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ADAPTER AND COMBINATION OF A BATTERY PACK AND AN ADAPTER

Abstract

A combination includes a battery pack and an adapter. The battery pack includes a battery pack interface at least capable of being detachably connected to a power tool. A first adapter includes a plug, an alternating current input interface, an alternating current-direct current conversion circuit, and a direct current output interface. A second adapter is capable of being electrically connected to the first adapter and the battery pack. The second adapter includes an adapter interface, a direct current interface, a voltage conversion circuit, and a two-way control module. The direct current interface is configured to be detachably electrically connected to the direct current output interface. The voltage conversion circuit is connected in series between the direct current interface and the adapter interface. The two-way control module is connected between the direct current interface and the adapter interface and connected to the voltage conversion circuit.

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Background/Summary

RELATED APPLICATION INFORMATION [0001] This application is a continuation of U.S. patent application Ser. No. 17/549,230, filed on Dec. 13, 2021, which application is a continuation of International Application Number PCT/CN2019/126426, filed on Dec. 18, 2019, through which this application also claims the benefit under 35 U.S.C. § 119(a) of Chinese Patent Application No. 201910518043.1, filed on Jun. 14, 2019 and Chinese Patent Application No. 201911047627.1, filed on Oct. 30, 2019. [0002] Through U.S. patent application Ser. No. 17/549,230, this application is also a continuation of International Application Number PCT/CN2020/136005, filed on Dec. 14, 2020, through which this application also claims the benefit under 35 U.S.C. § 119(a) of Chinese Patent Application No. 202010076760.6, filed on Jan. 23, 2020.

[0003] Each of these applications from which benefit is claimed is incorporated herein by reference in its entirety.

BACKGROUND

[0004] With the development of power tools, portable power tools have been increasingly used in different fields such as industry, construction, and garden machinery. People have higher requirements for the portable power tools.

[0005] In the related art, a battery pack is often used for supplying power to a power tool. The battery pack can only be adapted to the power tool, but cannot be adapted to the power supply of an external electronic device, which limits usage scenarios of the battery pack.

[0006] In addition, the power tool in the related art needs to be equipped with a special charger for charging the battery pack, and the charger in the related art has a relatively complicated structure and relatively high manufacturing costs and is bulky and inconvenient to carry.

SUMMARY

[0007] The present application provides an adapter and a combination of a battery pack and an adapter, which have relatively low costs, are convenient to carry, and can expand usage scenarios of a battery pack of a power tool.

[0008] An example provides a combination of a battery pack and an adapter. The combination of a battery pack and an adapter includes the battery pack. The battery pack includes a battery pack interface at least capable of being detachably connected to a power tool. A first adapter includes a plug, an alternating current input interface, an alternating current-direct current conversion circuit, and a direct current output interface. The plug is used for access to an alternating current. The alternating current input interface is electrically connected to the plug. The alternating current-direct current conversion circuit is electrically connected to the alternating current input interface and configured to convert the alternating current into a direct current. The direct current output

interface is electrically connected to the alternating current-direct current conversion circuit and configured to output the direct current. A second adapter is capable of being electrically connected to the first adapter and the battery pack and charging the battery pack with a charging power greater than 10 W. The second adapter includes an adapter interface, a direct current interface, a voltage conversion circuit, and a two-way control module. The adapter interface is configured to be detachably connected to the battery pack interface. The direct current interface is configured to be detachably electrically connected to the direct current output interface. The voltage conversion circuit is connected in series between the direct current interface and the adapter interface and configured to convert the direct current into an electric power output adapted to the battery pack. The two-way control module is connected between the direct current interface and the adapter interface and connected to the voltage conversion circuit, where the two-way control module is configured to be capable of controlling a current direction and an output voltage of the voltage conversion circuit according to a signal state of the direct current interface and a signal state of the adapter interface.

[0009] An example provides an adapter. The adapter includes an adapter interface and a direct current interface. The adapter interface is configured to be connected to a battery pack capable of being detachably connected to a power tool. The direct current is configured to be capable of being selectively connected to an external power consumption device or an external power supply device, where an output or input power of the direct current interface is greater than 10 W. The adapter further includes a voltage conversion circuit, a communication module, and a two-way control module. The voltage conversion circuit is connected in series between the direct current interface and the adapter interface, where the voltage conversion circuit is configured to convert electric power of the external power supply device into an electric power output adapted to the battery pack; and the voltage conversion circuit is configured to convert electric power of the battery pack into an electric power output adapted to the external power consumption device. The communication module is configured to be capable of sending a control signal to the two-way control module according to a signal state of the direct current interface. The two-way control module is connected between the direct current interface and the adapter interface and connected to the voltage conversion circuit, where the two-way control module is configured to control a current direction and an output voltage of the voltage conversion circuit according to the signal state of the direct current interface and a signal state of the adapter interface to selectively make the external power supply device charge the battery pack or make the battery pack discharged to supply power to the external power consumption device.

[0010] An example provides a combination of a battery pack and an adapter. The combination of a battery pack and an adapter includes the battery pack. The battery pack includes a battery pack interface at least capable of being detachably connected to a power tool. A first adapter includes a first plug, a first alternating current input interface, a first alternating current-direct current conversion circuit, and a first direct current output interface. The first plug is used for access to an alternating current. The first alternating current input interface is electrically connected to the first plug. The first alternating current-direct current conversion circuit is electrically connected to the first alternating current input interface and configured to convert the alternating current into a direct current. The first direct current output interface is electrically connected to the first alternating current-direct current conversion circuit and configured to output the direct current. A second adapter includes a second plug, a second alternating current input interface, a second alternating current-direct current conversion circuit, and a second direct current output interface. The second plug is used for access to the alternating current. The second alternating current input interface is electrically connected to the second plug.

[0011] The second alternating current-direct current conversion circuit is electrically connected to the second alternating current input interface and configured to convert the alternating current into the direct current. The second direct current output interface is electrically connected to the second

alternating current-direct current conversion circuit and configured to output the direct current. A third adapter is capable of being electrically connected to the first adapter, the second adapter, and the battery pack. The third adapter includes an adapter interface, a first direct current interface, a second direct current interface, a first voltage conversion circuit, a second voltage conversion circuit, and a two-way control module. The adapter interface is configured to be detachably connected to the battery pack interface. The first direct current interface is configured to be detachably electrically connected to the first direct current output interface, where an output or input power of the first direct current interface is greater than 10 W. The second direct current interface is configured to be detachably electrically connected to the second direct current output interface, where an output or input power of the second direct current interface is greater than 10 W. The first voltage conversion circuit is connected in series between the first direct current interface and the adapter interface and configured to convert a direct current of the first direct current output interface into an electric power output adapted to the battery pack. The second voltage conversion circuit is connected in series between the second direct current interface and the adapter interface and configured to convert a direct current of the second direct current output interface into the electric power output adapted to the battery pack. The two-way control module is connected between the first direct current interface or the second direct current interface, and the adapter interface and connected to the first voltage conversion circuit and the second voltage conversion circuit, where the two-way control module is configured to control a current direction and an output voltage of the first voltage conversion circuit according to a signal state of the first direct current interface and a signal state of the adapter interface; and the two-way control module is further configured to control a current direction and an output voltage of the second voltage conversion circuit according to a signal state of the second direct current interface and the signal state of the adapter interface. In the case where both the first alternating current input interface and the second alternating current input interface are connected to the alternating current, the battery pack is charged through the first direct current interface and the second direct current interface; a value range of a charging power of the first direct current interface is greater than 10 W; and a value range of a charging power of the second direct current interface is greater than 10 W.

[0012] An example provides an adapter. The adapter includes an adapter interface, a first direct current interface, a second direct current interface, a first voltage conversion circuit, and a two-way control module. The adapter interface is configured to be connected to a battery pack capable of being detachably connected to a power tool. The first direct current interface is configured to be capable of being electrically connected to an external power supply device, where an input power of the first direct current interface is greater than 10 W; and an input voltage range of the first direct current interface is 5 V to 20 V. The second direct current interface is capable of being electrically connected to an external power consumption device and configured to supply electric power of the external power supply device or electric power of the battery pack to the external power consumption device. The first voltage conversion circuit is connected in series between the first direct current interface and the adapter interface and configured to convert the electric power of the external power supply device into an electric power output adapted to the battery pack. The two-way control module is connected between the first direct current interface and the adapter interface and connected to the first voltage conversion circuit, where the two-way control module is configured to be capable of controlling a current direction and an output voltage of the first voltage conversion circuit according to a signal state of the first direct current interface and a signal state of the adapter interface. In the case where the first direct current interface is connected to the external power supply device and the second direct current interface is connected to the external power consumption device, the external power supply device is capable of charging the battery pack through the first direct current interface, and the external power supply device is capable of charging the external power consumption device through the second direct current interface.

[0013] An example provides an adapter. The adapter includes an adapter interface, a first direct

current interface, a second direct current interface, a first voltage conversion circuit, a second voltage conversion circuit, and a two-way control module. The adapter interface is configured to be connected to a battery pack capable of being detachably connected to a power tool. The first direct current interface is capable of being electrically connected to a first external power supply device, where an input power of the first direct current interface is greater than 10 W; and a value range of an input voltage of the first direct current interface is 5 V to 20 V. The second direct current interface is capable of being electrically connected to a second external power supply device, where an input power of the second direct current interface is greater than 10 W; and a value range of an input voltage of the second direct current interface is 5 V to 20 V. The first voltage conversion circuit is connected in series between the first direct current interface and the adapter interface and configured to convert a direct current of a first direct current output interface into an electric power output adapted to the battery pack. The second voltage conversion circuit is connected in series between the second direct current interface and the adapter interface and configured to convert a direct current of a second direct current output interface into the electric power output adapted to the battery pack. The two-way control module is connected between the first direct current interface or the second direct current interface and the adapter interface and connected to the first voltage conversion circuit and the second voltage conversion circuit, where the two-way control module is configured to control a current direction and an output voltage of the first voltage conversion circuit according to a signal state of the first direct current interface and a signal state of the adapter interface; and the two-way control module is further configured to control a current direction and an output voltage of the second voltage conversion circuit according to a signal state of the second direct current interface and the signal state of the adapter interface. In the case where the first direct current interface is connected to the first external power supply device and the second direct current interface is connected to the second external power supply device, the battery pack is charged through the first direct current interface and the second direct current interface.

[0014] An example provides a combination of a battery pack and an adapter. The combination of a battery pack and an adapter includes the battery pack and the adapter. The battery pack includes a battery pack interface at least capable of being detachably connected to a power tool. The adapter is capable of being electrically connected to the battery pack. The adapter includes a plug, an adapter interface, an alternating current-direct current conversion circuit, a direct current interface, an alternating current output interface, a first voltage conversion circuit, a second voltage conversion circuit, and a two-way control module. The plug is used for access to an alternating current. The adapter interface is configured to be detachably connected to the battery pack interface. The alternating current-direct current conversion circuit is configured to convert the alternating current into a direct current capable of charging the battery pack. The direct current interface is configured to be detachably electrically connected to an external power consumption device, where an output power of the direct current interface is greater than 10 W. The alternating current output interface is configured to output the alternating current. The first voltage conversion circuit is connected in series between the adapter interface and the alternating current output interface and configured to convert a direct current output by the battery pack into an alternating current output.

[0015] The second voltage conversion circuit is connected in series between the direct current interface and the adapter interface and configured to convert electric power of the battery pack into an electric power output adapted to the external power consumption device. The two-way control module is connected between the direct current interface and the adapter interface and connected to the second voltage conversion circuit, where the two-way control module is configured to be capable of controlling a current direction and an output voltage of the second voltage conversion circuit according to a signal state of the direct current interface and a signal state of the adapter interface.

[0016] An example provides a combination of a battery pack and an adapter. The combination of a battery pack and an adapter includes the battery pack and the adapter. The battery pack includes a

battery pack interface at least capable of being detachably connected to a power tool. The adapter includes an adapter interface, an alternating current output interface, a first voltage conversion circuit, a direct current interface, a second voltage conversion circuit, and a two-way control module. The adapter interface is configured to be connected to the battery pack capable of being detachably connected to the power tool. The alternating current output interface is configured to output an alternating current. The first voltage conversion circuit is connected in series between the adapter interface and the alternating current output interface and configured to convert a direct current output by the battery pack into an alternating current output.

[0017] The direct current interface is configured to be selectively connected to an external power consumption device or an external power supply device, where an output or input power of the direct current interface is greater than 10 W; and a value range of an input or output voltage of the direct current interface is 5 V to 20 V. The second voltage conversion circuit is connected in series between the direct current interface and the adapter interface, where the second voltage conversion circuit is configured to convert electric power of the external power supply device into an electric power output adapted to the battery pack; or the second voltage conversion circuit is configured to convert electric power of the battery pack into an electric power output adapted to the external power consumption device. The two-way control module is connected between the direct current interface and the adapter interface and connected to the second voltage conversion circuit, where the two-way control module is configured to be capable of controlling a current direction and an output voltage of the second voltage conversion circuit according to a signal state of the direct current interface and a signal state of the adapter interface.

[0018] The adapter and the combination of a battery pack and an adapter have simple structures and relatively low costs, are convenient to carry, expand usage scenarios of the power tool, the battery pack, the adapter, and the power supply device, and are convenient for a user to use.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0019] FIG. **1** is a structural view of a combination of a battery pack and an adapter according to an example;

[0020] FIG. **2** is a structural view of the battery pack in the combination of a battery pack and an adapter in FIG. **1**;

[0021] FIG. **3** is a structural view of the adapter in the combination of a battery pack and an adapter in FIG. **1**;

[0022] FIG. **4** is a schematic view of the battery pack in FIG. **2** and a power tool when used in combination;

[0023] FIG. **5** is an example of the combination of a battery pack and an adapter in FIG. **1**;

[0024] FIG. **6** is a circuit block diagram of the adapter in FIG. **5**;

[0025] FIG. **7** is a circuit block diagram of the adapter in FIG. **3**;

[0026] FIG. **8** is a circuit block diagram of the adapter in FIG. **3**;

[0027] FIG. **9** is a circuit block diagram of the adapter in FIG. **3**;

[0028] FIG. **10** is a circuit block diagram of the adapter in FIG. **3**;

[0029] FIG. **11** is a circuit block diagram of the adapter in FIG. **3**;

[0030] FIG. **12** is a structural view of the combination of a battery pack and an adapter in FIG. **1** according to another example;

[0031] FIG. **13** is a circuit block diagram of the adapter in FIG. **12**;

[0032] FIG. **14** is a circuit block diagram of the adapter in FIG. **3**;

[0033] FIG. **15** is a structural view of a combination of a battery pack and an adapter according to an example;

[0034] FIG. **16** is a circuit block diagram of the adapter in the combination of a battery pack and an adapter in FIG. **15**;
[0035] FIG. **17** is a structural view of a combination of a battery pack and an adapter according to an example;
[0036] FIG. **18** is a structural view of the adapter in the combination of a battery pack and an adapter in FIG. **17**;
[0037] FIG. **19** is a circuit block diagram of the adapter in FIG. **18**;
[0038] FIG. **20** is a circuit block diagram of a battery pack according to an example;
[0039] FIG. **21** is a circuit block diagram of an adapter according to an example;
[0040] FIG. **22** is a structural view of a combination of a battery pack and a tool lamp according to an example;
[0041] FIG. **23** is a circuit block diagram of the tool lamp in FIG. **22**;
[0042] FIG. **24** is a structural view of a power tool according to another example; and
[0043] FIG. **25** is a circuit block diagram of the power tool in FIG. **24**.

DETAILED DESCRIPTION

[0044] As shown in FIGS. **1** to **4**, a combination **10** of a battery pack and an adapter includes a battery pack **11**, a second adapter **12**, and a first adapter **13**. The battery pack **11** is configured to supply power to a power tool **20** (as shown in FIG. **4**), the second adapter **12** can enable the battery pack **11** to output electric power, and the first adapter **13** can supply power to charge the battery pack **11**. In some examples, a nominal voltage range of the battery pack **11** is 10 V to 60 V, and a battery capacity of the battery pack **11** is greater than or equal to 100 Wh and less than or equal to 2000 Wh. In some examples, the nominal voltage range of the battery pack **11** may also be 18 V to 24V, 24 V to 40 V, 40 V to 60 V, or 60 V to 120 V.
[0045] Although this example relates to a hand-held power tool, it is to be understood that the present application is not limited to the disclosed example and can be applied to other types of power tools, including but not limited to garden power tools and home products, such as a vehicle-type lawn mower and a hair dryer.
[0046] As shown in FIG. **2**, the battery pack **11** includes a battery **111** for storing electric power and a first casing **114** for accommodating the battery, and a battery pack terminal. The battery pack terminal includes a positive terminal **112** of the battery pack and a negative terminal **113** of the battery pack. The battery pack **11** outputs electric power through the positive terminal **112** of the battery pack and the negative terminal **113** of the battery pack. A first coupling portion **115** is formed on the first casing. The first coupling portion **115** can be detachably connected to a coupling portion of the power tool **20** so that the battery pack **11** can supply power to the power tool. The first coupling portion **115** can also enable the battery pack **11** to be electrically connected to the second adapter **12** when the battery pack **11** is coupled to the adapter **12**.
[0047] Referring to FIG. **3**, the second adapter **12** includes a second casing **122** and an interface **124**. The second casing **122** is formed with an adapter interface **121**, where the adapter interface **121** includes an electrical connection terminal and a second coupling portion **123**. The second coupling portion **123** may be coupled to the first coupling portion **115** of the battery pack. When the first coupling portion **115** of the battery pack is coupled to the second coupling portion **123**, the positive terminal **112** and the negative terminal **113** of the power supply are connected to the electrical connection terminal for access to or output of electric power. In some examples, the second coupling portion **123** is formed with a slot, and the electrical connection terminal is disposed in the slot. In other examples, the first coupling portion is formed with a guide groove, and the second coupling portion is provided with a guide rail fitting with the guide groove so that the battery pack may be slidably connected to the adapter along the guide rail. The second casing is further equipped with the interface **124** capable of charging and discharging. Here, the interface **124** of the second adapter **12** may be selectively connected to an external power consumption device or an external power supply device to selectively make the external power supply device

charge the battery pack or make the battery pack discharged to supply power to the external power consumption device. For a circuitry architecture, reference may be made to FIGS. **6** to **14**.

[0048] In some examples, referring to FIG. **5**, the second adapter **12** is electrically connected to the first adapter **13**. The first adapter **13** includes a power plug **131**, an alternating current input interface, an alternating current-direct current conversion circuit **132**, and a direct current output interface **133**. In an example, the power plug **131** is used for access to the alternating current. In some examples, an alternating current plug is inserted into an alternating current socket for access to the alternating current mains. A value range of the alternating current accessed through the plug is 110 V to 130 V or 210 V to 230 V. The alternating current input interface is electrically connected to the power plug **131** to access the alternating power; the alternating current-direct current conversion circuit **132** is electrically connected to the alternating current input interface and configured to convert the alternating current into the direct current; the direct current output interface **133** is electrically connected to the alternating current-direct current conversion circuit **132** and configured to output the direct current. The interface of the second adapter is electrically connected to the direct current output interface to access the direct current, so as to supply power to the battery pack. In this example, the first adapter **13** can also directly supply power to electronic terminals such as a laptop, a mobile phone, or a mobile power supply. In the example, the first adapter **13** is an external power supply device.

[0049] Referring to FIG. **6**, FIG. **6** is a circuit block diagram of the adapter in FIG. **5** according to an example. The first adapter **13** includes an alternating current input interface, an alternating current-direct current conversion circuit, and a direct current output interface. The alternating current input interface is accessed to the alternating current; the alternating current-direct current conversion circuit is configured to convert the accessed alternating current into the direct current; the direct current output interface can be electrically connected to the second adaptor **12** to output the direct current.

[0050] The second adapter **12** includes a first direct current interface **133**, an adapter interface **41**, and a circuit board **44**. The adapter interface **41** is configured to be electrically connected to the battery pack **11**. The first direct current interface **133** is electrically connected to the direct current output interface.

[0051] In an example, the first direct current interface has a charge state and a discharge state. In the case where the first direct current interface is in the charge state, the first direct current interface receives electric power from the external power supply device such as the first adapter **13** so that the battery pack is charged. In the case where the first direct current interface **133** is in the discharge state, the first direct current interface **133** can also supply electric power of the battery pack to the external power consumption device (referring to FIG. **7**).

[0052] The first direct current interface **133** includes at least two power terminals and a detection terminal **423**. The at least two power terminals include a first power terminal **421** such as Vbus1 and a second power terminal **422** such as Vbus2, and the detection terminal **423** includes a CC1 pin and a CC2 pin. Referring to the interface **124** shown in FIG. **3**, the interface **124** includes a slot and a plug tongue accommodated in the slot. A first power terminal, a second power terminal, and a detection terminal are disposed on an upper surface of the plug tongue, so as to correspond to the first power terminal **421** such as Vbus1, the second power terminal **422** such as Vbus2, and the detection terminal **423** such as the CC1 pin and/or the CC2 pin. The first power terminal **421** and the second power terminal **422** are configured to connect a positive electrode of the direct current to the positive terminal **112** of the battery pack **11**. In this manner, the circuit design of at least two power terminals can bear greater power transmission, greatly improving the power transmission capacity of the first direct current interface **133**, so that an output power or input power of the first direct current interface **133** is greater than 10 W, and thus the charging time or discharging time can be greatly shortened. For example, for a 2.5 Ah/24 V battery pack, it only takes 6 minutes for charging or discharging using this circuit architecture while in the related art, it often takes 6 to 7

hours using a charge circuit architecture or a discharge circuit architecture matched with the power tool.

[0053] The first power terminal **421** and the second power terminal **422** are configured to input or output electric power, the detection terminal **423** is configured to detect a signal state of the direct current interface, and the first direct current interface **133** has a charge state, a discharge state, and an empty state. In the case where the first direct current interface **133** is connected to the first adapter **13**, the detection terminal **423** detects that the first direct current interface **133** is in the charge state and sends a charge control signal to the circuit board so that the first adapter **13** charges the battery pack. In the case where the first direct current interface **133** is connected to an external power consumption device **401**, the detection terminal **423** detects that the first direct current interface **133** is in the discharge state and sends a discharge control signal to the circuit board **44** so that the battery pack is discharged to supply power to the external power consumption device **401**.

[0054] The circuit board **44** is connected in series between the adapter interface **41** and the first direct current interface **133**. In an example, the circuit board unit **44** is provided with a main controller **441**, a communication module **442**, a two-way power supply controller **443**, and a voltage conversion circuit **444**. The circuit board unit **44** may be one circuit board or may be integrated by multiple circuit boards, which is not limited herein.

[0055] In the case where the first direct current interface **133** is connected to the first adapter **13**, the detection terminal **423** detects that the first direct current interface **133** is in the charge state and sends the charge control signal to the voltage conversion circuit **444**. In an example, the detection terminal **423** detects that the first direct current interface **133** is in the charge state and sends the charge control signal to the communication module **442**.

[0056] The communication module **442** receives the charge control signal from the detection terminal **423** and transmits the charge control signal to the main controller **441**. The main controller **441** receives a communication signal of related information of the battery pack from the battery pack and transmits the communication signal to the communication module **442**. The communication module **442** receives the communication signal of the related information of the battery pack from the main controller and adjusts a voltage, current, and power of an external power supply device **402**.

[0057] The main controller **441** also receives the charge control signal from the communication module **442** and outputs a control signal to the two-way power supply controller **443**. The two-way power supply controller **443** receives the control signal from the main controller **441** and outputs a power supply control signal to the voltage conversion circuit to control a current direction of the voltage conversion circuit **444** and control the voltage conversion circuit **444** to adjust electric power of the external power supply device **401** to form an electric power output adapted to the battery pack so that the external power supply device **401** charges the battery pack. In an example, the two-way power supply controller **443** receives the control signal from the main controller **441** and outputs a reference voltage to the voltage conversion circuit **444** to control the current direction of the voltage conversion circuit **444**. For example, in the case where the first adapter **13** is connected to the first direct current interface **42**, a CS pin of the two-way power supply controller outputs a positive voltage to the voltage conversion circuit so that the external power supply device **402** charges the battery pack. In the case where the external power consumption device **401** is connected to the first direct current interface, the CS pin of the two-way power supply controller outputs a negative voltage to the voltage conversion circuit so that the battery pack is discharged to supply power to the external power consumption device **401**. The voltage conversion circuit **444** matches a voltage of the first direct current interface **42** with a voltage of the battery pack **11**.

[0058] In some examples, the detection terminal **423** of the first direct current interface **133** includes the CC1 pin and/or the CC2 pin, and the CC1 pin and/or the CC2 pin are control pins to generate a communication signal. The first power terminal **421** is a Vbus1 pin, and the second

power terminal **422** is a Vbus2 pin. The CC1 pin and/or the CC2 pin are used for determining whether a device connected to the first direct current interface **133** is an external power supply device or an external power consumption device, and the change of a state of the CC1 pin and/or the CC2 pin is detected by the communication module.

[0059] In another example of the present application, referring to the interface **124** shown in FIG. **3**, for example, the CC1 pin is disposed on the upper surface of the plug tongue and the CC2 pin is disposed on a lower surface of the plug tongue opposite to the upper surface. When a corresponding interface of the external power supply device or the external power consumption device is inserted into the interface **124** shown in FIG. **3**, the CC1 pin and the CC2 pin together generate a communication signal. For example, when the corresponding interface of the external power supply device is inserted in the interface **124** shown in FIG. **3** in a forward direction and the corresponding interface of the external power consumption device is inserted into the interface **124** shown in FIG. **3** in a backward direction, the CC1 pin on the upper surface of the plug tongue and the CC2 pin on the lower surface of the plug tongue together generate a communication signal.

[0060] When the CC1 pin and the CC2 pin are in an idle state, no device is connected in this case. In the case where the first adapter **13** is connected to the first direct current interface **133**, the CC1 pin and/or the CC2 pin detect a high level, the first adapter **13** is equivalent to a pull-up resistor, it is determined that the first direct current interface **133** is a power supply side, the battery pack **11** is equivalent to a pull-down resistor and determined as a power receiving side, the main controller **441** acquires current charge information of the battery pack and transmits the current charge information to a communication module **442** through an SDA pin and an SCL pin on the main controller **441**, the communication module **442** adjusts a voltage, current, and power of the external power supply device, a voltage adapted to the battery pack is obtained through the voltage conversion circuit **444**, and the external power supply device charges the battery pack with the voltage adapted to the battery pack. A standard voltage range of the first direct current interface **133** is 5 V to 20 V, which can achieve a continuously adjustable voltage from 5 V to 20 V and support any relatively large source output power of 10 W to 100 W.

[0061] Referring to FIG. **7**, in the case where the first direct current interface **133** is connected to the external power consumption device **401**, the CC1 pin and/or the CC2 pin detect a low level, the external power consumption device **401** is equivalent to a pull-down resistor, it is determined that the first direct current interface **133** is a power receiving side, the battery pack is equivalent to a pull-up resistor and determined as a power supply side, the communication module **442** detects the change in the state of the CC1 pin and/or the CC2 pin and transmits a signal to the main controller **441** through the SCL pin and the SDA pin, the main controller **441** outputs a control signal to the two-way power supply controller **443**, the two-way power supply controller receives the control signal and controls the current direction of the voltage conversion circuit **444**, and the voltage conversion circuit **444** matches a discharge voltage of the battery pack with a charge voltage required by the external power consumption device **401** so that the external power consumption device **401** is charged.

[0062] In this manner, a combination of a battery pack and an adapter shown in FIG. **5** is provided so that an external power supply device of a smartphone or a laptop available on site may be used for charging the battery pack with a high power through the first direct current interface, or the adapter may be used for outputting the electric power stored in the battery pack so that the battery pack is discharged to supply power to an external power consumption device such as the smartphone or the laptop. Therefore, the combination of a battery pack and an adapter is greatly convenient for a user to use. Since a design circuit architecture of the two-way power supply controller is adopted in the adapter, the charge and discharge control can be achieved through the same controller, which reduces the introduction of other operational amplifier circuits and simplifies the circuit structure. Moreover, the adapter can achieve high power greater than 10 W.

[0063] In some examples, the main controller **441**, the first communication module **442**, and the

two-way power supply controller **443** may be integrated into a system on a chip (SOC).
[0064] Reference may be made to an adapter **50** shown in FIG. **8** as one of the examples. The difference from the example shown in FIGS. **6** and **7** is that the adapter **50** includes a first direct current interface **52** and a second direct current interface **53**. The adapter **50** further includes a discharge circuit **55** and a charge circuit **56**.
[0065] The first direct current interface **52** is an interface that can achieve charge and discharge with a high power greater than 10 W and is the same type of interface as the first direct current interface **133** of the adapter **12** in the example shown in FIG. **6**.
[0066] The second direct current interface **53** is configured to be connected to an external power consumption device **501** and supply electric power to the external power consumption device **501**. The second direct current interface **53** is an interface that supplies power to an external device and has an operation power of 5 V/2 A.
[0067] The discharge circuit **55** is configured to convert electric power output by an adapter interface **51** into a voltage output adapted to the second direct current interface **53**; the discharge circuit **55** is disposed on a circuit board **54** and connected in series between the adapter interface **51** and the second direct current interface **53**. The discharge circuit **55** includes a second communication module **551** and a second voltage conversion circuit **552**.
[0068] The charge circuit **56** is configured to convert electric power of the external power supply device **502** connected to the first direct current interface **52** to charge the battery pack through the external power supply device **502**, and the charge circuit **56** is connected in series between the adapter interface **51** and the first direct current interface **52**.
[0069] In some examples, a second communication terminal **58** such as a DM2 pin is disposed in the second direct current interface **53**. The second communication terminal **58** is configured to detect an interface state of the second direct current interface **53**. The interface state of the second direct current interface **53** includes an empty state and a discharge state. In the case where the external power consumption device is connected to the second direct current interface, the second communication terminal **58** detects the discharge state and sends a communication signal to the second communication module **551**.
[0070] The second communication module **551** receives a communication signal of state information of the second direct current interface **53** and transmits the communication signal to the second voltage conversion circuit **552**.
[0071] The second voltage conversion circuit **552** receives a state signal of the second direct current interface from the second communication module **551** and then converts the voltage of the battery pack into a voltage adapted to the external power consumption device **501**.
[0072] The charge circuit **56** includes a first communication module **561**, a main controller **562**, a two-way power supply controller **563**, and a first voltage conversion circuit **564**.
[0073] The first voltage conversion circuit **564** is connected in series between the first direct current interface **52** and the adapter interface **51** and configured to convert the electric power of the external power supply device **502** into the electric power output adapted to the battery pack. The first voltage conversion circuit **564** converts a voltage of the first direct current interface **52** such that the voltage of the first direct current interface **52** is adapted to the voltage of the battery pack.
[0074] In the case where the first direct current interface **52** is connected to the external power supply device **502**, the detection terminal **57** detects a high level, determines that the first direct current interface is in the charge state, and sends the charge control signal to the first communication module **561**. The first communication module **561** receives the charge control signal from the detection terminal **57** and transmits the charge control signal to the main controller **562**. The main controller **562** is configured to be capable of receiving a communication signal about battery pack information from the battery pack and transmitting the communication signal of the battery pack information to the first communication module **561**. The first communication module **561** receives the communication signal of the related information of the battery pack from

the main controller **562** and adjusts a voltage, current, and power of the external power supply device **502**.

[0075] The main controller **562** is further configured to receive the charge control signal from the first communication module **561** and output a control signal to the two-way power supply controller **563**. The two-way power supply controller **563** can output a power supply control signal to the first voltage conversion circuit **564** according to the control signal from the main controller **562** to control a current direction of the first voltage conversion circuit **564** and control the first voltage conversion circuit **564** to adjust the electric power of the external power supply device **502** to adapt to an electric power output of the battery pack so that the external power supply device **502** charges the battery pack. In some examples, the two-way power supply controller **563** receives the control signal from the main controller **562** and outputs a reference voltage to the first voltage conversion circuit **564** to control the current direction of the first voltage conversion circuit **564**. For example, in the case where the external power supply device **502** is connected to the first direct current interface **52**, the CS pin of the two-way power supply controller **563** outputs a positive voltage to the voltage conversion circuit so that the external power supply device **502** charges the battery pack.

[0076] In some examples, the first direct current interface **52** includes at least two power terminals, where the at least two power terminals are connected to a positive electrode of the external power supply device **502** and configured to output electric power. First detection terminals **57** such as the CC1 pin and the CC2 pin are disposed in the first direct current interface **52** and configured to detect a signal state of the first direct current interface **52**, and the second communication terminal **58** such as the DM2 pin is disposed in the second direct current interface **53**, where the interface state of the second direct current interface is obtained through the second communication terminal **58** such as the DM2 pin. Since the second communication terminal such as the DM2 pin is different from the first detection terminals such as the CC1 pin and the CC2 pin of the first direct current interface **52**, the second communication terminal such as the DM2 pin cannot selectively have the charge state and the discharge state and is in the discharge state by default, or the second direct current interface **53** has no additional detection terminals or conductive terminals used for selecting the charge state and the discharge state. In the case where the external power consumption device **501** is inserted into the second direct current interface **53** and the external power supply device **502** is inserted into the first direct current interface **52**, a second detection terminal **58** detects that the power consumption device is connected, the first detection terminal **57** detects a high level, it is determined that the first direct current interface **52** is in the charge state, and the first direct current interface **52** is determined as the power supply side. The main controller **562** acquires the current charge information of the battery pack and transmits the current charge information to the first communication module **561** through the SDA pin and the SCL pin on the main controller **562**. The first communication module **561** adjusts the voltage, current, and power of the external power supply device **502**, a voltage adapted to the battery pack and/or the external power consumption device **501** is obtained through the first voltage conversion circuit **564**, and the external power supply device **502** charges the battery and/or the external power consumption device **501** with the voltage adapted to the battery and/or the external power consumption device **501**. For example, the external power supply device provides a 40 W charging power to the battery pack at 20 V/3 A and provides a 20 W charging power to a first power consumption device.

[0077] In this manner, in the case where the first direct current interface is connected to the external power supply device and the second direct current interface is connected to the external power consumption device, the external power supply device charges the battery pack through the first direct current interface, and the external power supply device is discharged to supply power to the external power consumption device through the second direct current interface. Moreover, through the adapter, it is possible to charge the external power consumption device and the battery pack at the same time. The charge circuit and the discharge circuit are divided into two sets of

circuits so that interference between the circuits can be reduced and each interface can work independently.

[0078] Referring to the adapter **50** shown in FIG. **9**, in some examples, in the case where a first power consumption device **601** is inserted into the second direct current interface **53** and a second power consumption device **602** is also inserted into the first direct current interface **52**, the first detection terminal **57** determines that the first direct current interface **52** is in the discharge state, the main controller **562** acquires current charge information of the first direct current interface **52** through the first communication module **561**, a voltage of the battery pack is matched with a voltage of the first power consumption device **501** and a voltage of the second power consumption device **502** through the second voltage conversion circuit **552** and the first voltage conversion circuit **564**, respectively, and then the battery pack outputs electric power to supply power to the first power consumption device **501** and the second power consumption device **502** at the same time.

[0079] In an example, in the case where the second power consumption device is inserted into the first direct current interface **52** and the first detection terminal **57** detects a low level and determines that the first direct current interface **52** is in the discharge state, the first detection terminal **57** sends the discharge control signal to the first communication module **661**.

[0080] The first communication module **561** is configured to be capable of receiving the discharge control signal from the first detection terminal **57** and transmitting the discharge control signal to the main controller **562**; the first communication module **561** is further configured to be capable of receiving a communication signal of charge information from the external power consumption device **502** and transmitting the communication signal of the charge information to the main controller **562**.

[0081] The main controller **562** is configured to be capable of receiving the discharge control signal and the communication signal of the charge information and outputting a control signal to the two-way power supply controller **563**.

[0082] The two-way power supply controller **563** is configured to be capable of outputting a power supply control signal to the first voltage conversion circuit **564** according to the received control signal from the main controller **562** to control the current direction of the first voltage conversion circuit **564** and control the first voltage conversion circuit **564** to adjust a voltage value so that the battery pack charges the external power consumption device **502**.

[0083] As an example, the main controller **562**, the first communication module **561**, and the two-way power supply controller **563** may be integrated into an SOC; or the main controller **562** and the two-way power supply controller **563** may be integrated into one control module.

[0084] In this manner, in the case where the first direct current interface **52** is connected to the external power consumption device and the second direct current interface **53** is connected to the external power consumption device, the battery pack can charge different external power consumption devices at the same time through the adapter so that usage scenarios of the battery pack are expanded and thus the battery pack is convenient for a user to use. At the same time, discharge circuits of two interfaces are divided into two sets of circuits so that interference between the circuits can be reduced and each interface can work independently.

[0085] Referring to FIG. **10**, the difference from FIG. **8** is that the adapter **70** in the example shown in FIG. **10** is equipped with a first direct current interface **72**, a second direct current interface **73**, and a third direct current interface **74**. The third direct current interface **74** and the first direct current interface **72** are the same type of interface as the first direct current interface **133** in the example shown in FIG. **6**. The first direct current interface **72** is provided with a detection terminal **721**, and the third direct current interface **74** is provided with a detection terminal **741**. In some examples, the first direct current interface **72** and the third direct current interface **74** both includes at least two power terminals, where the at least two power terminals are connected to the positive electrode of the external power supply device and configured to output electric power.

[0086] The adapter further includes a first discharge circuit **76**, a first charge circuit **77**, and a second charge circuit **78**.
[0087] The first direct current interface **72** and the third direct current interface **74** are interfaces that can achieve the input and output of high-power (greater than 10 W) electric power.
[0088] The second direct current interface **73** is configured to be connected to a first external power consumption device **701** and supply electric power of the battery pack to the first external power consumption device **701**. The second direct current interface **73** is an interface that supplies power to an external device and has an operation power of 5 V/2 A.
[0089] The first discharge circuit **76** is configured to convert the electric power of the battery pack or the electric power of the external power supply device into an electric power output adapted to the second direct current interface **73**. In some examples, the first discharge circuit **76** is disposed on a circuit board **75** and connected in series between an adapter interface **71** and the second direct current interface **73**.
[0090] The first charge circuit **77** is connected in series between the adapter interface **71** and the first direct current interface **72** and configured to convert electric power of a first external power supply device **702** connected to the first direct current interface **72** so that the first external power supply device **702** charges the battery pack and the first external power consumption device **701**.
[0091] The second charge circuit **78** is configured to convert electric power of a second external power supply device **703** connected to the third direct current interface **74** so that the second external power supply device **703** charges the battery pack and the first external power consumption device **701**, and the second charge circuit is connected in series between the adapter interface **71** and the third direct current interface **73**.
[0092] The first discharge circuit **76** includes a second communication module **761** and a second voltage conversion circuit **762**. The second communication module **761** is connected to the second voltage conversion circuit **762**, the second voltage conversion circuit **762** is connected to the adapter interface **71**, and the second voltage conversion circuit **762** converts a voltage accessed to the second voltage conversion circuit into a voltage adapted to the first external power consumption device **701** so that the first external power consumption device **701** is charged.
[0093] The first charge circuit **77** includes a first communication module **771**, a main controller **772**, a first two-way power supply controller **773**, and a first voltage conversion circuit **774**.
[0094] In the case where the first direct current interface **72** is connected to the first external power supply device **702**, the detection terminal detects a high level, determines that the first direct current interface **72** is in the charge state, and sends the charge control signal to the first communication module **771**. The first communication module **771** receives the charge control signal from the detection terminal **721** and outputs the charge control signal to the main controller **772**. The main controller **772** is configured to be capable of receiving a communication signal about battery pack information from the battery pack and transmitting the communication signal of the battery pack information to the first communication module **771**. The first communication module **771** receives the communication signal of related information of the battery pack from the main controller **772** and adjusts a voltage, current, and power of the first external power supply device **702**.
[0095] The main controller **772** is further configured to receive the charge control signal from the first communication module **771** and output a control signal to the first two-way power supply controller **773**. The first two-way power supply controller **773** is configured to be capable of outputting a power supply control signal to the first voltage conversion circuit **774** according to the control signal from the main controller **772** to control a current direction of the first voltage conversion circuit **774** and control the first voltage conversion circuit **774** to adjust electric power of the first external power supply device **702** to adapt to the electric power output of the battery pack so that the first external power supply device **702** charges the battery pack. In some examples, the first two-way power supply controller **773** receives the control signal from the main controller

772 and outputs a reference voltage to the first voltage conversion circuit **774** to control the current direction of the first voltage conversion circuit **774**. For example, in the case where the first external power supply device **702** is connected to the first direct current interface **72**, the CS pin of the two-way power supply controller outputs a positive voltage to the voltage conversion circuit so that the first external power supply device **702** charges the battery pack. In the case where the external power consumption device is connected to the first direct current interface **72**, the CS pin of the two-way power supply controller outputs a negative voltage to the voltage conversion circuit so that the battery pack charges the external power consumption device.

[0096] The second charge circuit **78** includes a third communication module **781**, a second two-way power supply controller **782**, and a third voltage conversion circuit **783**. The second charge circuit and the first charge circuit share the main controller **772** so that the main controller **772** controls the third voltage conversion circuit **783** to adjust electric power of the second external power supply device **703** to adapt to the electric power output of the battery pack and thus the second external power supply device **703** charges the battery pack.

[0097] In this manner, multiple external power supply devices can charge the battery pack through the first direct current interface **72** and the third direct current interface **74** at the same time so that the charging efficiency is higher and the speed is faster. It can be applied to a battery pack with a nominal voltage range of 40 V to 120 V.

[0098] In some examples, the second direct current interface **73** and/or the third direct current interface **74** may be inserted into the external power consumption device, and the battery pack can charge the connected power consumption device.

[0099] FIG. **11** shows an adapter **80** as one of the examples. The difference from FIG. **10** is that a third direct current interface **84** and a first direct current interface **82** of the adapter **80** in the example shown in FIG. **10** share a two-way power supply controller **873** and a first voltage conversion circuit **874**. Moreover, a positive terminal **821** of the first direct current interface **82** and a positive terminal **841** of the third direct current interface are connected in series to the first voltage conversion circuit **874**, and a negative terminal **822** of the first direct current interface **82** and a negative terminal **842** of the third direct current interface are connected in series to a second voltage conversion circuit **874**. A first communication module **871** is connected to a main controller **872**, and the main controller **872** acquires a current signal state of the first direct current interface **82** through the first communication module **871**. A third communication module **881** is also connected to the main controller **872**. The third communication module **881** acquires a signal state of the third direct current interface **84** and transmits a signal to the main controller **872**. The main controller **872** acquires current charge information of the battery pack and transmits a control signal to the two-way power supply controller **873**. The first voltage conversion circuit **874** is controlled to convert a voltage of the first direct current interface and a voltage of the third direct current interface such that the voltage of the first direct current interface and the voltage of the third direct current interface are adapted to a voltage of the battery pack and/or a voltage of a first external power consumption device. In this manner, a first external power supply device **801** and a second external power supply device **802** supply power to the battery pack and/or the first external power consumption device **801**.

[0100] In some examples, the first direct current interface **82** and the third direct current interface **84** may also be connected to the external power consumption device, and the battery pack supplies power to the first direct current interface **82**, a second direct current interface **83**, and the third direct current interface **84**. In an example, the first direct current interface **82** and the third direct current interface **84** can only operate in a charge or discharge mode at the same time.

[0101] In some examples, referring to a combination of a battery pack and an adapter shown in FIG. **12**, the combination of a battery pack and an adapter includes a battery pack **31**, a first adapter **301**, a second adapter **32**, and an external power consumption device **302**.

[0102] The difference from the combination of a battery pack and an adapter shown in FIG. **5** is

that the second adapter **32** further includes a second direct current interface **322***a*, where an input and output power of a first direct current interface **321***a* and the second direct current interface **322***a* is greater than 10 W. The first direct current interface **321***a* may be electrically connected to an external power supply device **301** to access electric power, where the external power supply device **301** may be a power adapter of a laptop. The second direct current interface **322***a* is connected to the external power consumption device **302** to provide a direct current from the external power supply device **301** or the electric power of the battery pack to the external power consumption device. The external power consumption device **302** may be a power consumption device such as a mobile phone, a tablet computer, and a wearable device, which is not limited herein.

[0103] Referring to FIG. **13**, FIG. **13** is a circuit block diagram of the adapter in FIG. **12** according to an example. The second adapter further includes a third direct current interface **93**, where an output power of the third direct current interface **93** is 5 V/2 A. The difference from the example shown in FIG. **10** is that a positive terminal **931** of the third direct current interface **93** and a positive terminal **921** of the second direct current interface **322***a* are connected in series to a first voltage conversion circuit **974**, and a negative terminal **932** of the third direct current interface **93** and a negative terminal **922** of the second direct current interface **322***a* are connected in series to the first voltage conversion circuit **974**. Both the first direct current interface **321***a* and the second direct current interface **322***a* include detection terminals, that is, the CC1 pin and the CC2 pin; and the third direct current interface **93** has communication terminals, that is, a DM1 pin or the DM2 pin. In an example, in the case where the second direct current interface **322***a* operates in the discharge state, an operation power of the second direct current interface **322***a* and an operation power of the third direct current interface **93** are the same, which are 5 V/2 A. In the case where the second direct current interface **322***a* operates in the charge state, the third direct current interface **93** cannot operate. Since the first direct current interface **321***a* has an independent control circuit, the first direct current interface **321***a* can operate independently. The first direct current interface **321***a* can be connected to the external power supply device for charging or connected to the external power consumption device for discharging.

[0104] In some examples, each of the first direct current interface **321***a* and the second direct current interface **322***a* includes at least two power positive terminals, where the at least two power positive terminals of the first direct current interface **321***a* are connected to a positive electrode of the external power supply device **301**; and the at least two power positive terminals of the second direct current interface **322***a* are connected to a positive electrode of the external power consumption device **302**.

[0105] In this manner, a combination of a battery pack and an adapter as shown in FIG. **12** is provided, and discharge is performed through the second direct current interface, so as to supply power to the external power consumption device. For example, the adapter may be configured to output the electric power stored in the battery pack to perform discharge to supply power to the external power consumption device such as a smartphone or a laptop so that the application scenarios are no longer limited to the discharge of the battery pack or the battery pack supplying power to the power tool, that is, the actual application scenarios of the battery pack are greatly expanded. At the same time, an external power supply device of a smartphone or a laptop available on site may also be used for charging the battery pack with a high power through the first direct current interface, which is greatly convenient for a user. Since a design circuit architecture of the two-way power supply controller is adopted in the adapter, the charge and discharge control can be achieved through the same controller, which reduces the introduction of other operational amplifier circuits and simplifies the circuit structure. Moreover, the adapter can achieve charge and discharge with a high power greater than 10 W.

[0106] FIG. **14** shows an adapter **90′** as one of the examples. The difference from the example shown in FIG. **13** is that a third direct current interface **94′** and a first direct current interface **92′**

share a two-way power supply controller **973′** and a first voltage conversion circuit **974′**. Positive terminals of the first direct current interface **92′**, a second direct current interface **93′**, and the third direct current interface **94′** are connected in series to the first voltage conversion circuit **974′**, and negative terminals of the first direct current interface **92′**, the second direct current interface **93′**, and the third direct current interface **94′** are also connected in series to the first voltage conversion circuit **974′**. Therefore, the first direct current interface **92′**, the second direct current interface **93′**, and the third direct current interface **94′** can operate in the discharge mode at the same time with an operation power of 5 V/2 A. In the case where the first direct current interface **92′** and the third direct current interface **94′** operate in the charge mode, the first direct current interface **92′** cannot operate.

[0107] FIG. **15** shows a combination **200***a* of a battery pack and an adapter as one of the examples, where the combination **200***a* of a battery pack and an adapter includes an adapter **210***a* and two battery packs **220***a* and **230***a*. In this example, the combination **200***a* of a battery pack and an adapter is a portable power system.

[0108] The battery pack **220***a* or the battery pack **230***a* may be the same or may be different, and both of the battery pack **220***a* and the battery pack **230***a* can supply power to a direct current power tool.

[0109] The adapter **210***a* may include a casing **211**, where the casing **211** is formed with an adapter interface that fits with a coupling portion of the battery pack **220***a* so that the battery pack can be detachably connected to the adapter **210***a*. Referring to FIG. **16**, the adapter **210***a* further includes an inverter **218** and a rectifier **217**, where the inverter **218** can convert the direct current output by the battery pack connected to the adapter **210***a* into the alternating current. The rectifier **217** can convert the alternating current accessed to the adapter **210***a* into the direct current that can charge the battery pack. Both the inverter **218** and the rectifier **217** are composed of corresponding circuit boards and circuit elements, and the circuit boards and circuit elements constituting the inverter are accommodated in an accommodation cavity formed by the casing **211**.

[0110] The adapter **210***a* further includes an alternating current input interface **214** that enables the adapter **210***a* to access the alternating current in the power grid. In an example, the alternating current input interface **214** may be configured to be a power plug shown in FIG. **15**, which has the advantage of ensuring the safety of electricity use; the alternating current input interface **214** may also be configured to be a general alternating current interface, which is convenient for a user to choose power cords of different lengths for a transfer. The adapter **210***a* can charge the battery pack connected to the adapter **210***a* through the accessed alternating current. The alternating current input interface **214** is electrically connected to the rectifier **217** so that the alternating current accessed to the alternating current input interface **214** is converted into the direct current, thereby charging the battery pack.

[0111] The adapter **210***a* further includes an alternating current output interface **213** configured to output the alternating current so that the combination **200***a* of a battery pack and an adapter can be used as an AC power supply. An electric power source of the alternating current output interface may be either the electric power stored in the battery pack connected to the adapter **210***a*, or the electric power accessed by the adapter **210***a* from elsewhere, such as the electric power, introduced from the alternating current input interface **214**, of the alternating current power grid. The alternating current output interface may be constructed in the form of a power socket shown in FIG. **13**, and the power socket may be designed to have the same specifications as a socket that outputs electric power from the local general grid so that the combination **200***a* of a battery pack and an adapter can supply power to the general AC power consumption device. The power sockets may be disposed on the same side of the adapter **210***a* or on different sides of the adapter **210***a*.

[0112] The adapter **210***a* can use the electric power of the battery pack to which the adapter **210***a* is connected and output the alternating current through the alternating current output interface. In an example, the alternating current output interface is at least electrically connected to the inverter

218, the inverter **218** is connected in series between the adapter interface and the alternating current output interface **213**, and the direct current from the battery pack is converted into the alternating current through the converter **218** and outputted to the alternating current output interface **213**.

[0113] The adapter **210***a* further includes a direct current interface, where the direct current interface is configured to be connected to an external power consumption device so that the adapter **210***a* outputs electric power. The voltage conversion circuit is connected in series between the direct current interface and the adapter interface and configured to convert the electric power of the battery pack into an electric power output adapted to the external power consumption device or convert electric power of an external power supply device into an electric power output adapted to the battery pack. In some examples, the adapter **210***a* includes a first direct current interface **215** and a second direct current interface **216**. The first direct current interface **215** is the same type of interface as the first direct current interface **133** in the example shown in FIG. **6**. The first direct current interface **215** is an interface that can achieve charge and discharge with a high power greater than 10 W, and the second direct current interface **216** is an interface with an operation power of 5 V/2 A. In an example, the first direct current interface **215** includes at least two power positive terminals, where the at least two power positive terminals are connected to a positive electrode of the external power consumption device or a positive electrode of the external power supply device.

[0114] In this manner, the first direct current interface **215** may be connected to a laptop adapter, a mobile phone charging terminal, or a mobile power supply, so as to charge the battery pack. The first direct current interface **215** can also charge a power consumption device such as a laptop and a mobile phone. The circuit design of at least two power positive terminals can bear greater power transmission, greatly improving the power transmission capacity of the first direct current interface **215**, so that an output power or input power of the first direct current interface **215** is greater than 10 W, and thus the charging time or discharging time can be greatly shortened.

[0115] The adapter **210***a* further includes a control module connected between the direct current interface and the adapter interface and connected to the voltage conversion circuit, where the control module is configured to be capable of controlling a current direction and an output voltage of the voltage conversion circuit according to a signal state of the direct current interface and a signal state of the adapter interface.

[0116] Referring to FIGS. **17** to **19**, a combination **200**′ of a battery pack and an adapter includes an adapter **240***a* and a battery pack **250**. In this example, the combination **200**′ of a battery pack and an adapter is a portable power system.

[0117] The battery pack **250** can supply power to a direct current power tool. In an example, the battery pack **250** includes a cell and a first casing **251**, where the cell is accommodated in the first casing **251**. The cell is configured to store energy and can be repeatedly charged and discharged. A lithium-ion battery or a graphene battery may be selected for the cell. The first casing **251** is configured to accommodate the cell and other components in the battery pack **250**, and the first casing **251** is formed with a coupling portion through which the battery pack **250** can be coupled to a power tool.

[0118] The adapter **240***a* may be coupled to the battery pack **250** described above so that the battery pack **250** can output the alternating current and/or the direct current through the adapter **240***a*.

[0119] Referring to FIGS. **18** and **19**, the adapter **240***a* further includes an alternating current output interface **241***a* configured to output the alternating current so that the combination **200**′ of a battery pack and an adapter may be used as an AC power supply. The alternating current output interface **241***a* is electrically connected to an inverter **244***a* and configured to output the alternating current. In some examples, the alternating current output interface **241***a* is constructed in the form of a power socket shown in FIG. **18**, and the power socket is designed to have the same specifications as a socket that outputs electric power from the local general grid so that the portable power system

can supply power to the general AC power consumption device. In some examples, the adapter **200** includes the alternating current output interface **241***a* configured to output 110 V to 130 V alternating current or 210 V to 230 V alternating current. In some examples, the adapter **240***a* includes two alternating current output interfaces **241***a* configured to output 110 V to 130 V alternating current or 210 V to 230 V alternating current, respectively.

[0120] The adapter **240***a* further includes a voltage conversion circuit and a direct current interface. In some examples, the adapter **240***a* includes a first direct current interface **242***a*, where the first direct current interface **242***a* is the same type of interface as the first direct current interface **133** in the example shown in FIG. **6** and configured to be connected to the external power consumption device so that the adapter **240***a* outputs electric power or configured to be connected to the external power supply device so that the battery pack is charged. In other examples, the adapter **240***a* includes a first direct current interface **242***a* and a second direct current interface **243***a*. In an example, the adapter **240***a* further includes a first voltage conversion circuit **245** and a second voltage conversion circuit **246** configured to convert the direct current output by the battery pack **250** into a direct current output with a preset voltage. The first voltage conversion circuit **245** may also be configured to convert the electric power of the external power supply device into the electric power adapted to the battery pack. The first direct current interface **242***a* includes at least two power positive terminals, where the at least two power positive terminals are connected to a positive electrode of the external power consumption device or a positive electrode of the external power supply device. The first direct current interface **242***a* is an interface that can achieve charge and discharge with a high power greater than 10 W, and the second direct current interface **243***a* is an interface with an operation power of 5 V/2 A.

[0121] The first direct current interface **242***a* may be connected to a laptop adapter, a mobile phone charging terminal, or a mobile power supply, so as to charge the battery pack, and the first direct current interface **242***a* may also be connected to a power supply device so that a power consumption device such as a laptop or a mobile phone is charged. In this manner, the circuit design of at least two power positive terminals in the first direct current interface can bear greater power transmission, greatly improving the power transmission capacity of the first direct current interface **242***a*, so that an output power or input power of the first direct current interface **242***a* is greater than 10 W, and thus the charging time or discharging time can be greatly shortened.

[0122] The adapter **240***a* further includes a controller **247** and a two-way power supply controller **248**. The controller **247** is connected between the first direct current interface **242***a* and an adapter interface **249**. The two-way power supply controller **248** is connected between the controller **247** and the first voltage conversion circuit **245**. The controller **247** is configured to be capable of outputting a control signal to the two-way power supply controller **248** according to the signal state of the direct current interface and the signal state of the adapter interface to control a current direction and an output voltage of the first voltage conversion circuit **245** so that the external power supply device charges the battery pack or the battery pack is discharged to supply power to the external power consumption device.

[0123] In the preceding example of the present application, in the combination of a battery pack and an adapter, the circuitry architecture of FIGS. **7** to **11**, FIG. **13**, and FIG. **14** may be used as the circuitry architecture of the direct current interface, which is not limited herein.

[0124] In this manner, the combinations **200** and **200′** of a battery pack and an adapter are often used as small and medium charging stations for outdoor operations with an output power greater than 100 W, such as 150 W, 300 W, 1200 W, and 2000 W, which is not limited herein. If this combination of a battery pack and an adapter with a high power can be designed to be capable of flexibly interacting with various available equipment on site, such as external power supply devices that provide the alternating current and/or the direct current and external power consumption devices that require the alternating current and/or the direct current to acquire electric power from each other, the usage scenarios of the power supply device can be greatly expanded.

[0125] In some examples, referring to FIG. **20**, a battery pack **60** is configured to supply power to a power tool **100***a* and detachably connected to the power tool **100***a*. The battery pack **60** includes a cell **61** and battery pack terminals, where the cell **61** is configured to store electric power, and the battery pack terminals include a positive terminal **621** of the battery pack, a negative terminal **622** of the battery pack, and a communication terminal **623**. The battery pack outputs electric power through the positive terminal **621** of the battery pack and the negative terminal **622** of the battery pack.

[0126] The battery pack further includes a direct current interface **63** and a circuit board unit **64**. The direct current interface **63** may be selectively connected to an external power consumption device or an external power supply device. In this manner, in the case where the direct current interface **63** is in the charge state, the direct current interface **63** receives electric power from the external power supply device; and in the case where the direct current interface **63** is in the discharge state, the direct current interface **63** supplies electric power of the battery pack to the external power consumption device.

[0127] The direct current interface **63** includes at least two power positive terminals, that is, a first power terminal **631** and a second power terminal **632**, such as Vbus1 and Vbus2, and the direct current interface **63** further includes a detection terminal **633**, such as CC1. The first power terminal **631** and the second power terminal **632** can be connected to a positive terminal of the external power consumption device or a positive terminal of the external power supply device for inputting or outputting electric power.

[0128] The detection terminal **633** is configured to detect a state signal of the direct current interface, where the direct current interface **63** has a charge state, a discharge state, and an empty state. In the case where the direct current interface **63** is connected to the external power supply device, the detection terminal **633** detects a high level, the external power supply device is equivalent to a pull-up resistor, it is determined that the direct current interface **63** is a power supply side, the cell **61** is equivalent to a pull-down resistor and determined as a power receiving side, and the detection terminal **633** determines that the direct current interface **63** is in the charge state and sends a charge control signal to the circuit board unit **64** so that the external power supply device charges the battery pack **60**. In the case where the direct current interface **60** is connected to the external power consumption device, the detection terminal **633** detects a low level, the external power consumption device is equivalent to a pull-down resistor, it is determined that the direct current interface **63** is a power receiving side, the cell **61** is equivalent to a pull-up resistor and determined as a power supply side, and the detection terminal **633** determines that the direct current interface **63** is in the discharge state and sends a discharge control signal to the circuit board unit **64** so that the battery pack **60** is discharged to supply power to the external power consumption device.

[0129] The circuit board unit **64** is connected in series between battery pack terminals **62** and the direct current interface **63**. As an example, a main controller **641**, a two-way power supply controller **642**, and a voltage conversion circuit **643** are disposed on the circuit board unit. The circuit board unit **64** may be one circuit board or may be integrated by multiple circuit boards, which is not limited herein.

[0130] In the case where the direct current interface **63** is connected to the external power supply device, the detection terminal **633** detects that the direct current interface **63** is in the charge state and sends the charge control signal to the main controller **641**. The main controller **641** is configured to receive the charge control signal from the detection terminal **633**, and the main controller **641** can further receive a communication signal of related information from the power tool **100***a*.

[0131] The main controller **641** outputs a control signal to the two-way power supply controller **642** according to the charge control signal; the two-way power supply controller **642** receives the control signal from the main controller **641** and outputs a power supply control signal to the

voltage conversion circuit **643** to control a current direction of the voltage conversion circuit **643** and control the voltage conversion circuit **643** to adjust the electric power of the external power supply device to form an electric power output adapted to a cell group and/or the power tool so that the external power supply device supplies power to the battery pack and/or the power tool.

[0132] In the case where the direct current interface is connected to the external power consumption device, the detection terminal **633** detects that the direct current interface **63** is in the discharge state and sends the discharge control signal to the main controller **641**. The main controller **641** is configured to receive the discharge control signal from the detection terminal **633** and output a control signal to the two-way power supply controller **642**; the two-way power supply controller **642** receives the control signal from the main controller **641** and outputs a power supply control signal to the voltage conversion circuit **643** to control the current direction of the voltage conversion circuit **643** such that the voltage conversion circuit **643** matches a discharge voltage of the cell **61** with a charge voltage required by the external power consumption device and thus the external power consumption device is charged.

[0133] In this manner, an external power supply device of a smartphone or a laptop available on site may be used for charging the battery pack with a high power through the direct current interface, and the battery pack may also output the electric power stored in the cell group to charge an external power consumption device such as the smartphone or the laptop. In this manner, the usage scenarios of the battery pack are expanded and thus the battery pack is convenient for a user to use. Since a design circuit architecture of the two-way power supply controller is adopted in the battery pack, the charge and discharge control can be achieved through the same controller, which reduces the introduction of other operational amplifier circuits and simplifies the circuit structure. Moreover, the battery pack can achieve charge and discharge with a high power greater than 10 W through the direct current interface.

[0134] In other examples, referring to an adapter **150** shown in FIG. **21**, the adapter **150** includes an adapter interface **151**, an interface assembly **152**, and a circuit board unit **153**. The interface assembly **152** includes a communication interface **154** and an electric power interface **155**. The adapter interface **151** is configured to be electrically connected to the battery pack to access the direct current. The interface assembly **152** can be selectively connected to an external power consumption device or an external power supply device to selectively make the external power supply device charge the battery pack or make the battery pack discharged to supply power to the external power consumption device. The external power consumption device may be a hand-held power tool or a garden power tool such as a vehicle-type lawn mower and a hair dryer, which is not limited herein. The external power supply device may be an adapter.

[0135] In an example, the communication interface **154** is configured to communicate with the circuit board unit **153**. The electric power interface **155** can be electrically connected to the circuit board unit **153** for inputting or outputting electric power. The electric power interface **155** includes a power positive terminal **1551** and a power negative terminal **1552**. In some examples, nickel sheets are used as the power positive terminal **1551** and the power negative terminal **1552** to input and output the direct current. A standard voltage range of the electric power interface **155** is 0V to 200V, which can achieve a continuously adjustable voltage from 0V to 200V and support any relatively large source output power of 6000 W.

[0136] The communication interface **154** is provided with a detection terminal **1541**, where the detection terminal **1541** is configured to detect a signal state of the interface assembly **152**. The interface assembly **152** has a charge state, a discharge state, and an empty state. In the case where the external power supply device is connected to the adapter, the detection terminal **1541** detects a high level, the external power supply device is equivalent to a pull-up resistor, it is determined that the electric power interface is a power supply side, the battery pack is equivalent to a pull-down resistor and determined as a power receiving side, and the detection terminal **1541** determines that the interface assembly **152** is in the charge state and sends a charge control signal to the circuit

board unit **153** so that the external power supply device charges the battery pack. In the case where the external power consumption device is connected to the adapter, the detection terminal **1541** detects a low level, the external power consumption device is equivalent to a pull-down resistor, it is determined that the electric power interface **155** is a power receiving side, the battery pack is equivalent to a pull-up resistor and determined as a power supply side, and the detection terminal **1541** determines that the interface assembly is in the discharge state and sends a discharge control signal to the circuit board so that the battery pack is discharged to supply power to the external power consumption device.

[0137] The circuit board unit **153** is connected in series between the adapter interface **151** and the communication interface **154**. As an example, a main controller **1531**, a two-way power supply controller **1532**, and a voltage conversion circuit **1533** are disposed on the circuit board unit **153**. The circuit board unit **153** may be one circuit board or may be integrated by multiple circuit boards, which is not limited herein.

[0138] In an example, in the case where the interface assembly **152** is connected to the external power supply device, the detection terminal **1541** detects that the interface assembly **152** is in the charge state and sends the charge control signal to the main controller **1531**. The main controller **1531** also receives a communication signal of related information of the battery pack from the battery pack and outputs a control signal to the two-way power supply controller **1532**. The two-way power supply controller **1532** is configured to output a power supply control signal to the voltage conversion circuit **1533** according to the received control signal from the main controller **1531** to control a current direction of the voltage conversion circuit **1533** and control the voltage conversion circuit **1533** to adjust the electric power of the external power supply device to form an electric power output adapted to the battery pack so that the external power supply device charges the battery pack. In other examples, in the case where the interface assembly **152** is connected to the external power consumption device, the detection terminal **1541** detects that the interface assembly **152** is in the discharge state and sends the discharge control signal to the main controller **1531**. The main controller **1531** also receives the communication signal of the related information of the battery pack from the battery pack and outputs a control signal to the two-way power supply controller **1532**. The two-way power supply controller **1532** receives the control signal and controls the current direction of the voltage conversion circuit **1533**, and the voltage conversion circuit **1533** matches a discharge voltage of the battery pack with a charge voltage required by the external power consumption device so that the external power consumption device is charged.

[0139] In an example, the communication interface **154** and the electric power interface **155** may also be integrated into one interface, which is not limited herein.

[0140] In this manner, power transmission with a higher voltage can be performed through the adapter, thereby greatly shortening the charging time of the battery pack. It can be applied to the common 36 V, 48 V, 54 V battery packs in the field of power tools. Moreover, the communication interface is provided so that the communication transmission is more stable. In addition, through the adapter, the battery pack can supply power to a power tool whose rated voltage is not adapted to a rated voltage of the battery pack. For example, a battery pack with a rated voltage of 48 V can supply power to a power tool with a rated voltage of 24 V or a battery pack with a rated voltage of 24 V can supply power to a power tool with a rated voltage of 18 V. In this manner, the usage scenarios of the battery pack are expanded and thus the battery pack is convenient for a user to use.

[0141] As shown in FIG. **1**, a combination of a battery pack **100** and a tool lamp **200** in an example of the present application includes the battery pack **100** and the tool lamp **200**. The battery pack **100** is configured to supply power to the tool lamp **200** and includes a cell for storing electric power and at least one battery pack interface **110** that can be detachably connected to the tool lamp **200**, where the battery pack interface **110** is provided with a battery pack terminal electrically connected to the tool lamp **200**.

[0142] As shown in FIG. **22**, the tool lamp **200** is specifically a hand-held lighting lamp. Referring

to FIG. **23**, the tool lamp **200** includes a lighting module **210**, an adapter interface **220**, a direct current interface **230**, and a circuit board unit **240**.

[0143] The lighting module **210** is a light-emitting diode (LED) light-emitting module. Of course, the lighting module **210** may also be configured to be other light-emitting units, as long as a lighting function is satisfied, which is not limited herein.

[0144] The adapter interface **220** is configured to be detachably connected to the battery pack interface **110** of the battery pack **100**. The adapter interface **220** includes an adapter positive terminal **221**, an adapter negative terminal **222**, and an adapter communication terminal **223**, where the adapter positive terminal **221** and the adapter negative terminal **222** are electrically connected to the battery pack terminal.

[0145] Referring to FIG. **23**, the direct current interface **230** is configured to be capable of being selectively connected to an external power consumption device or an external power supply device. In the case where the direct current interface **230** is in a charge state, electric power from the external power supply device is received; and in the case where the direct current interface **230** is in a discharge state, electric power of the battery pack **100** is supplied to the external power consumption device.

[0146] The direct current interface **230** includes a detection terminal **233** and an electric power terminal, where the detection terminal **233** detects a state signal of the direct current interface **230**, and the electric power terminal is configured to output or input electric power.

[0147] The electric power terminal of the direct current interface **230** includes at least two power positive terminals. Two power positive terminals are a first electric power terminal **231** and a second electric power terminal **232**, respectively, such as Vbus1 and Vbus2. The first electric power terminal **231** and the second electric power terminal **232** can be connected to a positive terminal of the external power consumption device or a positive terminal of the external power supply device and are configured to input or output electric power.

[0148] The output or input power of the direct current interface is P, where $P \leq 100$ W; or 100 W$\leq P \leq$200 W; or 200 W$\leq P \leq$500 W.

[0149] The output or input voltage of the direct current interface is U, where $U \leq 20$ V; or 20 V$\leq U \leq$60 V; or 60 V$\leq U \leq$100V.

[0150] The direct current interface **230** further includes the detection terminal **233** such as CC1. The detection terminal **233** is configured to detect the state signal of the direct current interface **230**, where the direct current interface **230** has the charge state, the discharge state, and an empty state.

[0151] Specifically, in the case where the direct current interface **230** is connected to the external power supply device, the detection terminal **233** detects a high level, the external power supply device is equivalent to a pull-up resistor, it is determined that the direct current interface **230** is a power supply side, the battery pack **100** is equivalent to a pull-down resistor and determined as a power receiving side, and the detection terminal **233** determines that the direct current interface **230** is in the charge state and sends a charge control signal to the circuit board unit **240** so that the external power supply device charges the battery pack **100**.

[0152] In the case where the direct current interface **230** is connected to the external power consumption device, the detection terminal **233** detects a low level, the external power consumption device is equivalent to a pull-down resistor, it is determined that the direct current interface **230** is a power receiving side, the battery pack **100** is equivalent to a pull-up resistor and determined as a power supply side, and the detection terminal **233** determines that the direct current interface **230** is in the discharge state and sends a discharge control signal to the circuit board unit **240** so that the battery pack **100** is discharged to supply power to the external power consumption device.

[0153] The circuit board unit **240** is connected in series between the adapter interface **220** and the direct current interface **230**; the circuit board unit **240** includes a two-way control module and a

one-way control module. The circuit board unit **240** may be one circuit board or may be integrated by multiple circuit boards, which is not limited herein.

[0154] The two-way control module is connected in series between the direct current interface **230** and the adapter interface **220**, where the two-way control module is configured to adjust electric power of the external power supply device according to a control signal of the direct current interface **230** to form an electric power input adapted to the battery pack **100** so that the external power supply device charges the battery pack **100**; or the two-way control module is configured to match a discharge voltage of the battery pack **100** with a power supply voltage required by the external power consumption device according to the control signal of the direct current interface **230** so that the external power consumption device is powered.

[0155] As a specific example, the two-way control module includes a main controller **241**, a two-way power supply controller **242**, and a voltage conversion circuit **243** that are disposed on the circuit board unit **240**.

[0156] In the case where the direct current interface **230** is connected to the external power supply device, the detection terminal **233** detects a charge signal and determines that the direct current interface **230** is in the charge state, and the detection terminal **233** sends the charge control signal to the main controller **241**; the main controller **241** outputs a control signal to the two-way power supply controller **242** according to the charge control signal; the two-way power supply controller **242** receives the control signal from the main controller **241** and outputs a power supply control signal to the voltage conversion circuit **243** to control a current direction of the voltage conversion circuit **243** and control the voltage conversion circuit **243** to adjust the electric power of the external power supply device to form the electric power input adapted to the battery pack **100** so that the external power supply device supplies power to the battery pack **100**.

[0157] The main controller **241** can also receive related communication signals from the adapter communication terminal **223** of the battery pack **100** to send power supply information adapted to the battery pack **100** to the main controller **241**, such as voltage and current information. The main controller **241** sends the control signal to the two-way power supply controller **242** according to the power supply information, and finally, the two-way power supply controller **242** outputs the power supply control signal to the voltage conversion circuit **243** to adjust electric power input by the external power supply device to the battery pack **100**.

[0158] In the case where the direct current interface **230** is connected to the external power consumption device, the detection terminal **233** detects a discharge signal and determines that the direct current interface **230** is in the discharge state, and the detection terminal **233** sends the discharge control signal to the main controller **241**; the main controller **241** outputs a control signal to the two-way power supply controller **242** according to the discharge control signal; the two-way power supply controller **242** receives the control signal from the main controller **241** and outputs a power supply control signal to the voltage conversion circuit **243** to control a current direction of the voltage conversion circuit **243**, and the voltage conversion circuit **243** matches the discharge voltage of the battery pack **100** with the power supply voltage required by the external power consumption device so that the external power consumption device is powered.

[0159] In this manner, an external power supply device of a smartphone or a laptop available on site may be used to supply power to the battery pack **100** through the direct current interface, and the battery pack **100** may also output the electric power stored in the cell to supply power to an external power consumption device such as the smartphone or the laptop. It is to be understood that the power supply includes a case where electric power is directly supplied to the external power consumption device for its use and a case where the external power consumption device is charged.

[0160] The tool lamp in the present application is provided with the direct current interface, the two-way control module, and the one-way control module, which expands the use of the tool lamp and is convenient for a user to use. It is to be understood that since a design circuit architecture of the two-way power supply controller is adopted in the tool lamp, the charge and discharge control

can be achieved through the same controller, which reduces the introduction of other operational amplifier circuits and simplifies the circuit structure.

[0161] The one-way control module is connected in series between the direct current interface **230** and the lighting module **210** and connected in series between the adapter interface **220** and the lighting module **210**, where the one-way control module is configured to convert the electric power of the external power supply device or the electric power of the battery pack **100** into an electric power input adapted to the lighting module **210**.

[0162] The one-way control module includes a one-way power supply controller **244** disposed on the circuit board unit **240** and connected in series between the direct current interface **230** and the lighting module **210**. In the case where the direct current interface **230** is connected to the external power supply device, the one-way power supply controller **244** receives and adjusts the electric power from the external power supply device to form the electric power input adapted to the lighting module **210** so that the external power supply device supplies power to the lighting module **210**.

[0163] The one-way power supply controller **244** is also connected in series between the voltage conversion circuit **243** and the lighting module **210**. In the case where the adapter interface **220** is connected to the battery pack **100**, the one-way power supply controller **244** receives and adjusts the electric power of the battery pack **100** to form the electric power input adapted to the lighting module **210** so that the battery pack **100** supplies power to the lighting module **210**.

[0164] It is to be understood that the tool lamp may be connected to the external power supply device or the external power consumption device through an adapter, and the adapter can make the tool lamp output electric power and can also supply electric power to charge the tool lamp and/or the battery pack. As shown in FIG. **22**, the adapter may include a power plug and an output interface; of course, the adapter may also include an input interface and an output interface that are configured to be connected to the tool lamp and the external power supply device or the external power consumption device, respectively.

[0165] An operation process of the tool lamp in the present application is described below.

[0166] A: the case where the direct current interface **230** is connected to the external power supply device.

[0167] If the battery pack **100** is not connected to the adapter interface **220**, the external power supply device supplies power to the lighting module **210** through the one-way control module, and the lighting module **210** can perform lighting. In this case, the adapter interface **220** is not powered on.

[0168] If the battery pack **100** is connected to the adapter interface **220**, the main controller **241** receives a signal from the adapter communication terminal **223** of the battery pack **100**, the external power supply device supplies power to the lighting module **210** through the one-way control module, and the external power supply device charges the battery pack **100** through the two-way control module. For a process of charging the battery pack **100** by the external power supply device, reference may be made to the preceding related description, which is not repeated herein.

[0169] B: the case where the direct current interface is connected to the external power consumption device.

[0170] In this case, the battery pack **100** is connected to the adapter interface **220**, and the battery pack **100** supplies power to the external power consumption device through the two-way control module; when there is a requirement for lighting, the battery pack **100** can also supply power to the lighting module **210** through the one-way control module, and the lighting module **210** can perform lighting.

[0171] C: the case where no device is connected to the direct current interface.

[0172] In this case, the battery pack **100** supplies power to the lighting module **210**. In the case where the battery pack **100** is connected to the adapter interface **220**, the lighting module **210** can perform lighting.

[0173] As shown in FIG. **24**, a power tool **300** in another example of the present application is provided. Referring to FIG. **25**, the power tool **300** includes a power module, an output unit, a cell **312**, a direct current interface **320**, and a two-way control module **330**.
[0174] As shown in FIG. **24**, the power tool **300** is a hand-held power tool such as an electric drill, a screwdriver, a nail gun, a wrench, and an angle grinder. Although this example relates to a hand-held power tool, it is to be understood that the present application is not limited to the disclosed example and can be applied to other types of power tools, including but not limited to garden power tools such as a vehicle-type lawn mower and home products such as a hair dryer.
[0175] Referring to FIG. **25**, the power module includes a motor **311** and the cell **312**. The motor **311** may be powered by the cell **312** or an external power supply device. The motor **311** is configured to drive the output unit to output power to an outside. For example, in the case where the power tool is the screwdriver, an output mechanism is an output shaft driven by the motor.
[0176] The cell **312** is configured to store power and can be repeatedly charged and discharged; the cell **312** may be a lithium-ion battery or a graphene battery.
[0177] The direct current interface **320** is configured to be capable of being selectively connected to an external power consumption device or an external power supply device. In the case where the direct current interface **320** is in a charge state, electric power from the external power supply device is received; and in the case where the direct current interface **320** is in a discharge state, electric power of the cell **312** is supplied to the external power consumption device.
[0178] Referring to FIG. **25**, the direct current interface **320** includes a detection terminal **323** and an electric power terminal, where the electric power terminal is configured to output or input electric power. The electric power terminal of the direct current interface **320** includes at least two power positive terminals. Two power positive terminals are a first electric power terminal **321** and a second electric power terminal **322**, respectively, such as Vbus1 and Vbus2. The first electric power terminal **321** and the second electric power terminal **322** can be connected to a positive terminal of the external power consumption device or a positive terminal of the external power supply device and are configured to input or output electric power.
[0179] The output or input power of the direct current interface is P, where $P \leq 100$ W; or 100 W$\leq P \leq$200 W; or 200 W$\leq P \leq$500 W.
[0180] The output or input voltage of the direct current interface is U, where $U \leq 20$ V; or 20 V$\leq U \leq$60 V; or 60 V$\leq U \leq$100V.
[0181] The direct current interface **320** further includes the detection terminal **323** such as CC1; the detection terminal **323** detects a state signal of the direct current interface **320**. The detection terminal **323** is configured to detect the state signal of the direct current interface **320**, where the direct current interface **320** has the charge state, the discharge state, and an empty state.
[0182] Specifically, in the case where the direct current interface **320** is connected to the external power supply device, the detection terminal **323** detects a high level, the external power supply device is equivalent to a pull-up resistor, it is determined that the direct current interface **320** is a power supply side, the cell **312** is equivalent to a pull-down resistor and determined as a power receiving side, and the detection terminal **323** determines that the direct current interface **320** is in the charge state and sends a charge control signal to the two-way control module **330** so that the external power supply device charges the cell **312**.
[0183] In the case where the direct current interface **320** is connected to the external power consumption device, the detection terminal **323** detects a low level, the external power consumption device is equivalent to a pull-down resistor, it is determined that the direct current interface **320** is a power receiving side, the cell **312** is equivalent to a pull-up resistor and determined as a power supply side, and the detection terminal **323** determines that the direct current interface **320** is in the discharge state and sends a discharge control signal to the two-way control module **330** so that the cell **312** is discharged to supply power to the external power consumption device.

[0184] The two-way control module **330** is connected in series between the power module **310** and the direct current interface **320**, where the two-way control module is configured to adjust electric power of the external power supply device according to a control signal of the direct current interface **320** to form an electric power input adapted to the cell **312** so that the external power supply device charges the cell **312**; or the two-way control module is configured to adjust the electric power of the external power supply device according to a signal of the motor **311** to form an electric power input adapted to the motor **311** so that the external power supply device supplies power to the motor **311**; the two-way control module **330** may also be configured to match a discharge voltage of the cell **312** with a power supply voltage required by the external power consumption device according to the control signal of the direct current interface **320** so that the external power consumption device is powered.
[0185] As a specific example, the two-way control module may be one circuit board or may be integrated by multiple circuit boards, which is not limited herein. The two-way control module in the present application includes a main controller **331**, a two-way power supply controller **332**, and a voltage conversion circuit **333** that are disposed on a circuit board.
[0186] Specifically, in the case where the direct current interface **320** is connected to the external power supply device, the detection terminal **323** detects a charge signal and determines that the direct current interface **320** is in the charge state, and the detection terminal **232** sends the charge control signal to the main controller **331**. The main controller **331** outputs a control signal to the two-way power supply controller **332** according to the charge control signal; the two-way power supply controller **332** receives the control signal from the main controller **331** and outputs a power supply control signal to the voltage conversion circuit **333** to control a current direction of the voltage conversion circuit **333** and control the voltage conversion circuit **333** to adjust the electric power of the external power supply device to form an electric power output adapted to the cell **312** or the motor **311** so that the external power supply device supplies power to the cell **312** or the motor **311**.
[0187] It is to be understood that the main controller **331** further includes a communication terminal communicatively connected to the motor, and the main controller **331** can receive a communication signal from the motor **311** to send power supply information adapted to the motor **311** to the main controller **331**, such as voltage and current information; the main controller **331** sends the control signal to the two-way power supply controller **332** according to the power supply information, and finally, the two-way power supply controller **332** outputs the power supply control signal to the voltage conversion circuit **333** to adjust electric power input by the external power supply device to the motor **311**.
[0188] In the case where the direct current interface **320** is connected to the external power consumption device, the detection terminal **323** detects a discharge signal and determines that the direct current interface **320** is in the discharge state, the detection terminal **323** sends the discharge control signal to the main controller **331**, and the main controller **331** outputs the control signal to the two-way power supply controller **332** according to the discharge control signal. The two-way power supply controller **332** receives the control signal and controls the current direction of the voltage conversion circuit **333**, and the voltage conversion circuit **333** matches the discharge voltage of the cell **312** with the power supply voltage required by the external power consumption device so that the external power consumption device is powered.
[0189] In this manner, an external power supply device of a smartphone or a laptop available on site may be used to charge the battery pack **100** through the direct current interface, and the battery pack **100** may also output the electric power stored in the cell to supply power to an external power consumption device such as the smartphone or the laptop. It is to be understood that the power supply includes a case where electric power is directly supplied to the external power consumption device for its use and a case where the external power consumption device is charged.
[0190] It is to be understood that the power tool may be connected to the external power supply

device or the external power consumption device through an adapter, and the adapter can make the battery pack output electric power and can also supply electric power to charge the power tool and/or the cell. As shown in FIG. **24**, the adapter may include a power plug and an output interface; of course, the adapter may also include an input interface and an output interface that are configured to be connected to the power tool and the external power supply device or the external power consumption device, respectively.

[0191] An operation process of the power tool in the present application is described below.

[0192] A: the case where the direct current interface **320** is connected to the external power supply device.

[0193] The main controller **331** receives a signal from the communication terminal of the motor **311**, the external power supply device supplies power to the motor **311** through the two-way control module, and the external power supply device may also charge the cell **312** through the two-way control module **330**. For a process of supplying power to the cell or the motor by the external power supply device, reference may be made to the preceding related description, which is not repeated herein.

[0194] Of course, in the case where the direct current interface **320** is connected to the external power supply device, the external power supply device may be configured to only supply power to the motor or only charge the cell. The preceding configuration may be implemented by a predetermined program set on the main controller **331**.

[0195] B: the case where the direct current interface is connected to the external power consumption device.

[0196] In this case, the cell **312** supplies power to the external power consumption device through the two-way control module **330**; and the cell **312** may also supply power to the motor, and the power tool **300** can operate normally.

[0197] C: the case where no device is connected to the direct current interface.

[0198] In this case, the cell **312** supplies power to the motor **311**, and the power tool can operate normally

Claims

1. A combination, comprising: a battery pack comprising a battery pack interface at least capable of being detachably connected to a power tool; and an adapter, capable of being electrically connected to the battery pack, comprising: a plug for access to an alternating current; an adapter interface configured to be detachably connected to the battery pack interface; an alternating current-direct current conversion circuit configured to convert the alternating current into a direct current capable of charging the battery pack; a direct current interface configured to be detachably electrically connected to an external power consumption device, wherein an output power of the direct current interface is greater than 10 W; an alternating current output interface configured to output an alternating current; a first voltage conversion circuit connected in series between the adapter interface and the alternating current output interface and configured to convert a direct current output by the battery pack into an alternating current output; a second voltage conversion circuit connected in series between the direct current interface and the adapter interface and configured to convert electric power of the battery pack into an electric power output adapted to the external power consumption device; and a two-way control module connected between the direct current interface and the adapter interface and connected to the second voltage conversion circuit, wherein the two-way control module is configured to be capable of controlling a current direction and an output voltage of the voltage conversion circuit according to a signal state of the direct current interface and a signal state of the adapter interface.

2. The combination of claim 1, wherein the direct current interface comprises at least two power positive terminals, and the at least two power positive terminals are connected to a positive

electrode of the external power consumption device.

3. The combination of claim 1, further comprising multiple ones of the adapter interface.

4. The combination of claim 1, wherein a value range of an output voltage of the direct current interface is 5 V to 20 V.

5. The combination of claim 1, wherein a nominal voltage range of the battery pack is 10 V to 120 V.

6. The combination of claim 1, wherein the battery pack comprises a guide groove configured to be slidably connected to the adapter, the adapter interface comprises an electrical connection terminal electrically connected to a battery pack terminal and a guide rail configured to fit with the guide groove so that the battery pack is slidably connected to the adapter.

7. The combination of claim 1, wherein the signal state of the direct current interface comprises a charge state and a discharge state.

8. The combination of claim 7, wherein the direct current interface comprises a detection terminal configured to detect the signal state of the direct current interface, and, in a case where the direct current interface is connected to the external power consumption device and the detection terminal detects that the direct current interface is in the discharge state, the detection terminal sends a discharge control signal to the two-way control module so that the two-way control module controls the current direction of the voltage conversion circuit and thus the battery pack is discharged to supply power to the external power consumption device.

9. The combination of claim 8, wherein the adapter further comprises a communication module, the communication module is configured to be capable of receiving the discharge control signal from the detection terminal and transmitting the discharge control signal to the control module, the communication module is further configured to be capable of receiving a communication signal of charge information from the external power consumption device and transmitting the communication signal of charge information to the two-way control module, the two-way control module comprises a main controller and a two-way power supply controller, the main controller is configured to be capable of receiving the discharge control signal and the communication signal of charge information and outputting a control signal to the two-way power supply controller, and the two-way power supply controller is configured to be capable of outputting a power supply control signal to the voltage conversion circuit according to the control signal from the main controller to control the current direction of the voltage conversion circuit and control the voltage conversion circuit to adjust a voltage value so that the battery pack charges the external power consumption device.

10. The combination of claim 7, wherein, in a case where the detection terminal detects a high level, it is determined that the direct current interface is in the charge state, and, in a case where the detection terminal detects a low level, it is determined that the first direct current interface is in the discharge state.

11. A combination, comprising: a battery pack comprising a battery pack interface at least capable of being detachably connected to a power tool; and an adapter comprising: an adapter interface configured to be connected to the battery pack and capable of being detachably connected to the power tool; an alternating current output interface configured to output an alternating current; a first voltage conversion circuit connected in series between the adapter interface and the alternating current interface and configured to convert a direct current output by the battery pack into an alternating current output; a direct current interface configured to be selectively connected to an external power consumption device or an external power supply device, wherein an output or input power of the direct current interface is greater than 10 W and a value range of an input or output voltage of the direct current interface is 5 V to 20 V; a second voltage conversion circuit connected in series between the direct current interface and the adapter interface, wherein the second voltage conversion circuit is configured to convert electric power of the external power supply device into an electric power output adapted to the battery pack; or the second voltage conversion circuit is

configured to convert electric power of the battery pack into an electric power output adapted to the external power consumption device; and a two-way control module connected between the direct current interface and the adapter interface and connected to the second voltage conversion circuit, wherein the two-way control module is configured to be capable of controlling a current direction of the second voltage conversion circuit according to a signal state of the direct current interface and a signal state of the adapter interface.

12. The combination of claim 11, wherein the direct current interface comprises at least two power positive terminals, and the at least two power positive terminals are connected to a positive electrode of the external power consumption device or a positive electrode of the external power supply device.

13. The combination of claim 11, wherein the battery pack comprises a guide groove configured to be slidably connected to the adapter, and the adapter interface comprises an electrical connection terminal electrically connected to a battery pack terminal and a guide rail configured to guide the guide groove to be slidably connected to the adapter.

14. The combination of claim 11, wherein a nominal voltage range of the battery pack is 10 V to 120 V.

15. The combination of claim 11, wherein the signal state of the direct current interface comprises a charge state and a discharge state.

16. The combination of claim 15, wherein the direct current interface comprises a detection terminal configured to detect the signal state of the direct current interface, and, in a case where the direct current interface is connected to the external power supply device and the detection terminal detects that the direct current interface is in the charge state, the detection terminal sends a charge control signal to the two-way control module so that the two-way control module controls the current direction of the second voltage conversion circuit and thus the external power supply device charges the battery pack.

17. The combination of claim 15, wherein the direct current interface comprises a detection terminal configured to detect the signal state of the direct current interface, and, in a case where the direct current interface is connected to the external power consumption device and the detection terminal detects that the direct current interface is in the discharge state, the detection terminal sends a discharge control signal to the two-way control module so that the two-way control module controls the current direction of the second voltage conversion circuit and thus the battery pack is discharged to supply power to the external power consumption device.

18. The combination of claim 16, wherein the adapter further comprises a communication module, the communication module is configured to be capable of receiving the charge control signal from the detection terminal and transmitting the charge control signal to the control module, the two-way control module comprises a main controller configured to be capable of receiving a communication signal about battery pack information from the battery pack and transmitting the communication signal about the battery pack information to the communication module, and the communication module is configured to receive the communication signal about the battery pack information and adjust a voltage, current, and power of the external power supply device so that the battery pack is charged.

19. The combination of claim 18, wherein the two-way control module further comprises a two-way power supply controller, the main controller is further configured to be capable of receiving the charge control signal and outputting a control signal to the two-way power supply controller, and the two-way power supply controller is configured to be capable of outputting a power supply control signal to the voltage conversion circuit according to the control signal from the main controller to control the current direction of the voltage conversion circuit and control the voltage conversion circuit to adjust a voltage value so that the external power supply device charges the battery pack.

20. The combination of claim 15, wherein, in a case where a detection terminal detects a high level,

it is determined that the direct current interface is in the charge state, and in a case where the detection terminal detects a low level, it is determined that the direct current interface is in the discharge state.