synchronous rectifier 20 and the battery 14. The voltage feedback circuit 22 receives the terminal voltage VT and a voltage across the battery 14 established by the pulse current PI. The voltage feedback circuit 22 respectively generates a first feedback voltage F1 and at least one pulse feedback voltage PF based on the terminal voltage VT and a voltage across the battery 14 established by the pulse current PI. The feedback resistor 24 is connected between the synchronous rectifier 20 and the battery 14 in series. The DC charging current DI, the trickle current TI, and the pulse current PI flow through the feedback resistor 24, so as to generate a first responsive voltage RES1, a trickle voltage RT, and at least one second responsive voltage RES2 across the feedback resistor 24. The current feedback circuit 26 is coupled to two ends of the feedback resistor 24, the synchronous rectifier 20, and the battery 14. The current feedback circuit 26 receives the first responsive voltage RES1, the trickle voltage RT, and the second responsive voltage RES2 and respectively generates a second feedback voltage F2, a trickle feedback voltage RF, and at least one pulse responsive voltage PR based on the first responsive voltage RES1, the trickle voltage RT, and the second responsive voltage RES2. The isolator has a primary side and a secondary side. The secondary side is coupled to the voltage feedback circuit 22 and the current feedback circuit 26. The controller 30 is coupled to the primary side of the isolator 28 and the resonate converter 18. The controller 30 receives the first feedback voltage F1, the second feedback voltage F2, the trickle feedback voltage RF, the pulse feedback voltage PF, and the pulse responsive voltage PR through the isolator 28. The controller 30 controls the resonate converter 18 and the synchronous rectifier 20 to adjust the DC charging voltage DV to be larger than the terminal voltage VT based on the first feedback voltage F1.

[0066] The controller 30 controls the resonate converter 18 and the synchronous rectifier 20 to generate the pulse voltage PV in response to the DC charging voltage DV. The controller 30 obtains the DC charging current DI according to the second feedback voltage F2. The controller 30 obtains the DC charging voltage DV according to the DC charging current DI. The controller 30 obtains the pulse current PI according to the pulse responsive voltage PR. The controller 30 obtains the trickle current TI according to the trickle feedback voltage RF. The controller 30 determines that the pulse feedback voltage PF satisfies the charged condition. When the terminal voltage VT is equal to the DC charging voltage DV, the controller 30 controls the resonate converter 18 and the synchronous rectifier 20 to convert the DC charging current DI into the trickle current TI until the value of the trickle current TI is decreased to the triggered current value.

[0067] In some embodiments of the present invention, the pulse feedback voltage PF includes the pulse period T, the first open-circuit voltage O1, and the second open-circuit voltage 02. The controller 30 determines whether the pulse feedback voltage PF satisfies the charged condition or the full condition based on the pulse period T, the first open-circuit voltage O1, and the second open-circuit voltage 02. Alternatively, the pulse feedback voltage PF includes the second battery voltage B2. The voltage feedback circuit 22 transmits the first battery voltage B1 to the controller 30 through the isolator 28. Thus, the controller 30 determines whether the first battery voltage B1, the second battery voltage B2, the DC charging current DI, and the pulse current PI satisfy the charged condition or the full condition. The controller 30 can adjust the number of the pulse currents PI for stopping generating the DC charging voltage DV, the periods of the DC charging current and the trickle current TI, the pulse period T, and the difference between the DC charging voltage DV and the corresponding terminal voltage VT. The controller 30 may be implemented with an analog controller, a digital controller, a low-resolution control chip, or a high-resolution control chip, but the present invention is not limited thereto.

[0068] The complete operation of the universal charg-

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ing device of the present invention is introduced as follows. The input rectifier 16 receives the AC voltage AV and converts the AC voltage AV into the input DC voltage ID. The voltage feedback circuit 22 receives the terminal voltage VT and generates a corresponding voltage based on the terminal voltage VT. The voltage feedback circuit 22 transmits the corresponding voltage to the controller 30 through the isolator 28. The controller 30 obtains the terminal voltage VT according to the corresponding voltage and determines that the terminal voltage VT is within the charging voltage range. The resonate converter 18 and the synchronous rectifier 20 provide an initial voltage IV for the battery 14 to generate an initial current IA. The initial current IA flows through the battery 14. The initial current IA flows through the feedback resistor 24 to establish a voltage drop across the feedback resistor 24. The current feedback circuit 26 receives the voltage drop and transmits the voltage drop to the controller 30 through the isolator 28. The controller 30 obtains the initial current IA according to the voltage drop. Because the initial current IA is larger than or equal to a given current value, the controller 30 determines that the battery 14 is a battery to be charged, such that the subsequent charging process is performed.

[0069] The input rectifier 16 receives the AC voltage AV and converts the AC voltage AV into an input DC voltage ID. Then, the resonate converter 18 receives the input DC voltage ID and convert the input DC voltage ID into the resonate voltage RV. The synchronous rectifier 20 receives the resonate voltage RV and convert the resonate voltage RV into the DC charging voltage DV. The DC charging voltage DV is applied to the battery 14 to charge the battery 14. Simultaneously, the resonate converter 18 and the synchronous rectifier 20 generate the DC charging current DI by applying the DC charging voltage DV. The DC charging current DI flows through the battery 14 and the feedback resistor 24.

[0070] Then, at least two first charging processes are performed. Each first charging process includes the following steps. The voltage feedback circuit 22 receives the terminal voltage VT and generates the first feedback voltage F1 based on the terminal voltage VT. The DC charging current DI establishes the first responsive voltage RES1 across the feedback resistor 24. The current feedback circuit 26 receives the first responsive voltage RES1 and generates the second feedback voltage F2 based on the first responsive voltage RES1. The controller 30 receives the first feedback voltage F1 and the second feedback voltage F2 through the isolator 28. The controller 30 obtains the terminal voltage VT according to the first feedback voltage F1. The controller 30 obtains the DC charging current DI according to the second feedback voltage F2. The controller 30 obtains the DC charging voltage DV according to the DC charging current DI. The controller 30 controls the resonate converter 18 and the synchronous rectifier 20 to adjust the DC charging voltage DV to be larger than the terminal voltage VT based on the first feedback voltage F1. The controller 30 controls the resonate converter 18 and the synchronous rectifier 20 to generate the pulse voltage PV in response to the DC charging voltage DV. The resonate converter 18 and the synchronous rectifier 20 respectively generate the DC charging current DI and the pulse current PI by applying the DC charging voltage DV and the pulse voltage PV. The voltage feedback circuit 22 receives a voltage across the battery 14 established by the pulse current PI and generates the pulse feedback voltage PF based on the voltage across the battery 14 established by the pulse current PI. Simultaneously, the pulse current PI flows through the feedback resistor 24 and establishes the second responsive voltage RES2 across the feedback resistor 24. The current feedback circuit 26 receives the second responsive voltage RES2 and generates the pulse responsive voltage PR based on the second responsive voltage RES2. The controller 30 receives the pulse feedback voltage PF and the pulse responsive voltage PR through the isolator 28. The controller 30 obtains the pulse current PI according to the pulse responsive voltage PR. The controller 30 determines that the pulse feedback voltage PF satisfies the charged condition. When the terminal voltage VT is equal to the DC charging voltage DV, the controller 30 controls the resonate converter 18 and the synchronous rectifier 20 to convert the DC charging current DI into the trickle current TI. The trickle current TI flows through the feedback resistor 24 and establishes the trickle voltage RT across the feedback resistor 24. The current feedback circuit 26 receives the trickle voltage RT and generates the trickle feedback voltage RF based on the trickle voltage RT. The controller 30 receives the trickle feedback voltage RF through the isolator 28. The controller 30 obtains the trickle current TI according to the trickle feedback voltage RF. When the controller 30 determines that the value of the trickle current TI is decreased to the triggered current value, the first charging process is finished.

[0071] After all the first charging processes, the second charging process is performed. The second charging process includes the following steps. The voltage feedback circuit 22 receives the terminal voltage VT and generates the first feedback voltage F1 based on the terminal voltage VT. The DC charging current DI establishes the first responsive voltage RES1 across the feedback resistor 24. The current feedback circuit 26 receives the first responsive voltage RES1 and generates the second feedback voltage F2 based on the first responsive voltage RES1. The controller 30 receives the first feedback voltage F1 and the second feedback voltage F2 through the isolator 28. The controller 30 obtains the terminal voltage VT according to the first feedback voltage F1. The controller 30 obtains the DC charging current DI according to the second feedback voltage F2. The controller 30 obtains the DC charging voltage DV according to the DC charging current DI. The controller 30 controls the resonate converter 18 and the synchronous rectifier 20 to adjust the DC charging voltage DV to be larger than the terminal voltage VT based on the first feedback volt-

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age F1. The controller 30 controls the resonate converter 18 and the synchronous rectifier 20 to generate the pulse voltage PV in response to the DC charging voltage DV. The resonate converter 18 and the synchronous rectifier 20 respectively generate the DC charging current DI and the pulse current PI by applying the DC charging voltage DV and the pulse voltage PV. The voltage feedback circuit 22 receives a voltage across the battery 14 established by the pulse current PI and generates the pulse feedback voltage PF based on the voltage across the battery 14 established by the pulse current PI. Simultaneously, the pulse current PI flows through the feedback resistor 24 and establishes the second responsive voltage RES2 across the feedback resistor 24. The current feedback circuit 26 receives the second responsive voltage RES2 and generates the pulse responsive voltage PR based on the second responsive voltage RES2. The controller 30 receives the pulse feedback voltage PF and the pulse responsive voltage PR through the isolator 28. The controller 30 obtains the pulse current PI according to the pulse responsive voltage PR. When the controller 30 determines that the pulse feedback voltage PF satisfies the full condition, the controller 30 controls the resonate converter 18 and the synchronous rectifier 20 to stop generating the DC charging voltage DV, the pulse voltage PV, the DC charging current DI, and the pulse current PI.

[0072] According to the embodiments provided above, the present invention can charge batteries with different rated voltages without knowing the battery capacity. This way, users only need one charging device to charge various batteries without purchasing additional matching charging devices. The present invention can save expenditure, avoid the damage to the battery caused by using the wrong charging device, or avoid the work safety hazards such as explosion caused by overcharging the battery.

[0073] The embodiments described above are only to exemplify the present invention but not to limit the scope of the present invention.

Claims

1. A universal charging device comprising:

a charger (10) coupled to at least one battery (14) and configured to receive an alternating-current (AC) voltage and convert the AC voltage into a direct-current (DC) charging voltage (DV), wherein the at least one battery (14) has a terminal voltage (VT) when the DC charging voltage (DV) is not applied, which terminal voltage (VT) is less than a rated voltage of the at least one battery (14); and

a power control detector (12) coupled to the at least one battery (14) and the charger (10), wherein after the charger (10) and the power control detector (12) determines that the at least one battery (14) is a battery to be charged, the charger (10) and the power control detector (12) sequentially perform at least two first charging processes;

wherein in each of the at least two first charging processes, the power control detector (12) detects the terminal voltage (VT), controls the charger (10) to adjust the DC charging voltage (DV) to be larger than the terminal voltage (VT) based on the terminal voltage (VT), and controls the charger (10) to generate at least one pulse voltage (PV) based on the DC charging voltage (DV), the charger (10) applies the DC charging voltage (DV) to charge the at least one battery (14) and respectively generates a direct-current (DC) charging current (DI) and at least one pulse current (PI) by applying the DC charging voltage (DV) and the at least one pulse voltage (PV) to the at least one battery (14) until the power control detector (12) determines that the terminal voltage (VT) is equal to the DC charging voltage (DV), the at least one pulse current (PI) flows through the at least one battery (14) to establish a first detected voltage across the at least one battery (14), when the power control detector (12) determines that the first detected voltage satisfies a charged condition and the terminal voltage (VT) is equal to the DC charging voltage (DV), the power control detector (12) controls the charger (10) to convert the DC charging current (DI) into a decreasing trickle current (TI) until a value of the trickle current (TI) is decreased to a triggered current value, and the triggered current value divided by a value of the corresponding DC charging current (DI) is equal to a fixed ratio less than 1 and larger than 0;

wherein before the charger (10) and the power control detector (12) sequentially perform the at least two first charging processes, the power control detector (12) detects the terminal voltage (VT) and drives the charger (10) to provide an initial voltage for the at least one battery (14) and generate an initial current (IA), the initial current (IA) flows through the at least one battery (14), and the power control detector (12) is configured to receive the initial current (IA) and determine that the at least one battery (14) is the battery to be charged according to the initial current (IA), the terminal voltage (VT), and a charging voltage range.

2. The universal charging device according to claim 1, wherein the at least one pulse current (PI) has a pulse period (T), an initial time point (t1), and a final time point (t2), the at least one pulse current (PI) establishes a first open-circuit voltage (O1) across the at least one battery (14) at the initial time point

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(t1), the at least one pulse current (PI) establishes a second open-circuit voltage (O2) across the at least one battery (14) at the final time point (t2), and the charged condition defines that an absolute value of a difference between the first open-circuit voltage (O1) and the second open-circuit voltage (O2) divided by the pulse period (T) is equal to or less than a given positive value.

3. The universal charging device according to claim 1, wherein the DC charging current (DI) establishes a first battery voltage (B1) across the at least one battery (14), the at least one pulse current (PI) establishes a second battery voltage (B2) across the at least one battery (14), and the charged condition defines that an absolute value of a difference between the first battery voltage (B1) and the second battery voltage (B2) divided by an absolute value of a difference between the DC charging current (DI) and the at least one pulse current (PI) is equal to or less than a given positive value.

4. The universal charging device according to claim 1, wherein after the charger (10) and the power control detector (12) perform the at least two first charging processes, the charger (10) and the power control detector (12) perform a second charging process, and wherein in the second charging process, the power control detector (12) detects the terminal voltage (VT), controls the charger (10) to adjust the DC charging voltage (DV) to be larger than the terminal voltage (VT) based on the terminal voltage (VT), and controls the charger (10) to generate the at least one pulse voltage (PV) in response to the DC charging voltage (DV), the charger (10) applies the DC charging voltage (DV) to charge the at least one battery (14) and respectively generates the DC charging current (DI) and the at least one pulse current (PI) by applying the DC charging voltage (DV) and the at least one pulse voltage (PV)to the at least one battery (14), the at least one pulse current (PI) establishes a second detected voltage across the at least one battery (14), and when the power control detector (12) determines the second detected voltage satisfies a full condition, the power control detector (12) controls the charger (10) to stop generating the DC charging voltage (DV), the at least one pulse voltage (PV), the DC charging current (DI), and the at least one pulse current (PI).

5. The universal charging device according to claim 4, wherein the at least one pulse current (PI) has a pulse period (T), an initial time point (t1), and a final time point (t2), the at least one pulse current (PI) establishes a first open-circuit voltage (O1) across the at least one battery (14) at the initial time point (t1), the at least one pulse current (PI) establishes a second open-circuit voltage (O2) across the at least one battery (14) at the final time point (t2), and the full condition defines that an absolute value of a difference between the first open-circuit voltage (O1) and the second open-circuit voltage (O2) divided by the pulse period (T) is larger than a given positive value.

6. The universal charging device according to claim 4, wherein the DC charging current (DI) establishes a first battery voltage (B1) across the at least one battery (14), the at least one pulse current (PI) establishes a second battery voltage (B2) across the at least one battery (14), and the full condition defines that an absolute value of a difference between the first battery voltage (B1) and the second battery voltage (B2) divided by an absolute value of a difference between the DC charging current (DI) and the at least one pulse current (PI) is larger than a given positive value.

7. The universal charging device according to claim 4, wherein the at least one pulse current (PI) comprises a plurality of pulse currents (PI), and when the power control detector (12) determines that the second detected voltage established by each of the plurality of pulse currents (PI) satisfies the full condition, the power control detector (12) controls the charger (10) to stop generating the DC charging voltage (DV).

8. The universal charging device according to claim 1, wherein in each of the at least two first charging processes, a period when the terminal voltage (VT) is equal to the DC charging voltage (DV) is less than a period when the DC charging voltage (DV) is larger than the terminal voltage (TV).

9. The universal charging device according to claim 1, wherein the at least two first charging processes comprise a previous first charging process and a next first charging process, and periods corresponding to the DC charging current (DI) and the trickle current (TI) in the previous first charging process are respectively larger than periods corresponding to the DC charging current (DI) and the trickle current (TI) in the next first charging process.

10. The universal charging device according to claim 1, wherein a pulse period (T) of the at least one pulse current (PI) is less than a period of a corresponding the DC charging current (DI).

11. The universal charging device according to claim 1, wherein the charger controls the DC charging voltage (DV) to be larger than the terminal voltage (VT), a difference between the DC charging voltage (DV) and a corresponding the terminal voltage (VT) is a given value, and the given values corresponding to the at least two first charging processes are equal.

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12. The universal charging device according to claim 1, wherein the at least two first charging processes comprise a previous first charging process and a next first charging process, when the charger (10) adjusts the DC charging voltage (DV) to be larger than the terminal voltage (VT), a difference between the DC charging voltage (DV) and a corresponding the terminal voltage (VT) is a given value, and the given value corresponding to the previous first charging process is larger than the given value corresponding to the next first charging process.

13. The universal charging device according to claim 1, wherein the at least two first charging processes comprise a previous first charging process and a next first charging process, and periods corresponding to the DC charging current (DI) and the trickle current (TI) in the previous first charging process are respectively less than periods corresponding to the DC charging current (DI) and the trickle current (TI) in the next first charging process.

14. The universal charging device according to claim 1, wherein the charger (10) comprises:

an input rectifier configured to receive the AC voltage (AV) and convert the AC voltage (AV) into an input direct-current (DC) voltage (DV);
a resonate converter (18) coupled to the input rectifier (16) and the power control detector (12), wherein the resonate converter (18) is configured to receive the input DC voltage (DV) and convert the input DC voltage (DV) into a resonate voltage (RV); and
a synchronous rectifier (20) coupled to the resonate converter (18) and the at least one battery (14), wherein the synchronous rectifier (20) is configured to receive the resonate voltage (RV) and convert the resonate voltage (RV) into the DC charging voltage (DV), the power control detector (12) is configured to control the resonate converter (18) and the synchronous rectifier (20) to adjust the DC charging voltage (DV) to be larger than the terminal voltage (VT) based on the terminal voltage (VT), the power control detector (12) is configured to control the resonate converter (18) and the synchronous rectifier (20) to generate the at least one pulse voltage (PV) in response to the DC charging voltage (DV), the resonate converter (18) and the synchronous rectifier (20) are configured to respectively generate the DC charging current (DI) and the at least one pulse current (PI) by applying the DC charging voltage (DV) and the at least one pulse voltage (PV), and when the terminal voltage (VT) is equal to the DC charging voltage (DV), the power control detector (12) controls the resonate converter (18) and the synchronous rectifier (20) to convert the DC charging current (DI) into the trickle current (TI).

15. The universal charging device according to claim 14, wherein the power control detector (12) comprises:

a voltage feedback circuit (22) coupled to the synchronous rectifier (20) and the at least one battery (14), wherein the voltage feedback circuit (22) is configured to receive the terminal voltage (VT) and a voltage across the at least one battery (14) established by the at least one pulse current (PI), and respectively generate a first feedback voltage (F1) and at least one pulse feedback voltage (PF) based on the terminal voltage (VT) and a voltage across the at least one battery (14) established by the at least one pulse current (PI);
a feedback resistor (24) connected between the synchronous rectifier (20) and the at least one battery (14) in series, wherein the DC charging current (DI), the trickle current (TI), and the at least one pulse current (PI) flow through the feedback resistor (24), so as to generate a first responsive voltage (RES1), a trickle voltage (RT), and at least one second responsive voltage (RES2) across the feedback resistor (24);
a current feedback circuit (26) coupled to two ends of the feedback resistor (24), the synchronous rectifier (20), and the at least one battery (14), wherein the current feedback circuit (26) is configured to receive the first responsive voltage (RES1), the trickle voltage (RT), and the at least one second responsive voltage (RES2) and respectively generate a second feedback voltage (F2), a trickle feedback voltage (RF), and at least one pulse responsive voltage (PR) based on the first responsive voltage (RES1), the trickle voltage (RT), and the at least one second responsive voltage (RES2);
an isolator (28) having a primary side and a secondary side, wherein the secondary side is coupled to the voltage feedback circuit (22) and the current feedback circuit (26); and
a controller (30) coupled to the primary side and the resonate converter (18), wherein the controller (30) is configured to receive the first feedback voltage (F1), the second feedback voltage (F2), the trickle feedback voltage (RF), the at least one pulse feedback voltage (PF), and the at least one pulse responsive voltage (PR) through the isolator (28), the controller (30) is configured to control the resonate converter (18) and the synchronous rectifier (20) to adjust the DC charging voltage (DV) to be larger than the terminal voltage (VT) based on the first feedback voltage (F1), the controller (30) is configured to control the resonate converter (18) and the syn-

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chronous rectifier (20) to generate the at least one pulse voltage (PV) in response to the DC charging voltage (DV), the controller (30) is configured to obtain the DC charging current (DI) according to the second feedback voltage (F2), the controller (30) is configured to obtain the DC charging voltage (DV) according to the DC charging current (DI), the controller (30) is configured to obtain the at least one pulse current (PI) according to the at least one pulse responsive voltage (PR), the controller (30) is configured to obtain the trickle current (TI) according to the trickle feedback voltage (RF), the controller (30) is configured to determine that the at least one pulse feedback voltage (PF) satisfies the charged condition, and when the terminal voltage (VT) is equal to the DC charging voltage (DV), the controller (30) controls the resonate converter (18) and the synchronous rectifier (20) to convert the DC charging current (DI) into the trickle current (TI) until the value of the trickle current (TI) is decreased to the triggered current value.

16. The universal charging device according to claim 1, wherein the fixed ratio is 90% or 85%.

17. The universal charging device according to claim 1, wherein an initial value of the terminal voltage (VT) divided by the rated voltage is less than or equal to 97%.

18. The universal charging device according to claim 1, wherein the at least one battery (14) is a lithium-ion battery.

19. The universal charging device according to claim 18, wherein the lithium-ion battery is a nickel-cobalt-lithium battery, a nickel-lithium battery, or a $LiFePO_4$ battery.

20. The universal charging device according to claim 1, wherein the rated voltage has a range of 9-72 volts.

21. The universal charging device according to claim 1, wherein the at least one battery (14) comprises 10-20 batteries connected in series.

22. A universal charging method charging at least one battery, the at least one battery (14) having a terminal voltage (VT) when a direct-current (DC) charging voltage (DV) is not applied, which terminal voltage (VT) is less than a rated voltage of the at least one battery (14), and the universal charging method comprising:

determining that the at least one battery (14) is a battery to be charged;

converting an alternating-current (AC) voltage (AV) into the DC charging voltage (DV); and

sequentially performing at least two first charging processes, wherein each of the at least two first charging processes comprising steps:

adjusting the DC charging voltage (DV) to be larger than the terminal voltage (VT) based on the terminal voltage (VT), applying the DC charging voltage (DV) to charge the at least one battery (14), generating at least one pulse voltage (PV) based on the DC charging voltage (DV), respectively generating a direct-current (DC) charging current (DI) and at least one pulse current (PI) by applying the DC charging voltage (DV) and the at least one pulse voltage (PV) until the terminal voltage (VT) is equal to the DC charging voltage (DV), the DC charging current (DI) and the at least one pulse current (PI) flowing through the at least one battery (14), the at least one pulse current (PI) flowing through the at least one battery (14) to establish a first detected voltage across the at least one battery (14), and the first detected voltage satisfying a charged condition;

when the terminal voltage (VT) is equal to the DC charging voltage (DV), converting the DC charging current (DI) into a decreasing trickle current (TI) until a value of the trickle current (TI) is decreased to a triggered current value, and the triggered current value divided by a value of the corresponding DC charging current (DI) is equal to a fixed ratio less than 1 and larger than 0; and

wherein in the step of determining that the at least one battery (14) is the battery to be charged, the terminal voltage (VT) is detected, an initial voltage (IV) is provided to the at least one battery (14) to generate an initial current (IA) that flows through the at least one battery (14), and the at least one battery (14) is determined as the battery to be charged according to the initial current (IA), the terminal voltage (VT), and a charging voltage range.

23. The universal charging method according to claim 22, wherein the at least one pulse current (PI) has a pulse period (T), an initial time point (t1), and a final time point (t2), the at least one pulse current (PI) establishes a first open-circuit voltage (O1) across the at least one battery (14) at the initial time point (t1), the at least one pulse current (PI) establishes a second open-circuit voltage (O2) across the at least one battery (14) at the final time point (t2), and the

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charged condition defines that an absolute value of a difference between the first open-circuit voltage (O1) and the second open-circuit voltage (O2) divided by the pulse period (T) is equal to or less than a given positive value.

24. The universal charging method according to claim 22, wherein the DC charging current (DI) establishes a first battery voltage (B1) across the at least one battery (14), the at least one pulse current (PI) establishes a second battery voltage (B2) across the at least one battery (14), and the charged condition defines that an absolute value of a difference between the first battery voltage (B1) and the second battery voltage (B2) divided by an absolute value of a difference between the DC charging current (DI) and the at least one pulse current (PI) is equal to or less than a given positive value.

25. The universal charging method according to claim 22, wherein after the step of performing the at least two first charging processes, performing a second charging process, and the second charging process comprises steps:

adjusting the DC charging voltage (DV) to be larger than the terminal voltage (VT) based on the terminal voltage (VT), applying the DC charging voltage (DV) to charge the at least one battery (14), generating the at least one pulse voltage (PV) in response to the DC charging voltage (DV), respectively generating the DC charging current (DI) and the at least one pulse current (PI) by applying the DC charging voltage (DV) and the at least one pulse voltage (PV), and the DC charging current (DI) and the at least one pulse current (PI) flowing through the at least one battery (14); and

the at least one pulse current (PI) establishing a second detected voltage across the at least one battery (14), and when the second detected voltage satisfies a full condition, stopping generating the DC charging voltage (DV), the at least one pulse voltage (PV), the DC charging current (DI), and the at least one pulse current (PI).

26. The universal charging method according to claim 25, wherein the at least one pulse current (PI) has a pulse period (T), an initial time point (t1), and a final time point (t2), the at least one pulse current (PI) establishes a first open-circuit voltage (O1) across the at least one battery (14) at the initial time point (t1), the at least one pulse current (PI) establishes a second open-circuit voltage (O2) across the at least one battery (14) at the final time point (t2), and the full condition defines that an absolute value of a difference between the first open-circuit voltage (O1) and the second open-circuit voltage (O2) divided by the pulse period (T) is larger than a given positive value.

27. The universal charging method according to claim 25, wherein the DC charging current (DI) establishes a first battery voltage (B1) across the at least one battery (14), the at least one pulse current (PI) establishes a second battery voltage (B2) across the at least one battery (14), and the full condition defines that an absolute value of a difference between the first battery voltage (B1) and the second battery voltage (B2) divided by an absolute value of a difference between the DC charging current (DI) and the at least one pulse current (PI) is larger than a given positive value.

28. The universal charging method according to claim 25, wherein the at least one pulse current (PI) comprises a plurality of pulse currents (PI), and when the second detected voltage established by each of the plurality of pulse currents (PI) satisfies the full condition, the DC charging voltage (DV) stops being generated.

29. The universal charging method according to claim 22, wherein in each of the at least two first charging processes, a period when the terminal voltage (VT) is equal to the DC charging voltage (DV) is less than a period when the DC charging voltage (DV) is larger than the terminal voltage (VT).

30. The universal charging method according to claim 22, wherein the at least two first charging processes comprise a previous first charging process and a next first charging process, and periods corresponding to the DC charging current (DI) and the trickle current (TI) in the previous first charging process are respectively larger than periods corresponding to the DC charging current (DI) and the trickle current (TI) in the next first charging process.

31. The universal charging method according to claim 22, wherein a pulse period (T) of the at least one pulse current (PI) is less than a period of a corresponding the DC charging current (DI).

32. The universal charging method according to claim 22, wherein in the step of adjusting the DC charging voltage (DV) to be larger than the terminal voltage (VT), a difference between the DC charging voltage (DV) and a corresponding the terminal voltage (VT) is a given value, and the given values corresponding to the at least two first charging processes are equal.

33. The universal charging method according to claim 22, wherein the at least two first charging processes comprise a previous first charging process and a

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next first charging process, in the step of adjusting the DC charging voltage (DV) to be larger than the terminal voltage (VT), a difference between the DC charging voltage (DV) and a corresponding the terminal voltage (VT) is a given value, and the given value corresponding to the previous first charging process is larger than the given value corresponding to the next first charging process.

34. The universal charging method according to claim 22, wherein the at least two first charging processes comprise a previous first charging process and a next first charging process, periods of the DC charging current (DI) and the trickle current (TI) corresponding to the previous first charging process are respectively less than periods of the DC charging current (DI) and the trickle current (TI) corresponding to the next first charging process.

35. The universal charging method according to claim 22, wherein the fixed ratio is 90% or 85%.

36. The universal charging method according to claim 22, wherein an initial value of the terminal voltage (VT) divided by the rated voltage is less than or equal to 97%.

Patentansprüche

1. Universal-Ladegerät, umfassend:

ein Ladegerät (10), das mit mindestens einer Batterie (14) gekoppelt und so konfiguriert ist, dass es eine Wechselspannung (AC) empfängt und die Wechselspannung in eine Gleichstrom-(DC)-Ladespannung umwandelt, wobei die mindestens eine Batterie (14) eine Klemmenspannung (VT) aufweist, wenn die Gleichstrom-Ladespannung (DV) nicht angelegt ist, wobei die Klemmenspannung (VT) geringer ist als eine Nennspannung der mindestens einen Batterie (14); und

einen Leistungssteuerungsdetektor (12), der mit der mindestens einen Batterie (14) und dem Ladegerät (10) gekoppelt ist, wobei, nachdem das Ladegerät (10) und der Leistungssteuerungsdetektor (12) festgestellt haben, dass die mindestens eine Batterie (14) eine zu ladende Batterie ist, das Ladegerät (10) und der Leistungssteuerungsdetektor (12) nacheinander mindestens zwei erste Ladevorgänge durchführen;

wobei in jedem der mindestens zwei ersten Ladevorgänge, der Leistungssteuerungsdetektor (12) die Klemmenspannung (VT) erfasst, das Ladegerät (10) so steuert, dass die Gleichstrom-Ladespannung (DV) auf der Grundlage der Klemmenspannung (VT) größer als die Klemmenspannung (VT) eingestellt wird, und das Ladegerät (10) steuert, um mindestens eine Impulsspannung (PV) auf der Grundlage der Gleichstrom-Ladespannung (DV) zu erzeugen, das Ladegerät (10) die Gleichstrom-Ladespannung (DV) anlegt, um die mindestens eine Batterie (14) zu laden, und entsprechend einen Ladegleichstrom (DI) und mindestens einen Impulsstrom (PI) erzeugt, indem es die Gleichstrom-Ladespannung (DV) und die mindestens eine Impulsspannung (PV) an die mindestens eine Batterie (14) anlegt, bis der Leistungssteuerungsdetektor (12) feststellt, dass die Klemmenspannung (VT) gleich der Gleichstrom-Ladespannung (DV) ist, der mindestens eine Impulsstrom (PI) durch die mindestens eine Batterie (14) fließt, um eine erste erfasste Spannung an der mindestens einen Batterie (14) zu erzeugen, wenn der Leistungssteuerungsdetektor (12) feststellt, dass die erste erfasste Spannung einen Ladezustand erfüllt und die Klemmenspannung (VT) gleich der Gleichstrom-Ladespannung (DV) ist, der Leistungssteuerungsdetektor (12) das Ladegerät (10) steuert, um den Ladegleichstrom (DI) in einen abnehmenden Erhaltungsstrom (TI) umzuwandeln, bis ein Wert des Erhaltungsstroms (TI) auf einen ausgelösten Stromwert gesunken ist und der ausgelöste Stromwert geteilt durch einen Wert des entsprechenden Ladegleichstroms (DI) gleich einem festen Verhältnis von weniger als 1 und größer als 0 ist;

wobei, bevor das Ladegerät (10) und der Leistungssteuerungsdetektor (12) nacheinander die mindestens zwei ersten Ladevorgänge durchführen, der Leistungssteuerungsdetektor (12) die Klemmenspannung (VT) erfasst und das Ladegerät (10) ansteuert, um eine Anfangsspannung für die mindestens eine Batterie (14) bereitzustellen und einen Anfangsstrom (IA) zu erzeugen, der Anfangsstrom (IA) durch die mindestens eine Batterie (14) fließt, und der Leistungssteuerungsdetektor (12) so konfiguriert ist, dass er den Anfangsstrom (IA) empfängt und bestimmt, dass die mindestens eine Batterie (14) die zu ladende Batterie ist, und zwar entsprechend dem Anfangsstrom (IA), der Klemmenspannung (VT) und einem Ladespannungsbereich.

2. Universal-Ladegerät nach Anspruch 1, wobei der mindestens eine Impulsstrom (PI) eine Impulsperiode (T), einen Anfangszeitpunkt (t1) und einen Endzeitpunkt (t2) aufweist, wobei der mindestens eine Impulsstrom (PI) eine erste Leerlaufspannung (O1) an der mindestens einen Batterie (14) zum Anfangszeitpunkt (t1) herstellt, der mindestens eine Impuls-

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strom (PI) eine zweite Leerlaufspannung (02) an der mindestens einen Batterie (14) zum Endzeitpunkt (t2) herstellt, und der Ladezustand definiert, dass ein absoluter Wert einer Differenz zwischen der ersten Leerlaufspannung (O1) und der zweiten Leerlaufspannung (02) geteilt durch die Impulsperiode (T) gleich oder kleiner als ein gegebener positiver Wert ist.

3. Universal-Ladegerät nach Anspruch 1, wobei der Ladegleichstrom (DI) eine erste Batteriespannung (B1) an der mindestens einen Batterie (14) erzeugt, der mindestens eine Impulsstrom (PI) eine zweite Batteriespannung (B2) an der mindestens einen Batterie (14) herstellt, und der Ladezustand definiert, dass ein Absolutwert einer Differenz zwischen der ersten Batteriespannung (B1) und der zweiten Batteriespannung (B2) geteilt durch einen Absolutwert einer Differenz zwischen dem Ladegleichstrom (DI) und dem mindestens einen Impulsstrom (PI) gleich oder kleiner als ein gegebener positiver Wert ist.

4. Universal-Ladegerät nach Anspruch 1, wobei nach der Durchführung der mindestens zwei ersten Ladevorgänge durch das Ladegerät (10) und den Leistungssteuerungsdetektor (12), das Ladegerät (10) und der Leistungssteuerungsdetektor (12) einen zweiten Ladevorgang durchführen, und wobei bei dem zweiten Ladevorgang, der Leistungssteuerungsdetektor (12) die Klemmenspannung (VT) erfasst, das Ladegerät (10) steuert, um die Gleichstrom-Ladespannung (DV) so einzustellen, dass sie größer als die Klemmenspannung (VT) ist, basierend auf der Klemmenspannung (VT), und das Ladegerät (10) steuert, um die mindestens eine Impulsspannung (PV) in Reaktion auf die Gleichstrom-Ladespannung (DV) zu erzeugen, das Ladegerät (10) die Gleichstrom-Ladespannung (DV) anlegt, um die mindestens eine Batterie (14) zu laden, und entsprechend den Ladegleichstrom (DI) und den mindestens einen Impulsstrom (PI) durch Anlegen der Gleichstrom-Ladespannung (DV) und der mindestens einen Impulsspannung (PV) an die mindestens eine Batterie (14) erzeugt, wobei der mindestens eine Impulsstrom (PI) eine zweite detektierte Spannung an der mindestens einen Batterie (14) herstellt, und wenn der Leistungssteuerungsdetektor (12) feststellt, dass die zweite erfasste Spannung eine Vollbedingung erfüllt, steuert der Leistungssteuerungsdetektor (12) das Ladegerät (10), um die Erzeugung der Gleichstrom-Ladespannung (DV), der mindestens einen Impulsspannung (PV), des Ladegleichstroms (DI) und des mindestens einen Impulsstroms (PI) zu beenden.

5. Universal-Ladegerät nach Anspruch 4, wobei der mindestens eine Impulsstrom (PI) eine Impulsperiode (T), einen Anfangszeitpunkt (t1) und einen Endzeitpunkt (t2) aufweist, wobei der mindestens eine Impulsstrom (PI) eine erste Leerlaufspannung (O1) an der mindestens einen Batterie (14) zum Anfangszeitpunkt (t1) herstellt, der mindestens eine Impulsstrom (PI) eine zweite Leerlaufspannung (02) an der mindestens einen Batterie (14) zum Endzeitpunkt (t2) herstellt, und die Vollbedingung definiert, dass ein absoluter Wert einer Differenz zwischen der ersten Leerlaufspannung (O1) und der zweiten Leerlaufspannung (02) geteilt durch die Impulsperiode (T) größer als ein gegebener positiver Wert ist.

6. Universal-Ladegerät nach Anspruch 4, wobei der Ladegleichstrom (DI) eine erste Batteriespannung (B1) an der mindestens einen Batterie (14) erzeugt, der mindestens eine Impulsstrom (PI) eine zweite Batteriespannung (B2) an der mindestens einen Batterie (14) erzeugt, und die Vollbedingung definiert, dass ein absoluter Wert einer Differenz zwischen der ersten Batteriespannung (B1) und der zweiten Batteriespannung (B2), geteilt durch einen absoluten Wert einer Differenz zwischen dem Ladegleichstrom (DI) und dem mindestens einen Impulsstrom (PI), größer als ein gegebener positiver Wert ist.

7. Universal-Ladegerät nach Anspruch 4, wobei der mindestens eine Impulsstrom (PI) eine Vielzahl von Impulsströmen (PI) umfasst, und wenn der Leistungssteuerungsdetektor (12) feststellt, dass die zweite erfasste Spannung, die durch jeden der Vielzahl von Impulsströmen (PI) festgelegt wird, die Vollbedingung erfüllt, steuert der Leistungssteuerungsdetektor (12) das Ladegerät (10), um die Erzeugung der Gleichstrom-Ladespannung (DV) zu beenden.

8. Universal-Ladegerät nach Anspruch 1, wobei in jedem der mindestens zwei ersten Ladevorgänge eine Periode, in der die Klemmenspannung (VT) gleich der Gleichstrom-Ladespannung (DV) ist, kleiner ist als eine Periode, in der die Gleichstrom-Ladespannung (DV) größer ist als die Klemmenspannung (TV).

9. Universal-Ladegerät nach Anspruch 1, wobei die mindestens zwei ersten Ladevorgänge einen vorhergehenden ersten Ladevorgang und einen nächsten ersten Ladevorgang umfassen und Perioden, die dem Ladegleichstrom (DI) und dem Erhaltungsstrom (TI) in dem vorhergehenden ersten Ladevorgang entsprechen, jeweils größer sind als Perioden, die dem Ladegleichstrom (DI) und dem Erhaltungsstrom (TI) in dem nächsten ersten Ladevorgang entsprechen.

10. Universal-Ladegerät nach Anspruch 1, wobei eine Impulsperiode (T) des mindestens einen Impulsstroms (PI) kleiner ist als eine Periode eines entsprechenden Ladegleichstroms (DI).

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11. Universal-Ladegerät nach Anspruch 1, wobei das Ladegerät die Gleichstrom-Ladespannung (DV) so steuert, dass sie größer als die Klemmenspannung (VT) ist, eine Differenz zwischen der Gleichstrom-Ladespannung (DV) und einer entsprechenden Klemmenspannung (VT) ein vorgegebener Wert ist und die vorgegebenen Werte, die den mindestens zwei ersten Ladevorgängen entsprechen, gleich sind.

12. Universal-Ladegerät nach Anspruch 1, wobei die mindestens zwei ersten Ladevorgänge einen vorhergehenden ersten Ladevorgang und einen nächsten ersten Ladevorgang umfassen, wenn das Ladegerät (10) die Gleichstrom-Ladespannung (DV) so einstellt, dass sie größer als die Klemmenspannung (VT) ist, eine Differenz zwischen der Gleichstrom-Ladespannung (DV) und einer entsprechenden Klemmenspannung (VT) ein gegebener Wert ist, und der gegebene Wert, der dem vorhergehenden ersten Ladevorgang entspricht, größer als der gegebene Wert ist, der dem nächsten ersten Ladevorgang entspricht.

13. Universal-Ladegerät nach Anspruch 1, wobei die mindestens zwei ersten Ladevorgänge einen vorhergehenden ersten Ladevorgang und einen nächsten ersten Ladevorgang umfassen und Perioden, die dem Ladegleichstrom (DI) und dem Erhaltungsstrom (TI) in dem vorhergehenden ersten Ladevorgang entsprechen, entsprechend kleiner sind als Perioden, die dem Ladegleichstrom (DI) und dem Erhaltungsstrom (TI) in dem nächsten ersten Ladevorgang entsprechen.

14. Universal-Ladegerät nach Anspruch 1, wobei das Ladegerät (10) umfasst:

einen Eingangsgleichrichter, der so konfiguriert ist, dass er die Wechselspannung (AV) empfängt und die Wechselspannung (AV) in eine Eingangs-Gleichstromspannung (DV) umwandelt;
einen Resonanzwandler (18), der mit dem Eingangsgleichrichter (16) und dem Leistungssteuerungsdetektor (12) gekoppelt ist, wobei der Resonanzwandler (18) so konfiguriert ist, dass er die Eingangs-Gleichstromspannung (DV) empfängt und die Eingangs-Gleichstromspannung (DV) in eine Resonanzspannung (RV) umwandelt; und
einen Synchrongleichrichter (20), der mit dem Resonanzwandler (18) und der mindestens einen Batterie (14) gekoppelt ist, wobei der Synchrongleichrichter (20) so konfiguriert ist, dass er die Resonanzspannung (RV) empfängt und die Resonanzspannung (RV) in die Gleichstrom-Ladespannung (DV) umwandelt, wobei der Leistungssteuerungsdetektor (12) so konfiguriert ist, dass er den Resonanzwandler (18) und den Synchrongleichrichter (20) so steuert, dass die Gleichstrom-Ladespannung (DV) so eingestellt wird, dass sie größer als die Klemmenspannung (VT) ist, basierend auf der Klemmenspannung (VT), der Leistungssteuerungsdetektor (12) so konfiguriert ist, dass er den Resonanzwandler (18) und den Synchrongleichrichter (20) steuert, um die mindestens eine Impulsspannung (PV) in Reaktion auf die Gleichstrom-Ladespannung (DV) zu erzeugen, der Resonanzwandler (18) und der Synchrongleichrichter (20) so konfiguriert sind, dass sie den Ladegleichstrom (DI) und den mindestens einen Impulsstrom (PI) durch Anlegen der Gleichstrom-Ladespannung (DV) und der mindestens einen Impulsspannung (PV) erzeugen, und wenn die Klemmenspannung (VT) gleich der Gleichstrom-Ladespannung (DV) ist, steuert der Leistungssteuerungsdetektor (12) den Resonanzwandler (18) und den Synchrongleichrichter (20), um den Ladegleichstrom (DI) in den Erhaltungsstrom (TI) umzuwandeln.

15. Universal-Ladegerät nach Anspruch 14, wobei der Leistungssteuerungsdetektor (12) umfasst:

eine Spannungsrückkopplungsschaltung (22), die mit dem Synchrongleichrichter (20) und der mindestens einen Batterie (14) gekoppelt ist, wobei die Spannungsrückkopplungsschaltung (22) so konfiguriert ist, dass sie die Klemmenspannung (VT) und eine Spannung an der mindestens einen Batterie (14), die durch den mindestens einen Impulsstrom (PI) erzeugt wird, zu empfangen und entsprechend eine erste Rückkopplungsspannung (F1) und mindestens eine Impulsrückkopplungsspannung (PF) auf der Grundlage der Klemmenspannung (VT) und einer Spannung an der mindestens einen Batterie (14), die durch den mindestens einen Impulsstrom (PI) erzeugt wird,
einen Rückkopplungswiderstand (24), der zwischen dem Synchrongleichrichter (20) und der mindestens einen Batterie (14) in Reihe geschaltet ist, wobei der Ladegleichstrom (DI), der Erhaltungsstrom (TI) und der mindestens eine Impulsstrom (PI) durch den Rückkopplungswiderstand (24) fließen, um eine erste Ansprechspannung (RES1), eine Erhaltungsspannung (RT) und mindestens eine zweite Ansprechspannung (RES2) an dem Rückkopplungswiderstand (24) zu erzeugen;
eine Stromrückkopplungsschaltung (26), die mit zwei Enden des Rückkopplungswiderstands (24), dem Synchrongleichrichter (20) und der mindestens einen Batterie (14) verbunden ist,

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wobei die Stromrückkopplungsschaltung (26) so konfiguriert ist, dass sie die erste Ansprechspannung (RES1), die Erhaltungsspannung (RT) und die mindestens eine zweite Ansprechspannung (RES2) zu empfangen und entsprechend eine zweite Rückkopplungsspannung (F2), eine Erhaltungs-Rückkopplungsspannung (RF) und mindestens eine Impuls-Ansprechspannung (PR) auf der Grundlage der ersten Ansprechspannung (RES1), der Erhaltungsspannung (RT) und der mindestens einen zweiten Ansprechspannung (RES2) zu erzeugen;
einen Isolator (28) mit einer Primärseite und einer Sekundärseite, wobei die Sekundärseite mit der Spannungsrückkopplungsschaltung (22) und der Stromrückkopplungsschaltung (26) gekoppelt ist; und
eine Steuerung (30), die mit der Primärseite und dem Resonanzwandler (18) gekoppelt ist, wobei die Steuerung (30) so konfiguriert ist, dass sie die erste Rückkopplungsspannung (F1), die zweite Rückkopplungsspannung (F2), die Erhaltungs-Rückkopplungsspannung (RF), die mindestens eine Impulsrückkopplungsspannung (PF) und die mindestens eine Impuls-Ansprechspannung (PR) über den Isolator (28) empfängt, die Steuerung (30) so konfiguriert ist, dass sie den Resonanzwandler (18) und den Synchrongleichrichter (20) steuert, um die Gleichstrom-Ladespannung (DV) so einzustellen, dass sie größer ist als die Klemmenspannung (VT) auf der Grundlage der ersten Rückkopplungsspannung (F1), die Steuerung (30) so konfiguriert ist, dass sie den Resonanzwandler (18) und den Synchrongleichrichter (20) so steuert, dass sie die mindestens eine Impulsspannung (PV) in Reaktion auf die Gleichstrom-Ladespannung (DV) erzeugt, die Steuerung (30) so konfiguriert ist, dass sie den Ladegleichstrom (DI) entsprechend der zweiten Rückkopplungsspannung (F2) erhält, die Steuerung (30) so konfiguriert ist, dass sie die Gleichstrom-Ladespannung (DV) entsprechend dem Ladegleichstrom (DI) erhält, die Steuerung (30) konfiguriert ist, den mindestens einen Impulsstrom (PI) entsprechend der mindestens einen Impuls-Ansprechspannung (PR) zu erhalten, die Steuerung (30) konfiguriert ist, den Erhaltungsstrom (TI) entsprechend der Erhaltungs-Rücckopplungsspannung (RF) zu erhalten, die Steuerung (30) so konfiguriert ist, dass sie feststellt, dass die mindestens eine Impulsrückkopplungsspannung (PF) die Ladebedingung erfüllt, und wenn die Klemmenspannung (VT) gleich der Gleichstrom-Ladespannung (DV) ist, die Steuerung (30) den Resonanzwandler (18) und den Synchrongleichrichter (20) steuert, um den Ladegleichstrom (DI) in den Erhaltungsstrom (TI) umzuwandeln, bis der Wert des Erhaltungsstroms (TI) auf den ausgelösten Stromwert verringert ist.

16. Universal-Ladegerät nach Anspruch 1, wobei das feste Verhältnis 90% oder 85% beträgt.

17. Universal-Ladegerät nach Anspruch 1, wobei ein Anfangswert der Klemmenspannung (VT) geteilt durch die Nennspannung weniger als oder gleich 97% beträgt.

18. Universal-Ladegerät nach Anspruch 1, wobei die mindestens eine Batterie (14) eine Lithium-Ionen-Batterie ist.

19. Universal-Ladegerät nach Anspruch 18, wobei die Lithium-Ionen-Batterie eine Nickel-Kobalt-Lithium-Batterie, eine Nickel-Lithium-Batterie oder eine $LiFePO_4$-Batterie ist.

20. Universal-Ladegerät nach Anspruch 1, wobei die Nennspannung einen Bereich von 9-72 Volt hat.

21. Universal-Ladegerät nach Anspruch 1, wobei die mindestens eine Batterie (14) 10-20 in Reihe geschaltete Batterien umfasst.

22. Universal-Ladeverfahren zum Laden mindestens einer Batterie, wobei die mindestens eine Batterie (14) eine Klemmenspannung (VT) aufweist, wenn keine Gleichstrom-Ladespannung (DV) angelegt ist, wobei die Klemmenspannung (VT) geringer ist als eine Nennspannung der mindestens einen Batterie (14), und wobei das universelle Ladeverfahren umfasst:

Bestimmen, dass die mindestens eine Batterie (14) eine zu ladende Batterie ist; Umwandeln einer Wechselspannung (AV) in die Gleichstrom-Ladespannung (DV); und sequentielles Durchführen von mindestens zwei ersten Ladevorgängen, wobei jeder der mindestens zwei ersten Ladevorgänge Schritte umfasst: Einstellen der Gleichstrom-Ladespannung (DV), so dass sie größer ist als die Klemmenspannung (VT), basierend auf der Klemmenspannung (VT), Anlegen der Gleichstrom-Ladespannung (DV) zum Laden der mindestens einen Batterie (14), Erzeugen mindestens einer Impulsspannung (PV) auf der Basis der Gleichstrom-Ladespannung (DV), entsprechend Erzeugen eines Ladegleichstroms (DI) und mindestens eines Impulsstroms (PI) durch Anlegen der Gleichstrom-Ladespannung (DV) und der mindestens einen Impulsspannung (PV), bis die Klemmenspannung (VT) gleich der Gleichstrom-Ladespannung (DV) ist, wobei der Ladegleichstrom (DI) und der mindestens eine Impulsstrom (PI)

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durch die mindestens eine Batterie (14) fließen, wobei der mindestens eine Impulsstrom (PI) durch die mindestens eine Batterie (14) fließt, um eine erste erfasste Spannung über der mindestens einen Batterie (14) zu erzeugen, und wobei die erste erfasste Spannung einen Ladezustand erfüllt;
wenn die Klemmenspannung (VT) gleich der Gleichstrom-Ladespannung (DV) ist, Umwandeln des Ladegleichstroms (DI) in einen abnehmenden Erhaltungsstrom (TI), bis ein Wert des Erhaltungsstroms (TI) auf einen ausgelösten Stromwert abnimmt und der ausgelöste Stromwert geteilt durch einen Wert des entsprechenden Ladegleichstroms (DI) gleich einem festen Verhältnis kleiner als 1 und größer als 0 ist; und wobei in dem Schritt des Bestimmens, dass die mindestens eine Batterie (14) die zu ladende Batterie ist, die Klemmenspannung (VT) erfasst wird, eine Anfangsspannung (IV) der mindestens einen Batterie (14) zugeführt wird, um einen Anfangsstrom (IA) zu erzeugen, der durch die mindestens eine Batterie (14) fließt, und die mindestens eine Batterie (14) als die zu ladende Batterie gemäß dem Anfangsstrom (IA), der Klemmenspannung (VT) und einem Ladespannungsbereich bestimmt wird.

23. Universal-Ladeverfahren nach Anspruch 22, wobei der mindestens eine Impulsstrom (PI) eine Impulsperiode (T), einen Anfangszeitpunkt (t1) und einen Endzeitpunkt (t2) aufweist, wobei der mindestens eine Impulsstrom (PI) eine erste Leerlaufspannung (O1) an der mindestens einen Batterie (14) zum Anfangszeitpunkt (t1), der mindestens eine Impulsstrom (PI) eine zweite Leerlaufspannung (02) an der mindestens einen Batterie (14) zum Endzeitpunkt (t2) herstellt, und der Ladezustand definiert, dass ein absoluter Wert einer Differenz zwischen der ersten Leerlaufspannung (O1) und der zweiten Leerlaufspannung (02) geteilt durch die Impulsperiode (T) gleich oder kleiner als ein gegebener positiver Wert ist.

24. Universal-Ladeverfahren nach Anspruch 22, wobei der Ladegleichstrom (DI) eine erste Batteriespannung (B1) an der mindestens einen Batterie (14) herstellt, der mindestens eine Impulsstrom (PI) eine zweite Batteriespannung (B2) an der mindestens einen Batterie (14) herstellt und der Ladezustand definiert, dass ein absoluter Wert einer Differenz zwischen der ersten Batteriespannung (B1) und der zweiten Batteriespannung (B2), dividiert durch einen absoluten Wert einer Differenz zwischen dem Ladegleichstrom (DI) und dem mindestens einen Impulsstrom (PI), gleich oder kleiner als ein gegebener positiver Wert ist.

25. Universal-Ladeverfahren nach Anspruch 22, wobei nach dem Schritt des Durchführens der mindestens zwei ersten Ladevorgänge ein zweiter Ladevorgang durchgeführt wird, und der zweite Ladevorgang die Schritte umfasst:

Einstellen der Gleichstrom-Ladespannung (DV), so dass sie größer als die Klemmenspannung (VT) ist, basierend auf der Klemmenspannung (VT), Anlegen der Gleichstrom-Ladespannung (DV), um die mindestens eine Batterie (14) zu laden, Erzeugen der mindestens einen Impulsspannung (PV) als Reaktion auf die Gleichstrom-Ladespannung (DV), entsprechend Erzeugen des Ladegleichstroms (DI) und des mindestens einen Impulsstroms (PI) durch Anlegen der Gleichstrom-Ladespannung (DV) und der mindestens einen Impulsspannung (PV), und der Ladegleichstrom (DI) und der mindestens eine Impulsstrom (PI) durch die mindestens eine Batterie (14) fließen; und
der mindestens eine Impulsstrom (PI) eine zweite detektierte Spannung über der mindestens einen Batterie (14) herstellt, und wenn die zweite detektierte Spannung eine Vollbedingung erfüllt, die Erzeugung der Gleichstrom-Ladespannung (DV), der mindestens einen Impulsspannung (PV), des Ladegleichstroms (DI) und des mindestens einen Impulsstroms (PI) stoppt.

26. Universal-Ladeverfahren nach Anspruch 25, wobei der mindestens eine Impulsstrom (PI) eine Impulsperiode (T), einen Anfangszeitpunkt (t1) und einen Endzeitpunkt (t2) aufweist, wobei der mindestens eine Impulsstrom (PI) eine erste Leerlaufspannung (O1) an der mindestens einen Batterie (14) zum Anfangszeitpunkt (t1) einrichtet, der mindestens eine Impulsstrom (PI) eine zweite Leerlaufspannung (02) an der mindestens einen Batterie (14) zum Endzeitpunkt (t2) herstellt, und die Vollbedingung definiert, dass ein absoluter Wert einer Differenz zwischen der ersten Leerlaufspannung (O1) und der zweiten Leerlaufspannung (02) geteilt durch die Impulsperiode (T) größer als ein gegebener positiver Wert ist.

27. Universal-Ladeverfahren nach Anspruch 25, wobei der Ladegleichstrom (DI) eine erste Batteriespannung (B1) an der mindestens einen Batterie (14) erzeugt, der mindestens eine Impulsstrom (PI) eine zweite Batteriespannung (B2) an der mindestens einen Batterie (14) erzeugt und die Vollbedingung definiert, dass ein Absolutwert einer Differenz zwischen der ersten Batteriespannung (B1) und der zweiten Batteriespannung (B2) geteilt durch einen Absolutwert einer Differenz zwischen dem Ladegleichstrom (DI) und dem mindestens einen Impulsstrom (PI) größer als ein gegebener positiver Wert ist.

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28. Universal-Ladeverfahren nach Anspruch 25, wobei der mindestens eine Impulsstrom (PI) eine Vielzahl von Impulsströmen (PI) umfasst, und wenn die zweite erfasste Spannung, die durch jeden der Vielzahl von Impulsströmen (PI) erzeugt wird, die Vollbedingung erfüllt, wird die Erzeugung der Gleichstrom-Ladespannung (DV) beendet.

29. Universal-Ladeverfahren nach Anspruch 22, wobei in jedem der mindestens zwei ersten Ladevorgänge, eine Periode, in der die Klemmenspannung (VT) gleich der Gleichstrom-Ladespannung (DV) ist, kleiner ist als eine Periode, in der die Gleichstrom-Ladespannung (DV) größer als die Klemmenspannung (VT) ist.

30. Universal-Ladeverfahren nach Anspruch 22, wobei die mindestens zwei ersten Ladevorgänge einen vorhergehenden ersten Ladevorgang und einen nächsten ersten Ladevorgang umfassen, und Perioden, die dem Ladegleichstrom (DI) und dem Erhaltungsstrom (TI) im vorhergehenden ersten Ladevorgang entsprechen, entsprechend größer sind als Perioden, die dem Ladegleichstrom (DI) und dem Erhaltungsstrom (TI) im nächsten ersten Ladevorgang entsprechen.

31. Universal-Ladeverfahren nach Anspruch 22, wobei eine Impulsperiode (T) des mindestens einen Impulsstroms (PI) kleiner ist als eine Periode eines entsprechenden Ladegleichstroms (DI).

32. Universal-Ladeverfahren nach Anspruch 22, wobei in dem Schritt des Einstellens der Gleichstrom-Ladespannung (DV), um größer als die Klemmenspannung (VT) zu sein, eine Differenz zwischen der Gleichstrom-Ladespannung (DV) und einer entsprechenden Klemmenspannung (VT) ein gegebener Wert ist, und die gegebenen Werte, die den mindestens zwei ersten Ladeprozessen entsprechen, gleich sind.

33. Universal-Ladeverfahren nach Anspruch 22, wobei die mindestens zwei ersten Ladevorgänge einen vorhergehenden ersten Ladevorgang und einen nächsten ersten Ladevorgang umfassen, wobei in dem Schritt des Einstellens der Gleichstrom-Ladespannung (DV), um größer als die Klemmenspannung (VT) zu sein, eine Differenz zwischen der Gleichstrom-Ladespannung (DV) und einer entsprechenden Klemmenspannung (VT) ein gegebener Wert ist, und der gegebene Wert, der dem vorhergehenden ersten Ladevorgang entspricht, größer als der gegebene Wert ist, der dem nächsten ersten Ladevorgang entspricht.

34. Universal-Ladeverfahren nach Anspruch 22, wobei die mindestens zwei ersten Ladevorgänge einen vorhergehenden ersten Ladevorgang und einen nächsten ersten Ladevorgang umfassen, wobei Perioden des Ladegleichstroms (DI) und des Erhaltungsstroms (TI), die dem vorhergehenden ersten Ladevorgang entsprechen, entsprechend kleiner sind als Perioden des Ladegleichstroms (DI) und des Erhaltungsstroms (TI), die dem nächsten ersten Ladevorgang entsprechen.

35. Universal-Ladeverfahren nach Anspruch 22, wobei das feste Verhältnis 90% oder 85% beträgt.

36. Universal-Ladeverfahren nach Anspruch 22, wobei ein Anfangswert der Klemmenspannung (VT) geteilt durch die Nennspannung kleiner oder gleich 97% ist.

Revendications

1. Dispositif de charge universel comprenant :

un chargeur (10) couplé à au moins une batterie (14) et configuré pour recevoir une tension alternative (CA) et convertir la tension CA en une tension continue (CC) de charge (DV), dans lequel la au moins une batterie (14) présente une tension aux bornes (VT) quand la tension CC de charge (DV) n'est pas appliquée, laquelle tension aux bornes (VT) est inférieure à une tension nominale de la au moins une batterie (14) ; et

un détecteur de commande de puissance (12) couplé à la au moins une batterie (14) et au chargeur (10), dans lequel après que le chargeur (10) et le détecteur de commande de puissance (12) ont déterminé que la au moins une batterie (14) est une batterie à charger, le chargeur (10) et le détecteur de commande de puissance (12) effectuent séquentiellement au moins deux premiers processus de charge ;

dans lequel dans chacun des au moins deux premiers processus de charge, le détecteur de commande de puissance (12) détecte la tension aux bornes (VT), commande le chargeur (10) pour ajuster la tension CC de charge (DV) pour qu'elle soit supérieure à la tension aux bornes (VT) sur la base de la tension aux bornes (VT), et commande le chargeur (10) pour générer au moins une tension d'impulsion (PV) sur la base de la tension CC de charge (DV), le chargeur (10) applique la tension CC de charge (DV) pour charger la au moins une batterie (14) et génère respectivement un courant continu (CC) de charge (DI) et au moins un courant d'impulsion (PI) en appliquant la tension CC de charge (DV) et la au moins une tension d'impulsion (PV) à la au moins une batterie (14) jusqu'à ce que le détecteur de commande de puissance (12) déter-

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mine que la tension aux bornes (VT) est égale à la tension CC de charge (DV), le au moins un courant d'impulsion (PI) circulent à travers la au moins une batterie (14) pour établir une première tension détectée à travers la au moins une batterie (14), quand le détecteur de commande de puissance (12) détermine que la première tension détectée satisfait à une condition de charge et que la tension aux bornes (VT) est égale à la tension CC de charge (DV), le détecteur de commande de puissance (12) commande le chargeur (10) pour convertir le courant CC de charge (DI) en un courant d'entretien (TI) décroissant jusqu'à ce qu'une valeur du courant d'entretien (TI) diminue jusqu'à une valeur de courant déclenché, et la valeur de courant déclenché divisée par une valeur du courant CC de charge (DI) correspondant est égale à un rapport fixe inférieur à 1 et supérieur à 0;
dans lequel avant que le chargeur (10) et le détecteur de commande de puissance (12) n'effectuent séquentiellement les au moins deux premiers processus de charge, le détecteur de commande de puissance (12) détecte la tension aux bornes (VT) et commande le chargeur (10) pour fournir une tension initiale pour la au moins une batterie (14) et génère un courant initial (IA), le courant initial (IA) circule à travers la au moins une batterie (14), et le détecteur de commande de puissance (12) est configuré pour recevoir le courant initial (IA) et déterminer que la au moins une batterie (14) est la batterie à charger en fonction du courant initial (IA), de la tension aux bornes (VT), et d'une plage de tension de charge.

2. Dispositif de charge universel selon la revendication 1, dans lequel le au moins un courant d'impulsion (PI) présente une période d'impulsion (T), un instant initial (t1), et un instant final (t2), le au moins un courant d'impulsion (PI) établit une première tension en circuit ouvert (O1) à travers la au moins une batterie (14) à l'instant initial (t1), le au moins un courant d'impulsion (PI) établit une seconde tension en circuit ouvert (02) à travers la au moins une batterie (14) à l'instant final (t2), et la condition chargée définit qu'une valeur absolue d'une différence entre la première tension en circuit ouvert (O1) et la seconde tension en circuit ouvert (02) divisée par la période d'impulsion (T) est inférieure ou égale à une valeur positive donnée.

3. Dispositif de charge universel selon la revendication 1, dans lequel le courant CC de charge (D!) établit une première tension de batterie (B1) à travers la au moins une batterie (14), le au moins un courant d'impulsion (PI) établit une seconde tension de batterie (B2) à travers la au moins une batterie (14), et la condition chargée définit qu'une valeur absolue d'une différence entre la première tension de batterie (B1) et la seconde tension de batterie (B2) divisée par une valeur absolue d'une différence entre le courant CC de charge (DI) et le au moins un courant d'impulsion (PI) est inférieure ou égale à une valeur positive donnée.

4. Dispositif de charge universel selon la revendication 1, dans lequel après que le chargeur (10) et le détecteur de commande de puissance (12) ont effectué les au moins deux premiers processus de charge, le chargeur (10) et le détecteur de commande de puissance (12) effectuent un second processus de charge, et dans lequel dans le second processus de charge, le détecteur de commande de puissance (12) détecte la tension aux bornes (VT), commande le chargeur (10) pour ajuster la tension CC de charge (DV) pour qu'elle soit supérieure à la tension aux bornes (VT) sur la base de la tension aux bornes (VT), et commande le chargeur (10) pour générer la au moins une tension d'impulsion (PV) en réponse à la tension CC de charge (DV), le chargeur (10) applique la tension CC de charge (DV) pour charger la au moins une batterie (14) et génère respectivement le courant CC de charge (DI) et le au moins un courant d'impulsion (PI) en appliquant la tension CC de charge (DV) et la au moins une tension d'impulsion (PV) à la au moins une batterie (14), le au moins un courant d'impulsion (PI) établit une seconde tension détectée à travers la au moins une batterie (14), et quand le détecteur de commande de puissance (12) détermine que la seconde tension détectée satisfait à une condition complète, le détecteur de commande de puissance (12) commande le chargeur (10) pour arrêter la génération de la tension CC de charge (DV), de la au moins une tension d'impulsion (PV), du courant CC de charge (DI), et du au moins un courant d'impulsion (PI).

5. Dispositif de charge universel selon la revendication 4, dans lequel le au moins un courant d'impulsion (PI) présente une période d'impulsion (T), un instant initial (t1), et un instant final (t2), le au moins un courant d'impulsion (PI) établit une première tension en circuit ouvert (O1) à travers la au moins une batterie (14) à l'instant initial (t1), le au moins un courant d'impulsion (PI) établit une seconde tension en circuit ouvert (02) à travers la au moins une batterie (14) à l'instant final (t2), et la condition complète définit qu'une valeur absolue d'une différence entre la première tension en circuit ouvert (O1) et la seconde tension en circuit ouvert (02) divisée par la période d'impulsion (T) est supérieure à une valeur positive donnée.

6. Dispositif de charge universel selon la revendication 4, dans lequel le courant CC de charge (D!) établit

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une première tension de batterie (B1) à travers la au moins une batterie (14), le au moins un courant d'impulsion (PI) établit une seconde tension de batterie (B2) à travers la au moins une batterie (14), et la condition complète définit qu'une valeur absolue d'une différence entre la première tension de batterie (B1) et la seconde tension de batterie (B2) divisée par une valeur absolue d'une différence entre le courant CC de charge (DI) et le au moins un courant d'impulsion (PI) est supérieure à une valeur positive donnée.

7. Dispositif de charge universel selon la revendication 4, dans lequel le au moins un courant d'impulsion (PI) comprend une pluralité de courants d'impulsion (PI), et quand le détecteur de commande de puissance (12) détermine que la seconde tension détectée établie par chacun de la pluralité de courants d'impulsion (PI) satisfait à la condition complète, le détecteur de commande de puissance (12) commande le chargeur (10) pour arrêter la génération de la tension CC de charge (DV).

8. Dispositif de charge universel selon la revendication 1, dans lequel dans chacun des au moins deux premiers processus de charge, une période pendant laquelle la tension aux bornes (VT) est égale à la tension CC de charge (DV) est inférieure à une période pendant laquelle la tension CC de charge (DV) est supérieure à la tension aux bornes (TV).

9. Dispositif de charge universel selon la revendication 1, dans lequel les au moins deux premiers processus de charge comprennent un premier processus de charge précédent et un premier processus de charge suivant, et les périodes correspondant au courant CC de charge (DI) et au courant d'entretien (TI) dans le premier processus de charge précédent sont respectivement supérieures aux périodes correspondant au courant CC de charge (DI) et au courant d'entretien (TI) dans le premier processus de charge suivant.

10. Dispositif de charge universel selon la revendication 1, dans lequel une période d'impulsion (T) du au moins un courant d'impulsion (PI) est inférieure à une période du courant CC de charge (DI) correspondant.

11. Dispositif de charge universel selon la revendication 1, dans lequel le chargeur commande la tension CC de charge (DV) pour qu'elle soit supérieure à la tension aux bornes (VT), une différence entre la tension CC de charge (DV) et la tension aux bornes (VT) correspondante est une valeur donnée, et les valeurs données correspondant aux au moins deux premiers processus de charge sont égales.

12. Dispositif de charge universel selon la revendication 1, dans lequel les au moins deux premiers processus de charge comprennent un premier processus de charge précédent et un premier processus de charge suivant, quand le chargeur (10) ajuste la tension CC de charge (DV) pour qu'elle soit supérieure à la tension aux bornes (VT), une différence entre la tension CC de charge (DV) et la tension aux bornes (VT) correspondante est une valeur donnée, et la valeur donnée correspondant au premier processus de charge précédent est supérieure à la valeur donnée correspondant au premier processus de charge suivant.

13. Dispositif de charge universel selon la revendication 1, dans lequel les au moins deux premiers processus de charge comprennent un premier processus de charge précédent et un premier processus de charge suivant, et les périodes correspondant au courant CC de charge (DI) et au courant d'entretien (TI) dans le premier processus de charge précédent sont respectivement inférieures aux périodes correspondant au courant CC de charge (DI) et au courant d'entretien (TI) dans le premier processus de charge suivant.

14. Dispositif de charge universel selon la revendication 1, dans lequel le chargeur (10) comprend :

un redresseur d'entrée configuré pour recevoir la tension CA (AV) et convertir la tension CA (AV) en une tension continue (CC) d'entrée (DV) ;
un convertisseur résonant (18) couplé au redresseur d'entrée (16) et au détecteur de commande de puissance (12), dans lequel le convertisseur résonant (18) est configuré pour recevoir la tension CC d'entrée (DV) et convertir la tension CC d'entrée (DV) en une tension de résonance (RV) ; et
un redresseur synchrone (20) couplé au convertisseur résonant (18) et à la au moins une batterie (14), dans lequel le redresseur synchrone (20) est configuré pour recevoir la tension de résonance (RV) et convertir la tension de résonance (RV) en la tension CC de charge (DV), le détecteur de commande de puissance (12) est configuré pour commander le convertisseur résonant (18) et le redresseur synchrone (20) pour ajuster la tension CC de charge (DV) pour qu'elle soit supérieure à la tension aux bornes (VT) sur la base de la tension aux bornes (VT), le détecteur de commande de puissance (12) est configuré pour commander le convertisseur résonant (18) et le redresseur synchrone (20) pour générer la au moins une tension d'impulsion (PV) en réponse à la tension CC de charge (DV), le convertisseur résonant (18) et le redresseur

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synchrone (20) sont configurés pour générer respectivement le courant CC de charge (DI) et le au moins un courant d'impulsion (PI) en appliquant la tension CC de charge (DV) et la au moins une tension d'impulsion (PV), et quand la tension aux bornes (VT) est égale à la tension CC de charge (DV), le détecteur de commande de puissance (12) commande le convertisseur résonant (18) et le redresseur synchrone (20) pour convertir le courant CC de charge (DI) en le courant d'entretien (TI).

15. Dispositif de charge universel selon la revendication 14, dans lequel le détecteur de commande de puissance (12) comprend :

un circuit de rétroaction de tension (22) couplé au redresseur synchrone (20) et à la au moins une batterie (14), dans lequel le circuit de rétroaction de tension (22) est configuré pour recevoir la tension aux bornes (VT) et une tension à travers la au moins une batterie (14) établie par le au moins un courant d'impulsion (PI), et génèrent respectivement une première tension de rétroaction (F1) et au moins une tension de rétroaction d'impulsion (PF) sur la base de la tension aux bornes (VT) et d'une tension à travers la au moins une batterie (14) établie par le au moins un courant d'impulsion (PI) ;
une résistance de rétroaction (24) connectée entre le redresseur synchrone (20) et la au moins une batterie (14) en série, dans lequel le courant CC de charge (DI), le courant d'entretien (TI), et le au moins un courant d'impulsion (PI) circulent à travers la résistance de rétroaction (24), afin de générer une première tension de réponse (RES1), une tension d'entretien (RT), et au moins une seconde tension de réponse (RES2) à travers la résistance de rétroaction (24) ; un circuit de rétroaction de courant (26) couplé à deux extrémités de la résistance de rétroaction (24), au redresseur synchrone (20), et à la au moins une batterie (14), dans lequel le circuit de rétroaction de courant (26) est configuré pour recevoir la première tension de réponse (RES1), la tension d'entretien (RT), et la au moins une seconde tension de réponse (RES2) et génèrent respectivement une seconde tension de rétroaction (F2), une tension de rétroaction d'entretien (RF), et au moins une tension de réponse d'impulsion (PR) sur la base de la première tension de réponse (RES1), de la tension d'entretien (RT), et de la au moins une seconde tension de réponse (RES2) ;
un isolateur (28) présentant un côté primaire et un côté secondaire, dans lequel le côté secondaire est couplé au circuit de rétroaction de tension (22) et au circuit de rétroaction de courant (26) ; et
un dispositif de commande (30) couplé au côté primaire et au convertisseur résonant (18), dans lequel le dispositif de commande (30) est configuré pour recevoir la première tension de rétroaction (F1), la seconde tension de rétroaction (F2), la tension de rétroaction d'entretien (RF), la au moins une tension de rétroaction d'impulsion (PF), et la au moins une tension de réponse d'impulsion (PR) à travers l'isolateur (28), le dispositif de commande (30) est configuré pour commander le convertisseur résonant (18) et le redresseur synchrone (20) pour ajuster la tension CC de charge (DV) pour qu'elle soit supérieure à la tension aux bornes (VT) sur la base de la première tension de rétroaction (F1), le dispositif de commande (30) est configuré pour commander le convertisseur résonant (18) et le redresseur synchrone (20) pour générer la au moins une tension d'impulsion (PV) en réponse à la tension CC de charge (DV), le dispositif de commande (30) est configuré pour obtenir le courant CC de charge (DI) en fonction de la seconde tension de rétroaction (F2), le dispositif de commande (30) est configuré pour obtenir la tension CC de charge (DV) en fonction du courant CC de charge (DI), le dispositif de commande (30) est configuré pour obtenir le au moins un courant d'impulsion (PI) en fonction de la au moins une tension de réponse d'impulsion (PR), le dispositif de commande (30) est configuré pour obtenir le courant d'entretien (TI) en fonction de la tension de rétroaction d'entretien (RF), le dispositif de commande (30) est configuré pour déterminer que la au moins une tension de rétroaction d'impulsion (PF) satisfait à la condition chargée, et quand la tension aux bornes (VT) est égale à la tension CC de charge (DV), le dispositif de commande (30) commande le convertisseur résonant (18) et le redresseur synchrone (20) pour convertir le courant CC de charge (DI) en le courant d'entretien (TI) jusqu'à ce que la valeur du courant d'entretien (TI) diminue jusqu'à la valeur du courant déclenché.

16. Dispositif de charge universel selon la revendication 1, dans lequel le rapport fixe est de 90 % ou 85 %.

17. Dispositif de charge universel selon la revendication 1, dans lequel une valeur initiale de la tension aux bornes (VT) divisée par la tension nominale est inférieure ou égale à 97 %.

18. Dispositif de charge universel selon la revendication 1, dans lequel la au moins une batterie (14) est une batterie au lithium-ion.

19. Dispositif de charge universel selon la revendication

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18, dans lequel la batterie au lithium-ion est une batterie au nickel-cobalt-lithium, une batterie au nickel-lithium, ou une batterie au $LiFePO_4$.

20. Dispositif de charge universel selon la revendication 1, dans lequel la tension nominale présente une plage de 9-72 volts.

21. Dispositif de charge universel selon la revendication 1, dans lequel la au moins une batterie (14) comprend 10-20 batteries connectées en série.

22. Procédé de charge universel chargeant au moins une batterie, la au moins une batterie (14) présentant une tension aux bornes (VT) quand une tension continue (CC) de charge (DV) n'est pas appliquée, laquelle tension aux bornes (VT) est inférieure à une tension nominale de la au moins une batterie (14), et le procédé de charge universel comprenant les étapes consistant à :

déterminer que la au moins une batterie (14) est une batterie à charger ;
convertir une tension alternative (CA) (AV) en tension CC de charge (DV) ; et effectuer séquentiellement au moins deux premiers processus de charge, dans lequel chacun des au moins deux premiers processus de charge comprend les étapes consistant à :

ajuster la tension CC de charge (DV) pour qu'elle soit supérieure à la tension aux bornes (VT) sur la base de la tension aux bornes (VT), appliquer la tension CC de charge (DV) pour charger la au moins une batterie (14), générer au moins une tension d'impulsion (PV) sur la base de la tension CC de charge (DV), générer respectivement un courant continu (CC) de charge (DI) et au moins un courant d'impulsion (PI) en appliquant la tension CC de charge (DV) et la au moins une tension d'impulsion (PV) jusqu'à ce que la tension aux bornes (VT) soit égale à la tension CC de charge (DV), le courant CC de charge (DI) et le au moins un courant d'impulsion (PI) circulant à travers la au moins une batterie (14), le au moins un courant d'impulsion (PI) circulant à travers la au moins une batterie (14) pour établir une première tension détectée à travers la au moins une batterie (14), et la première tension détectée satisfaisant à une condition chargée ;
quand la tension aux bornes (VT) est égale à la tension CC de charge (DV), convertir le courant CC de charge (DI) en un courant d'entretien (TI) décroissant jusqu'à ce qu'une valeur du courant d'entretien (TI) diminue jusqu'à une valeur de courant déclenché, et la valeur du courant déclenché divisée par une valeur du courant CC de charge (DI) correspondant est égale à un rapport fixe inférieur à 1 et supérieur à 0 ; et dans lequel, dans l'étape consistant à déterminer que la au moins une batterie (14) est la batterie à charger, la tension aux bornes (VT) est détectée, une tension initiale (IV) est fournie à la au moins une batterie (14) pour générer un courant initial (IA) qui circule à travers la au moins une batterie (14), et la au moins une batterie (14) est déterminée comme étant la batterie à charger en fonction du courant initial (IA), de la tension aux bornes (VT), et d'une plage de tension de charge.

23. Procédé de charge universel selon la revendication 22, dans lequel le au moins un courant d'impulsion (PI) présente une période d'impulsion (T), un instant initial (t1), et un instant final (t2), le au moins un courant d'impulsion (PI) établit une première tension en circuit ouvert (O1) à travers la au moins une batterie (14) à l'instant initial (t1), le au moins un courant d'impulsion (PI) établit une seconde tension en circuit ouvert (02) à travers la au moins une batterie (14) à l'instant final (t2), et la condition chargée définit qu'une valeur absolue d'une différence entre la première tension en circuit ouvert (O1) et la seconde tension en circuit ouvert (02) divisée par la période d'impulsion (T) est inférieure ou égale à une valeur positive donnée.

24. Procédé de charge universel selon la revendication 22, dans lequel le courant CC de charge (D!) établit une première tension de batterie (B1) à travers la au moins une batterie (14), le au moins un courant d'impulsion (PI) établit une seconde tension de batterie (B2) à travers la au moins une batterie (14), et la condition chargée définit qu'une valeur absolue d'une différence entre la première tension de batterie (B1) et la seconde tension de batterie (B2) divisée par une valeur absolue d'une différence entre le courant CC de charge (DI) et le au moins un courant d'impulsion (PI) est inférieure ou égale à une valeur positive donnée.

25. Procédé de charge universel selon la revendication 22, dans lequel, après l'étape consistant à effectuer les au moins deux premiers processus de charge, un second processus de charge est effectué, et le second processus de charge comprend les étapes consistant à :

ajuster la tension CC de charge (DV) pour qu'elle soit supérieure à la tension aux bornes (VT) sur la base de la tension aux bornes (VT), ap-

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pliquer la tension CC de charge (DV) pour charger la au moins une batterie (14), générer la au moins une tension d'impulsion (PV) en réponse à la tension CC de charge (DV), générer respectivement le courant CC de charge (DI) et le au moins un courant d'impulsion (PI) en appliquant la tension CC de charge (DV) et la au moins une tension d'impulsion (PV), et le courant CC de charge (DI) et le au moins un courant d'impulsion (PI) circulant à travers la au moins une batterie (14) ; et

le au moins un courant d'impulsion (PI) établissant une seconde tension détectée à travers la au moins une batterie (14), et quand la seconde tension détectée satisfait à une condition complète, arrêter la génération de la tension CC de charge (DV), de la au moins une tension d'impulsion (PV), du courant CC de charge (DI), et du au moins un courant d'impulsion (PI).

26. Procédé de charge universel selon la revendication 25, dans lequel le au moins un courant d'impulsion (PI) présente une période d'impulsion (T), un instant initial (t1), et un instant final (t2), le au moins un courant d'impulsion (PI) établit une première tension en circuit ouvert (O1) à travers la au moins une batterie (14) à l'instant initial (t1), le au moins un courant d'impulsion (PI) établit une seconde tension en circuit ouvert (02) à travers la au moins une batterie (14) à l'instant final (t2), et la condition complète définit qu'une valeur absolue d'une différence entre la première tension en circuit ouvert (O1) et la seconde tension en circuit ouvert (02) divisée par la période d'impulsion (T) est supérieure à une valeur positive donnée.

27. Procédé de charge universel selon la revendication 25, dans lequel le courant CC de charge (D!) établit une première tension de batterie (B1) à travers la au moins une batterie (14), le au moins un courant d'impulsion (PI) établit une seconde tension de batterie (B2) à travers la au moins une batterie (14), et la condition complète définit qu'une valeur absolue d'une différence entre la première tension de batterie (B1) et la seconde tension de batterie (B2) divisée par une valeur absolue d'une différence entre le courant CC de charge (DI) et le au moins un courant d'impulsion (PI) est supérieure à une valeur positive donnée.

28. Procédé de charge universelle selon la revendication 25, dans lequel le au moins un courant d'impulsion (PI) comprend une pluralité de courants d'impulsion (PI), et quand la seconde tension détectée établie par chacun de la pluralité de courants d'impulsion (PI) satisfait à la condition complète, la tension CC de charge (DV) cesse d'être générée.

29. Procédé de charge universel selon la revendication 22, dans lequel dans chacun des au moins deux premiers processus de charge, une période pendant laquelle la tension aux bornes (VT) est égale à la tension CC de charge (DV) est inférieure à une période pendant laquelle la tension CC de charge (DV) est supérieure à la tension aux bornes (TV).

30. Procédé de charge universel selon la revendication 22, dans lequel les au moins deux premiers processus de charge comprennent un premier processus de charge précédent et un premier processus de charge suivant, et les périodes correspondant au courant CC de charge (DI) et au courant d'entretien (TI) dans le premier processus de charge précédent sont respectivement supérieures aux périodes correspondant au courant CC de charge (DI) et au courant d'entretien (TI) dans le premier processus de charge suivant.

31. Procédé de charge universel selon la revendication 22, dans lequel une période d'impulsion (T) du au moins un courant d'impulsion (PI) est inférieure à une période du courant CC de charge (DI) correspondant.

32. Procédé de charge universel selon la revendication 22, dans lequel, dans l'étape consistant à ajuster la tension CC de charge (DV) pour qu'elle soit supérieure à la tension aux bornes (VT), une différence entre la tension CC de charge (DV) et la tension aux bornes (VT) correspondante est une valeur donnée, et les valeurs données correspondant aux au moins deux premiers processus de charge sont égales.

33. Procédé de charge universel selon la revendication 22, dans lequel les au moins deux premiers processus de charge comprennent un premier processus de charge précédent et un premier processus de charge suivant, dans l'étape consistant à ajuster la tension CC de charge (DV) pour qu'elle soit supérieure à la tension aux bornes (VT), une différence entre la tension CC de charge (DV) et la tension aux bornes (VT) correspondante est une valeur donnée, et la valeur donnée correspondant au premier processus de charge précédent est supérieure à la valeur donnée correspondant au premier processus de charge suivant.

34. Procédé de charge universel selon la revendication 22, dans lequel les au moins deux premiers processus de charge comprennent un premier processus de charge précédent et un premier processus de charge suivant, les périodes du courant CC de charge (DI) et du courant d'entretien (TI) correspondant au premier processus de charge précédent sont respectivement inférieures aux périodes du courant CC de charge (DI) et du courant d'entretien (TI) corres-

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pondant au premier processus de charge suivant.

35. Procédé de charge universel selon la revendication 22, dans lequel le rapport fixe est de 90 % ou 85 %.

36. Procédé de charge universel selon la revendication 22, dans lequel une valeur initiale de la tension aux bornes (VT) divisée par la tension nominale est inférieure ou égale à 97 %.

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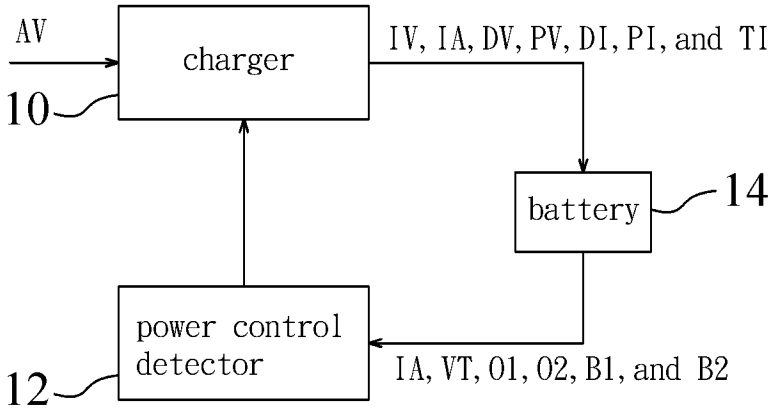


Fig. 1

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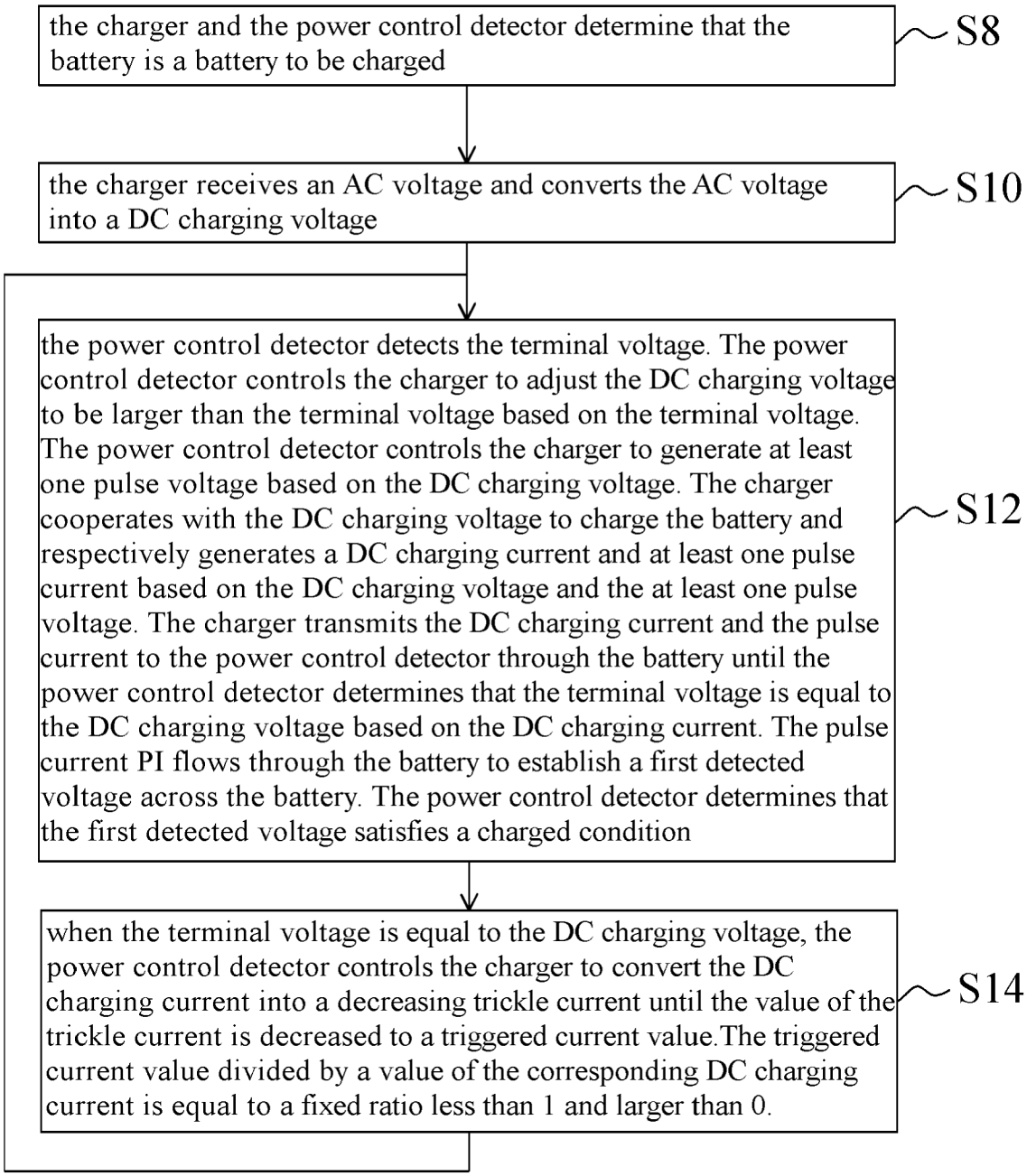


Fig. 2

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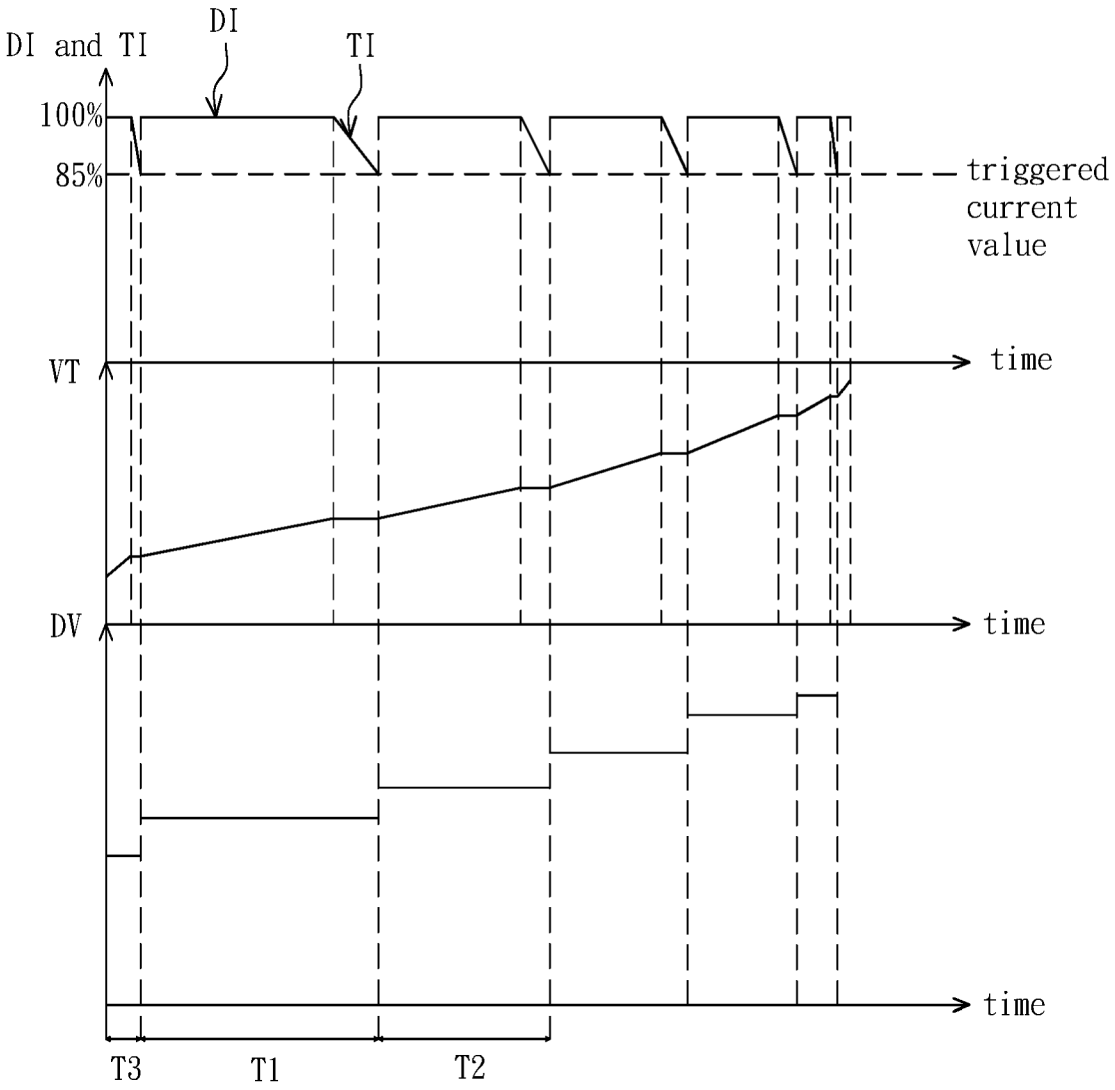


Fig. 3

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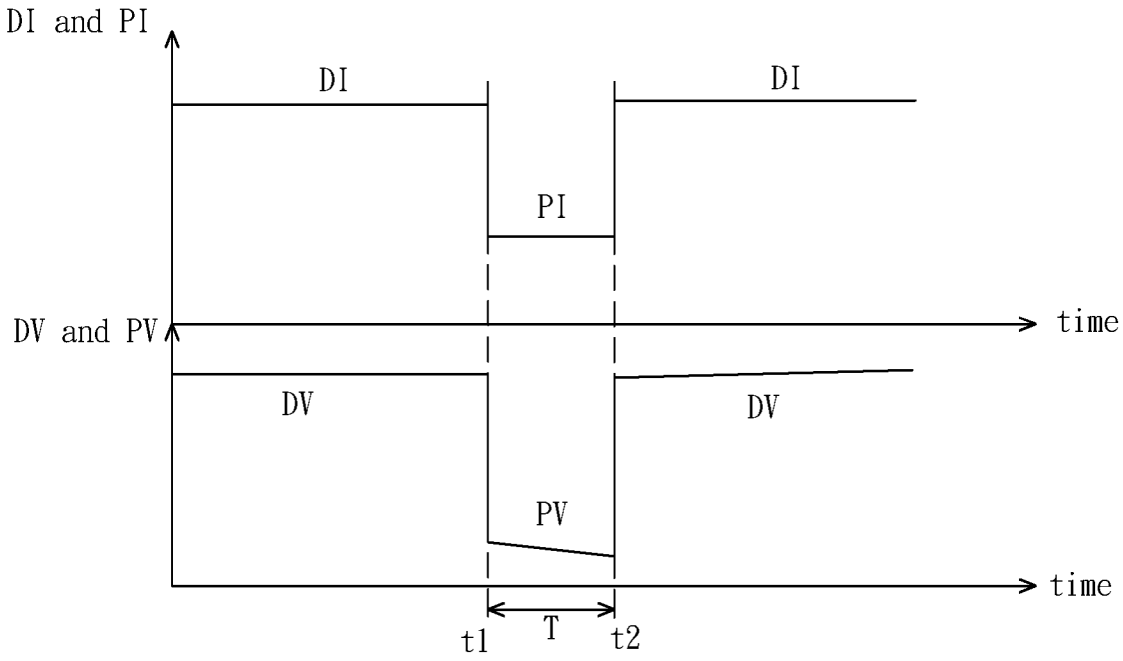


Fig. 4

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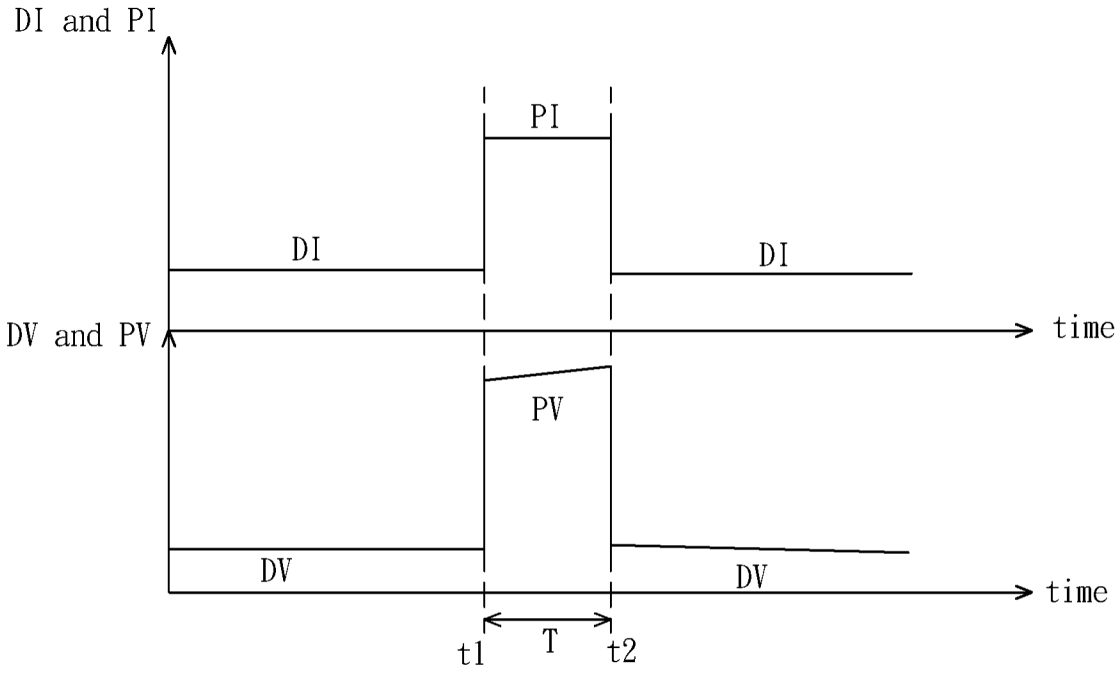


Fig. 5

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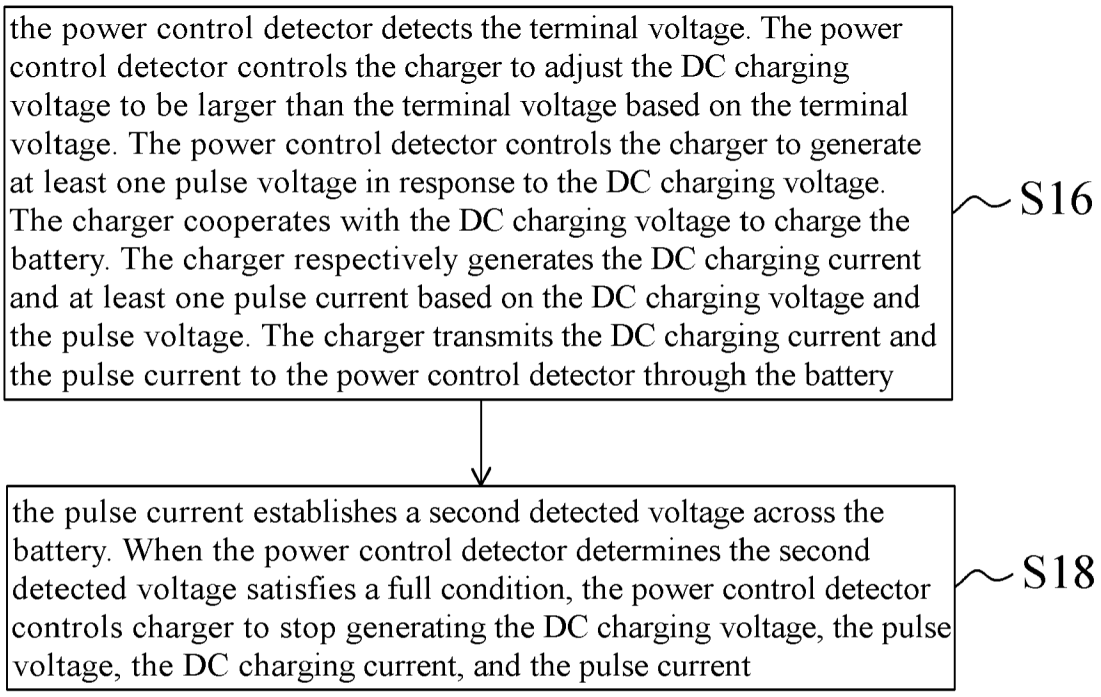


Fig. 6

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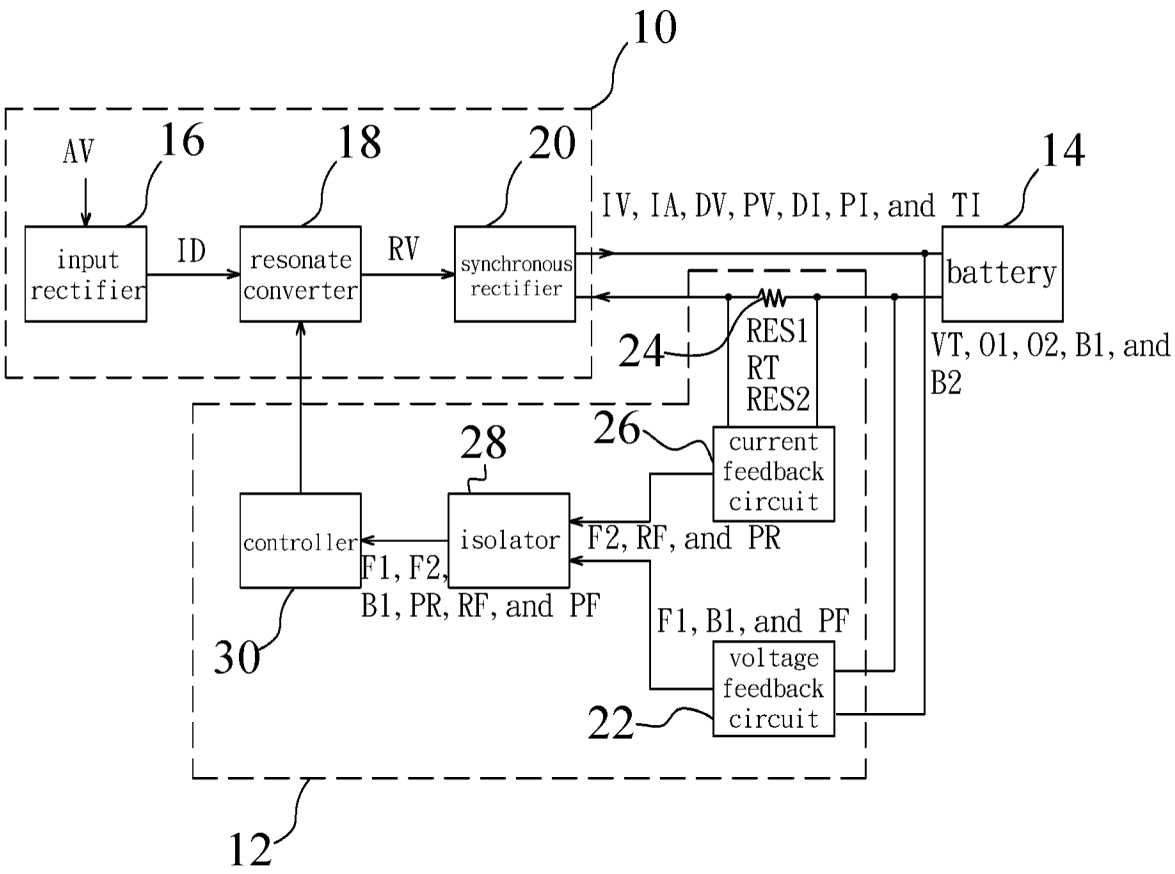


Fig. 7

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