US00RE49976E

(19) **United States**
(12) **Reissued Patent**
Lei

(10) **Patent Number: US RE49,976 E**
(45) **Date of Reissued Patent: May 21, 2024**

(54) **BATTERY CLAMP**

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(21) Appl. No.: **17/112,920**

(22) Filed: **Dec. 4, 2020**

Related U.S. Patent Documents

Reissue of:
(64) Patent No.: **10,148,105**
Issued: **Dec. 4, 2018**
Appl. No.: **15/245,146**
Filed: **Aug. 23, 2016**

(30) **Foreign Application Priority Data**

Jun. 30, 2016 (CN) 201610506106.8
Jun. 30, 2016 (CN) 201610506137.3
Jun. 30, 2016 (CN) 201620692248.3

(51) **Int. Cl.**
F02N 11/10 (2006.01)
F02N 11/12 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***F02N 11/10*** (2013.01); ***F02N 11/12*** (2013.01); ***H01R 11/24*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H02J 7/0045; H02J 7/0029; H02J 7/0047; H02J 7/0063; H02J 7/342; H02J 7/00034;
(Continued)

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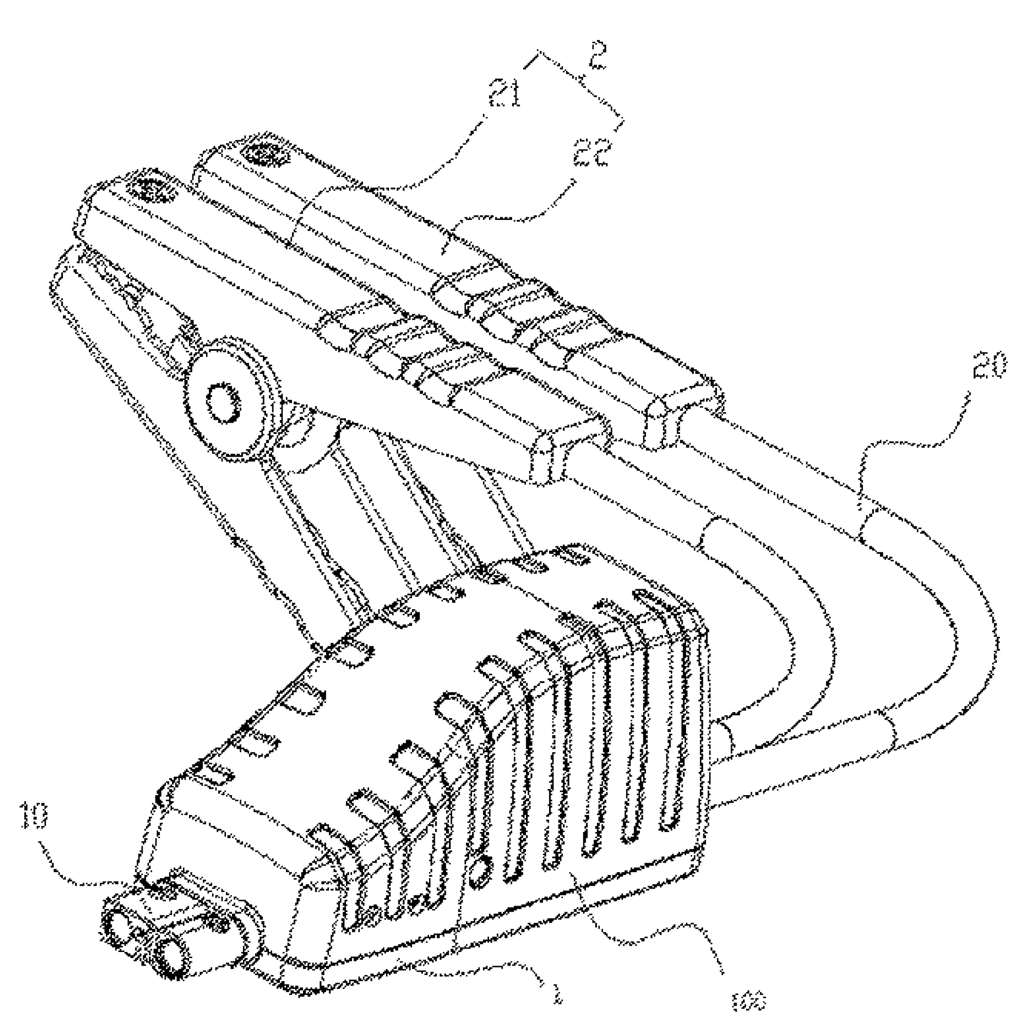
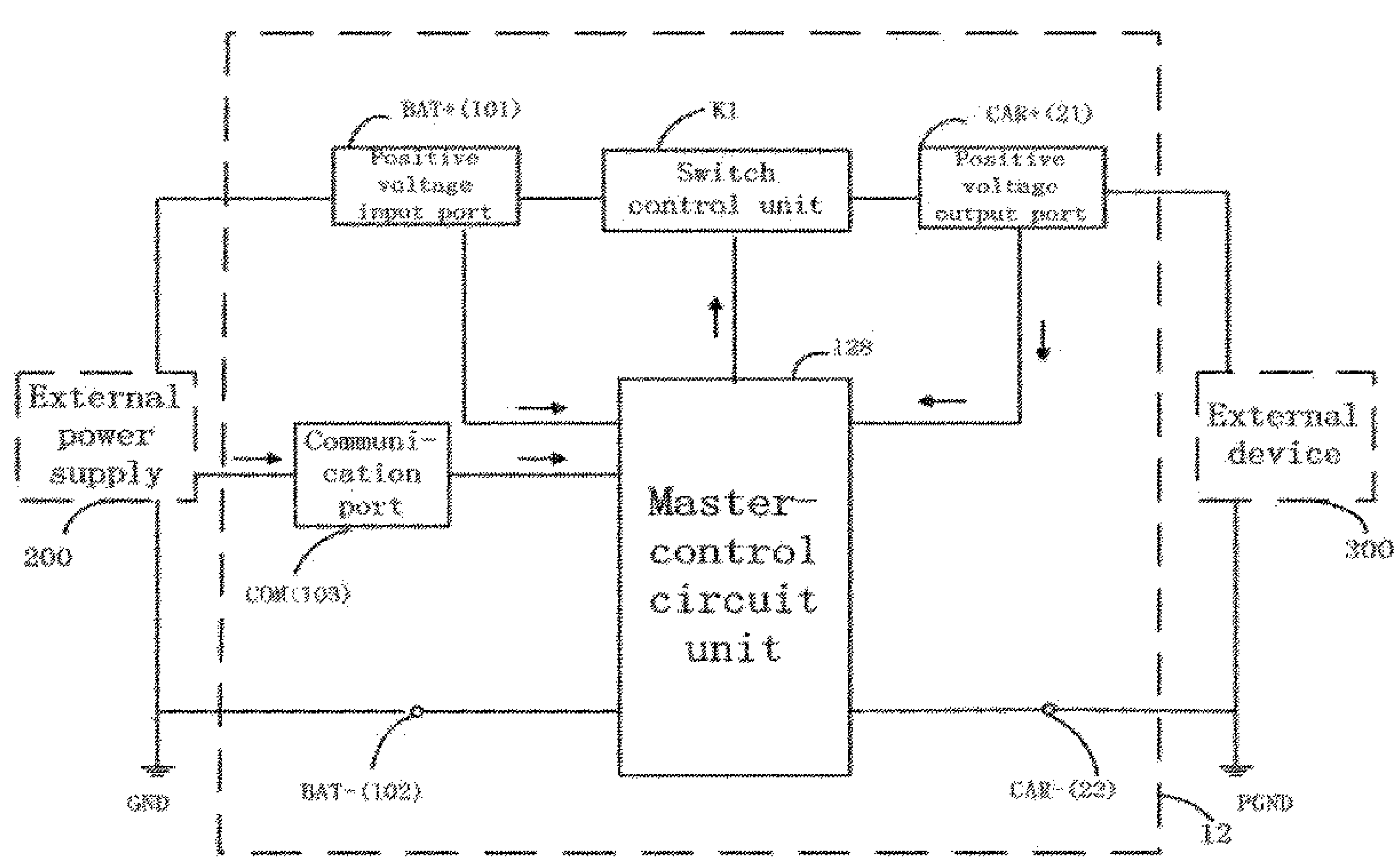
(57) **ABSTRACT**

The present invention provides a battery clamp, comprising: a first and second wire clamps and a control device. Each of the first and second wire clamps is electrically connected to the control device. The control device comprises: a housing; a master-control board mounted within the housing; and connectors disposed at one side of the housing, and being electrically connected to the master-control board, comprising: at least a first and second electrode connectors, which are connected to an external power supply for receiving power, and at least one communication connector connected to the external power supply for building a communication connection between the battery clamp and the external power supply. The battery clamp is communicatively connected to the external power supply by the communication connector, thereby effectively solving the problems of a lithium battery in an external power supply e.g. battery bulge or explosion resulted from improper uses.

16 Claims, 10 Drawing Sheets





(51) **Int. Cl.**

F02N 11/14	(2006.01)
H01M 10/42	(2006.01)
H01R 11/24	(2006.01)
H01R 13/66	(2006.01)
H02J 7/00	(2006.01)
H02J 7/34	(2006.01)

(52) **U.S. Cl.**

CPC ***H01R 13/6666*** (2013.01); ***H02J 7/0029*** (2013.01); ***H02J 7/0045*** (2013.01); ***H02J 7/0047*** (2013.01); ***H02J 7/0063*** (2013.01); ***H02J 7/342*** (2020.01); *F02N 11/14* (2013.01); *F02N 2200/063* (2013.01); *H01M 10/4257* (2013.01); *H02J 7/00034* (2020.01); *H02J 7/00304* (2020.01); *H02J 7/00308* (2020.01); *H02J 7/00309* (2020.01); *H02J 7/0048* (2020.01); *H02J 7/00714* (2020.01); *H02J 7/007182* (2020.01); *H02J 7/007194* (2020.01)

(58) **Field of Classification Search**

CPC .. H02J 2007/0067; F02N 11/10; F02N 11/12; F02N 11/14; F02N 2200/063; H01R 11/24; H01R 13/6666; H01M 10/4257; Y02E 60/10

USPC 320/105

See application file for complete search history.

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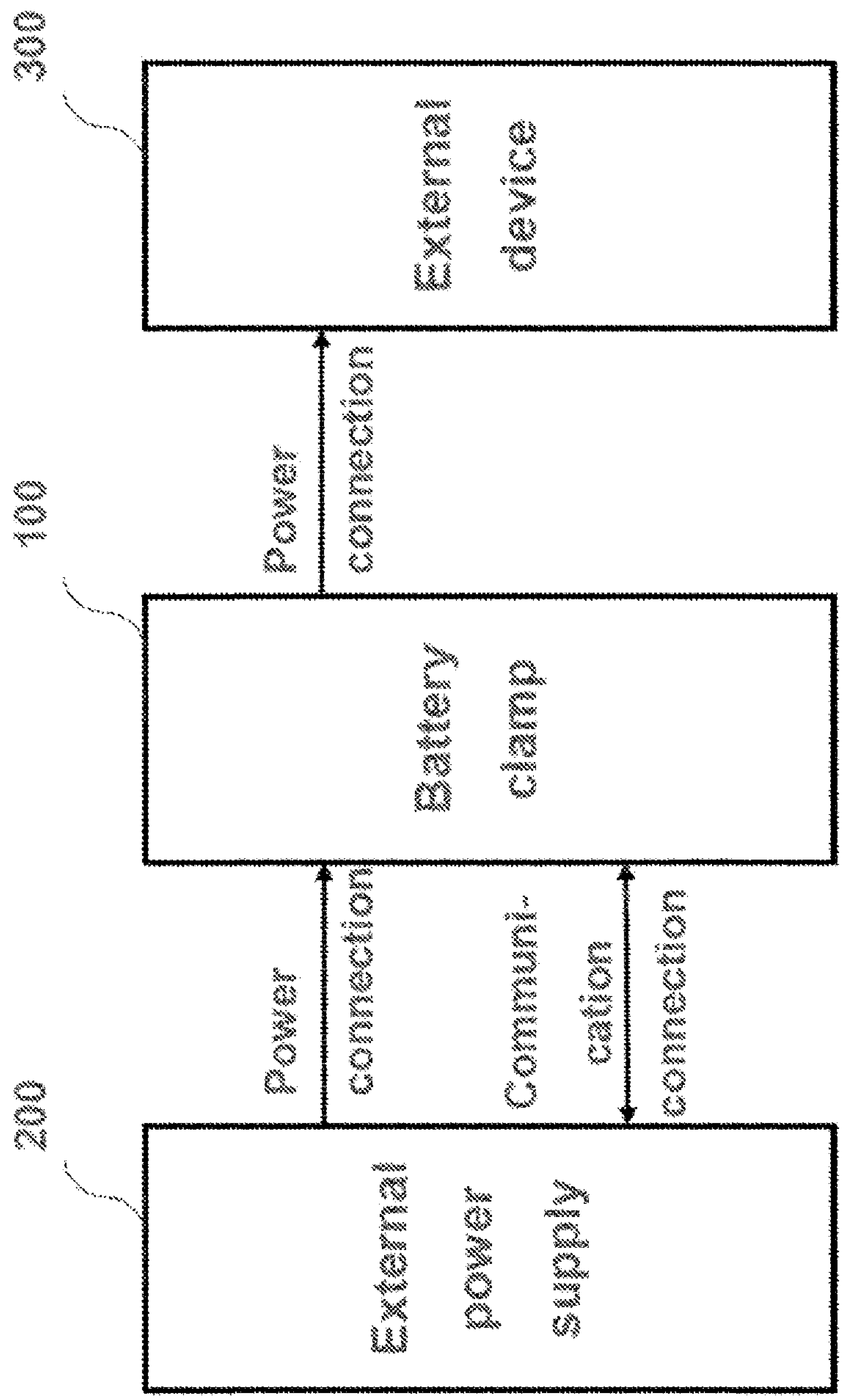

300
External device
100
Power connection
Battery clamp
200
Power connection
Communi-cation connection
External power supply

Fig. 1

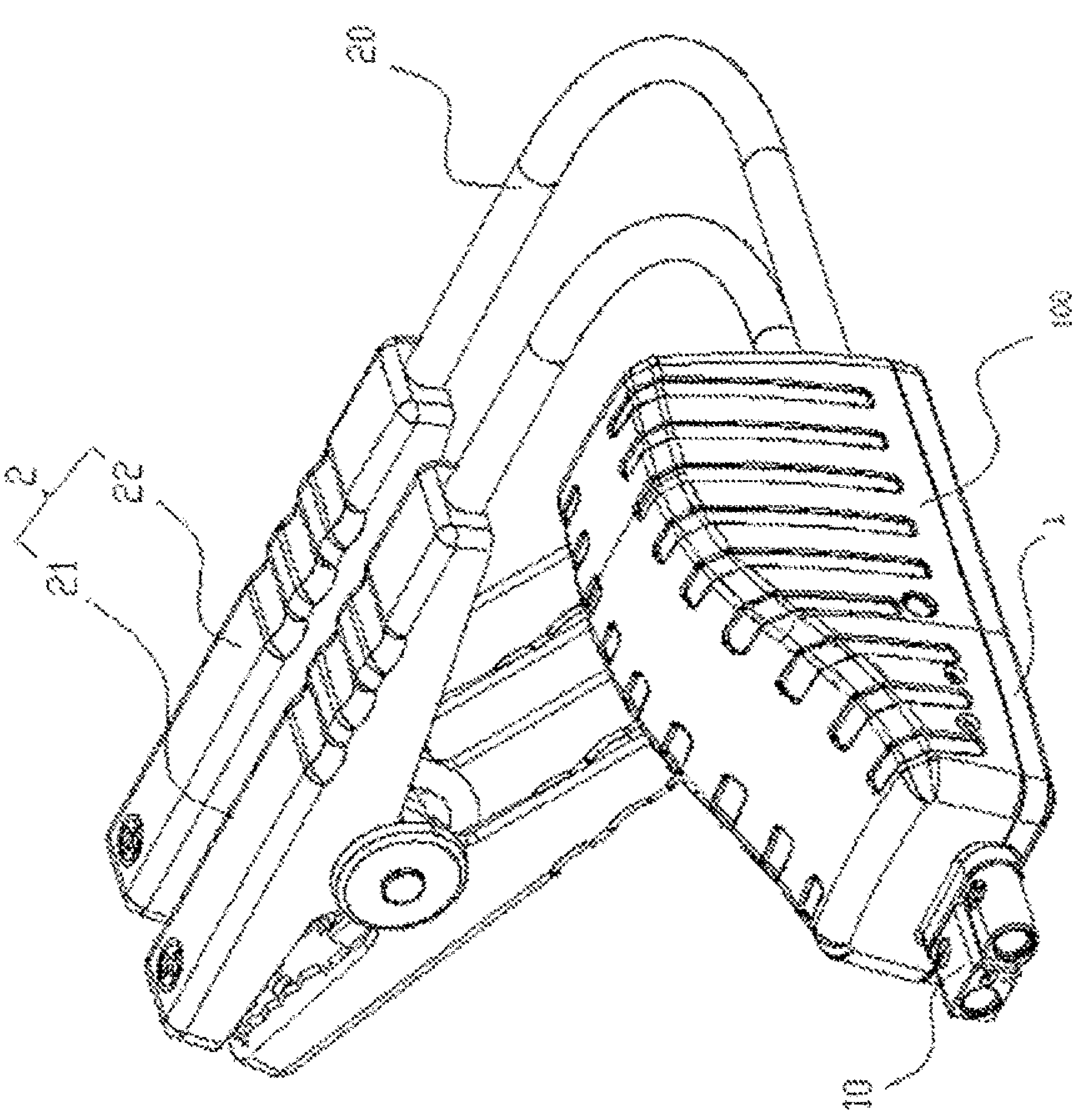
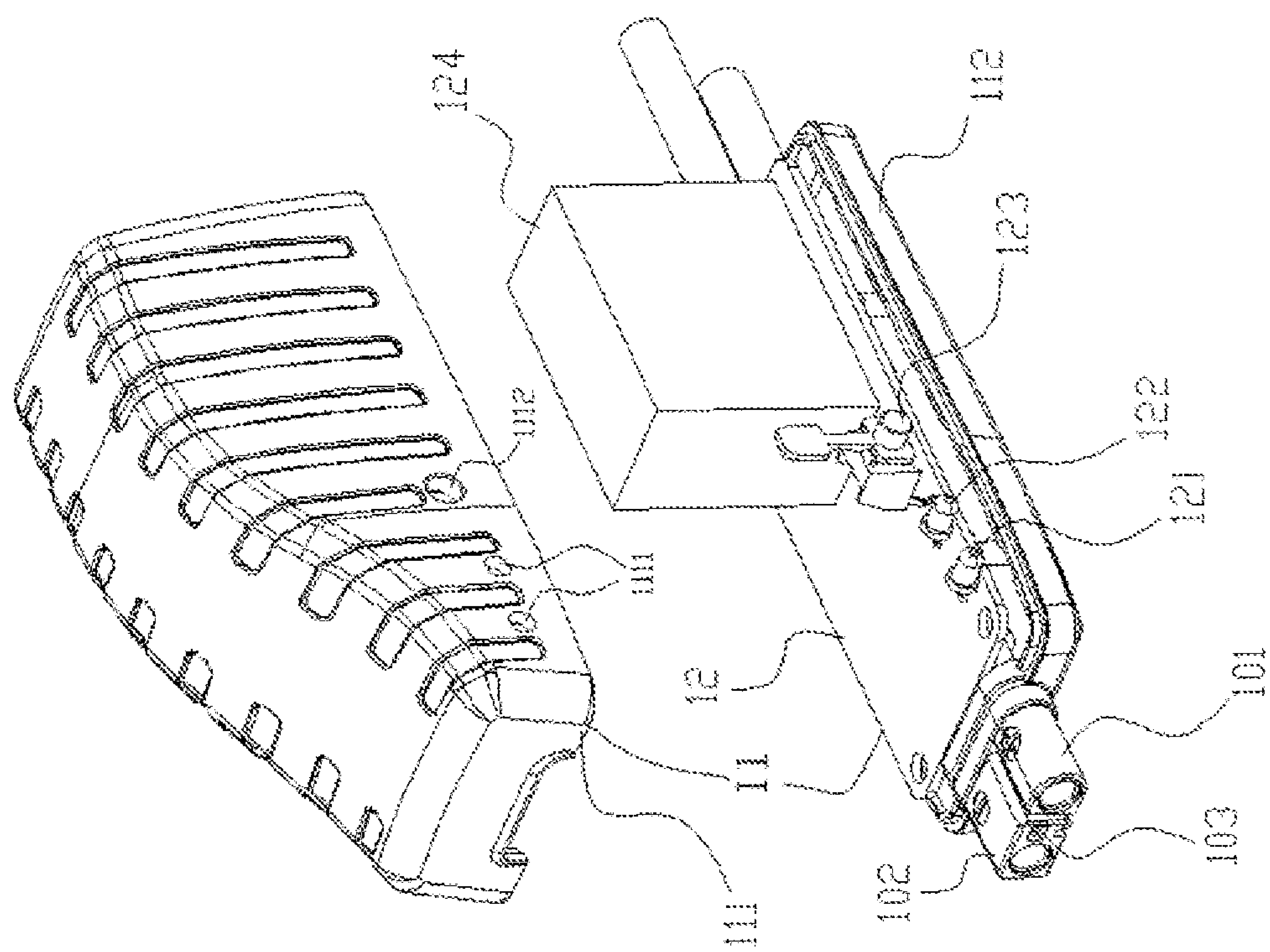


Fig. 2



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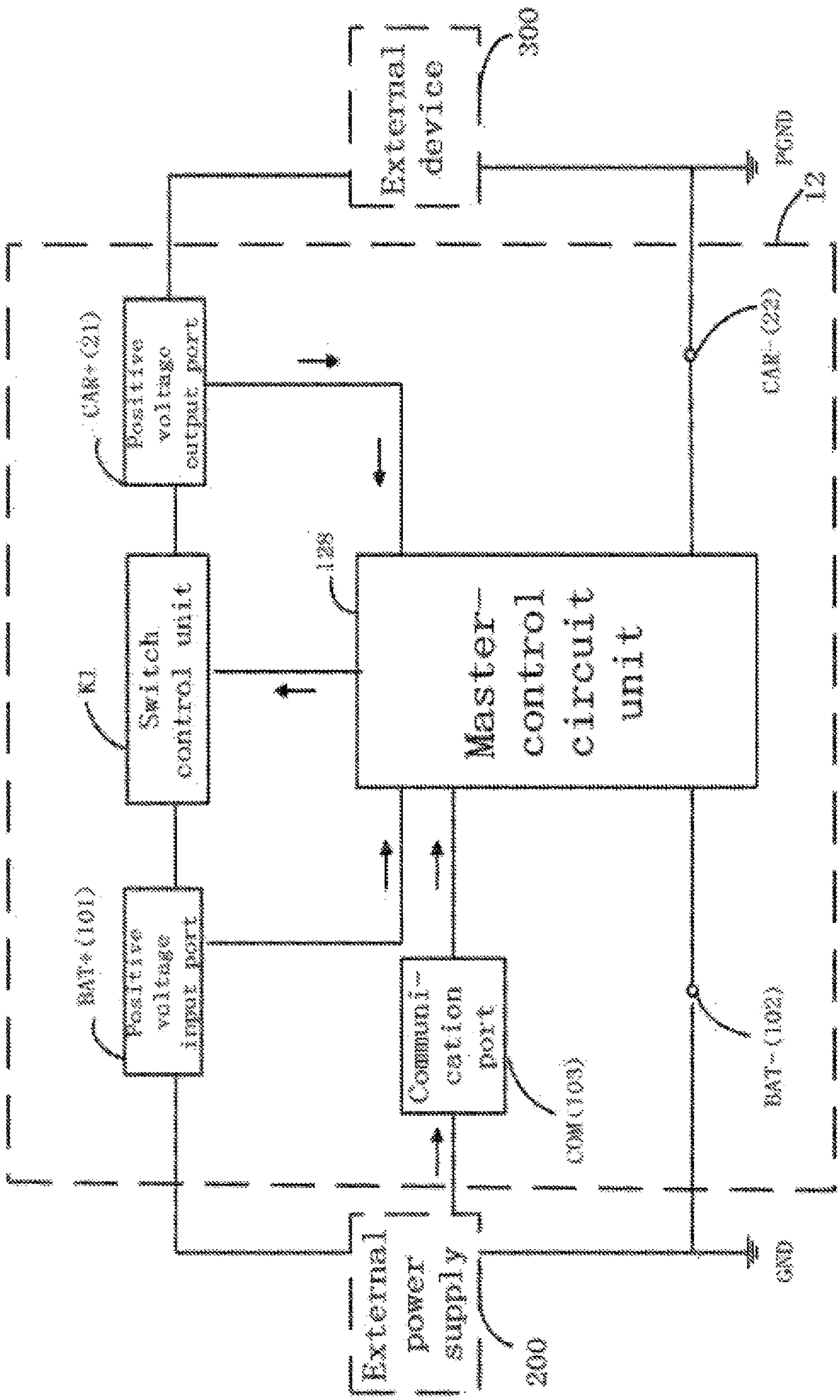

External device
300
12
PGND
CAR+ (21)
Positive voltage output port
CAR- (22)
K1
Switch control unit
128
Master control circuit unit
BAT+ (101)
Positive voltage input port
Communication port
COM (103)
BAT- (102)
External power supply
200
GND

Fig. 4

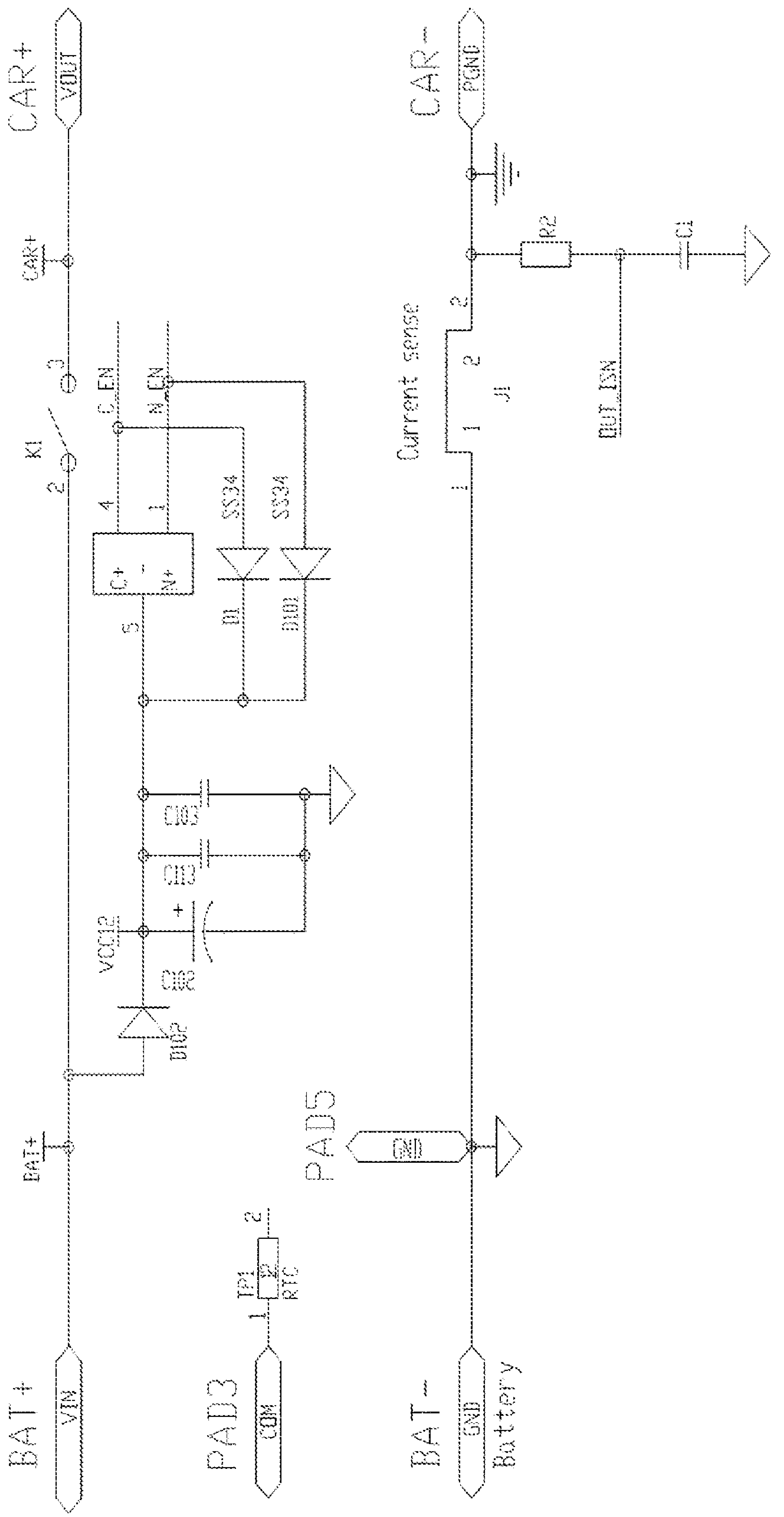
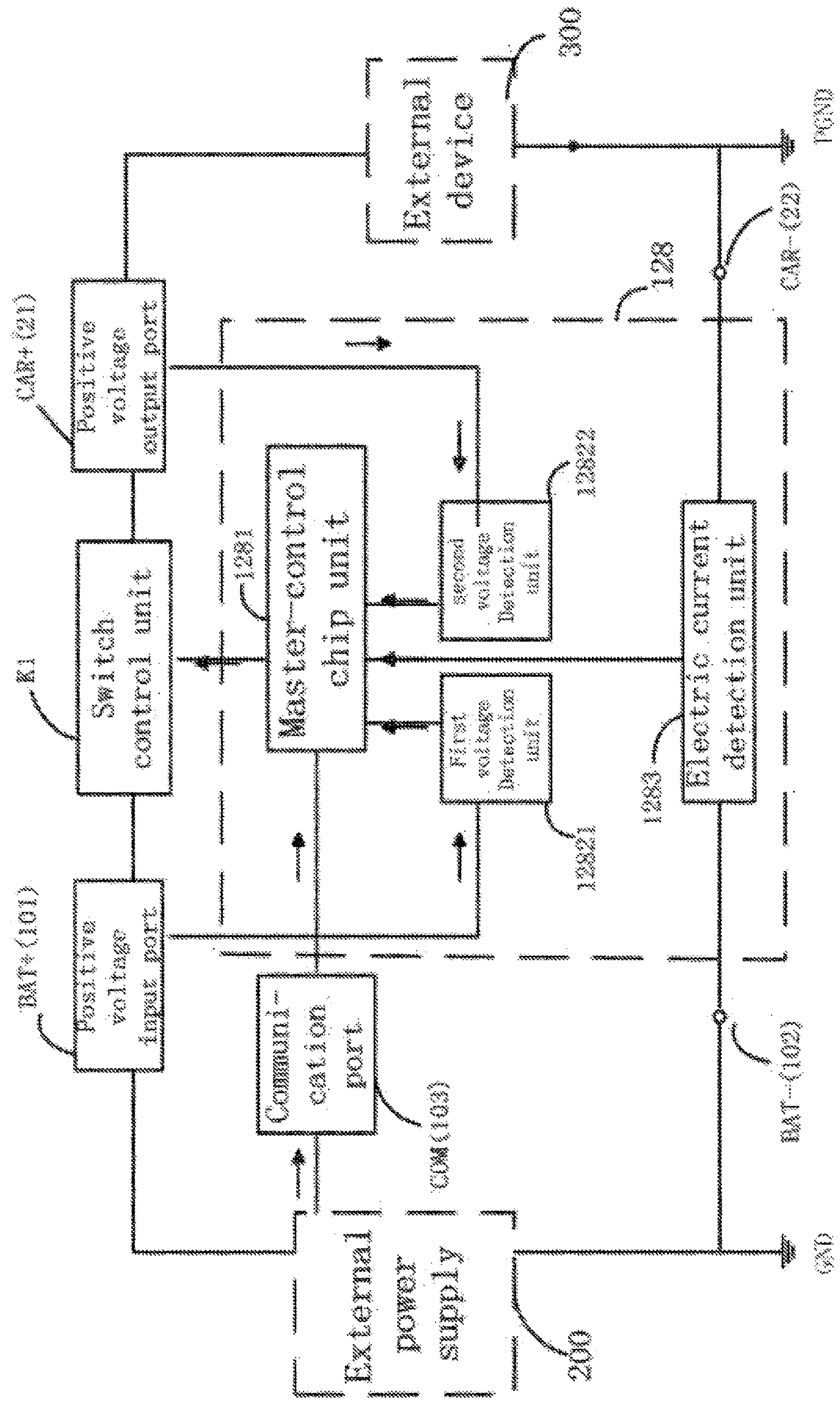
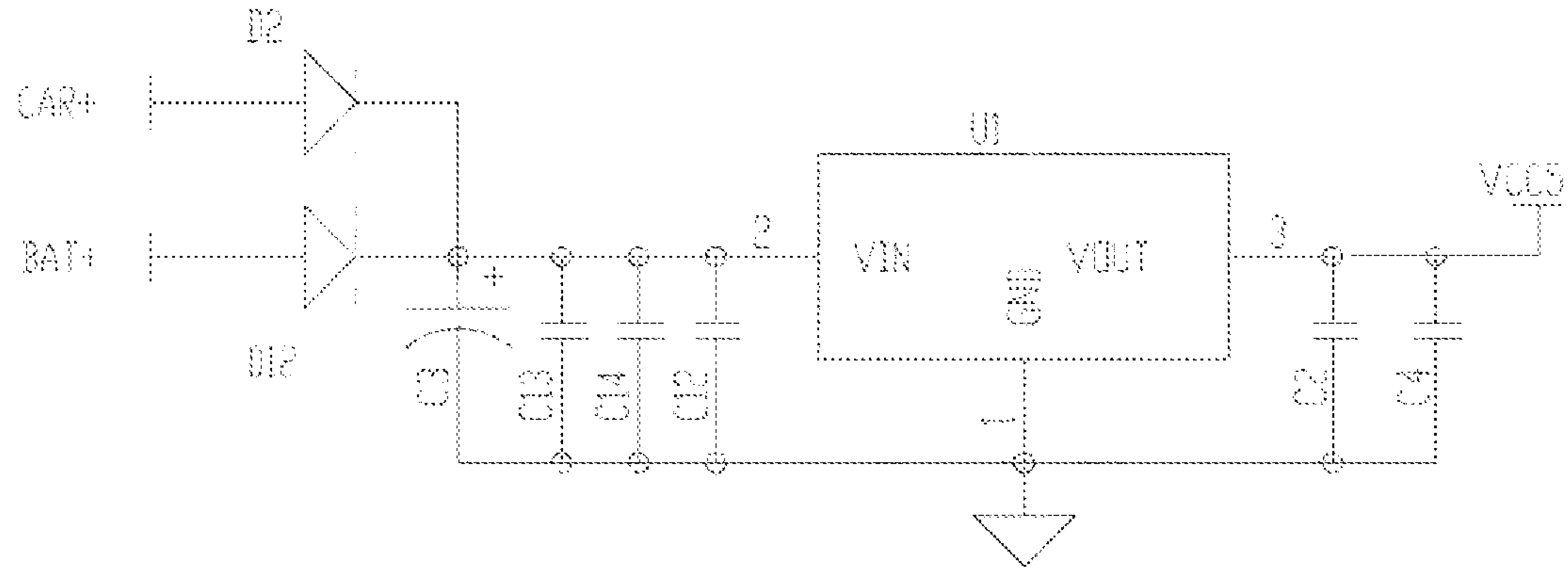

BAT+
VIN
PAD3
COM
BAT−
GND
Battery
TP1
RTC
BAT+
PAD5
GND
D102
VCC12
C102
C113
C103
D1
D101
SS34
SS34
C+
N+
K1
C_EN
N_EN
CAR+
CAR+
VOUT
CAR−
PGND
Current sense
J1
R2
C1
OUT_ISN

Fig. 5



External device
300
Positive voltage output port
CAR+(21)
Switch control unit
K1
Positive voltage input port
BAT+(101)
Communi-cation port
COM(103)
External power supply
200
128
Master-control chip unit
1281
Second voltage Detection unit
12822
First voltage Detection unit
12821
Electric current detection unit
1283
CAR-(22)
BAT-(102)
PGND
GND

Fig. 6



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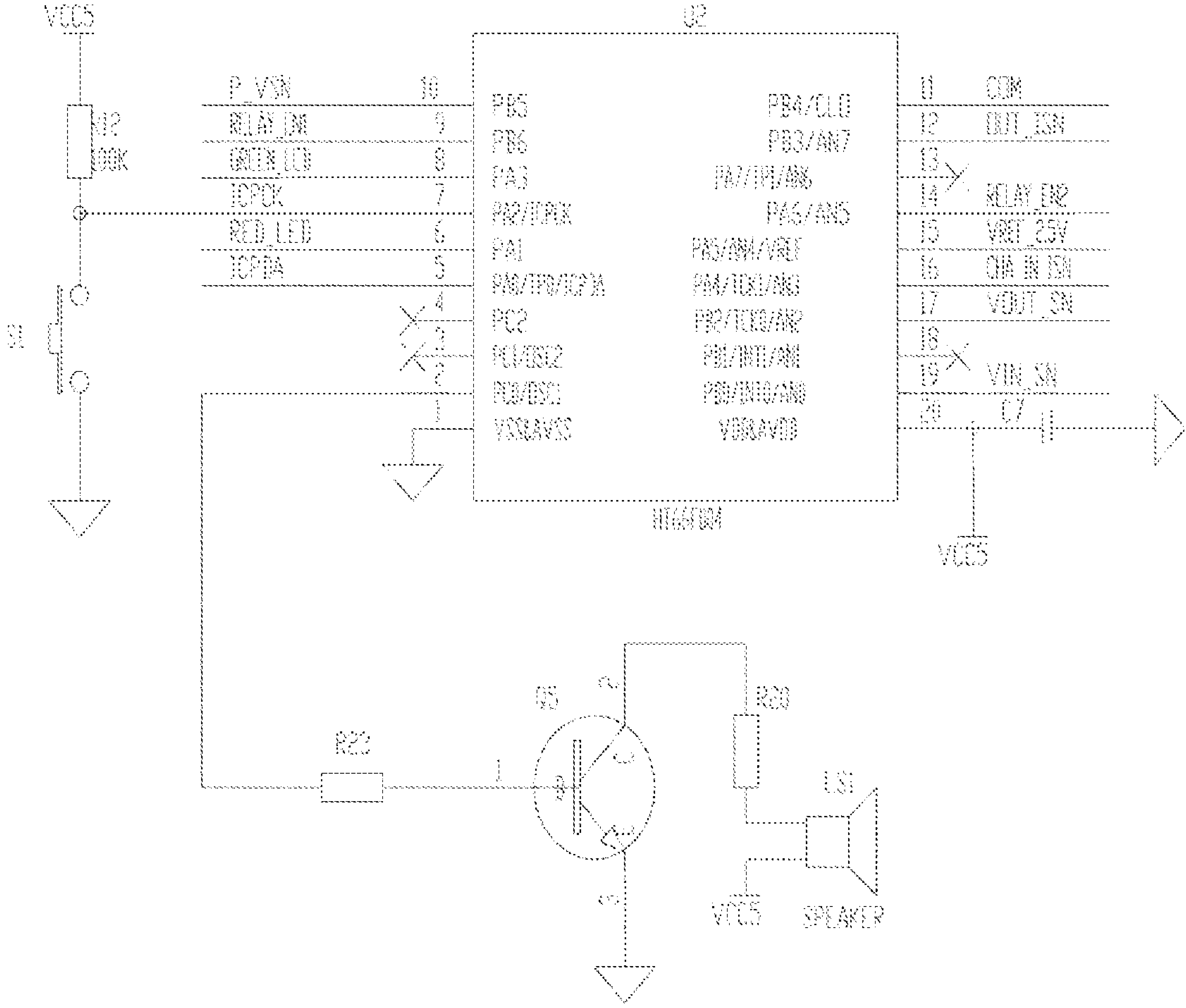

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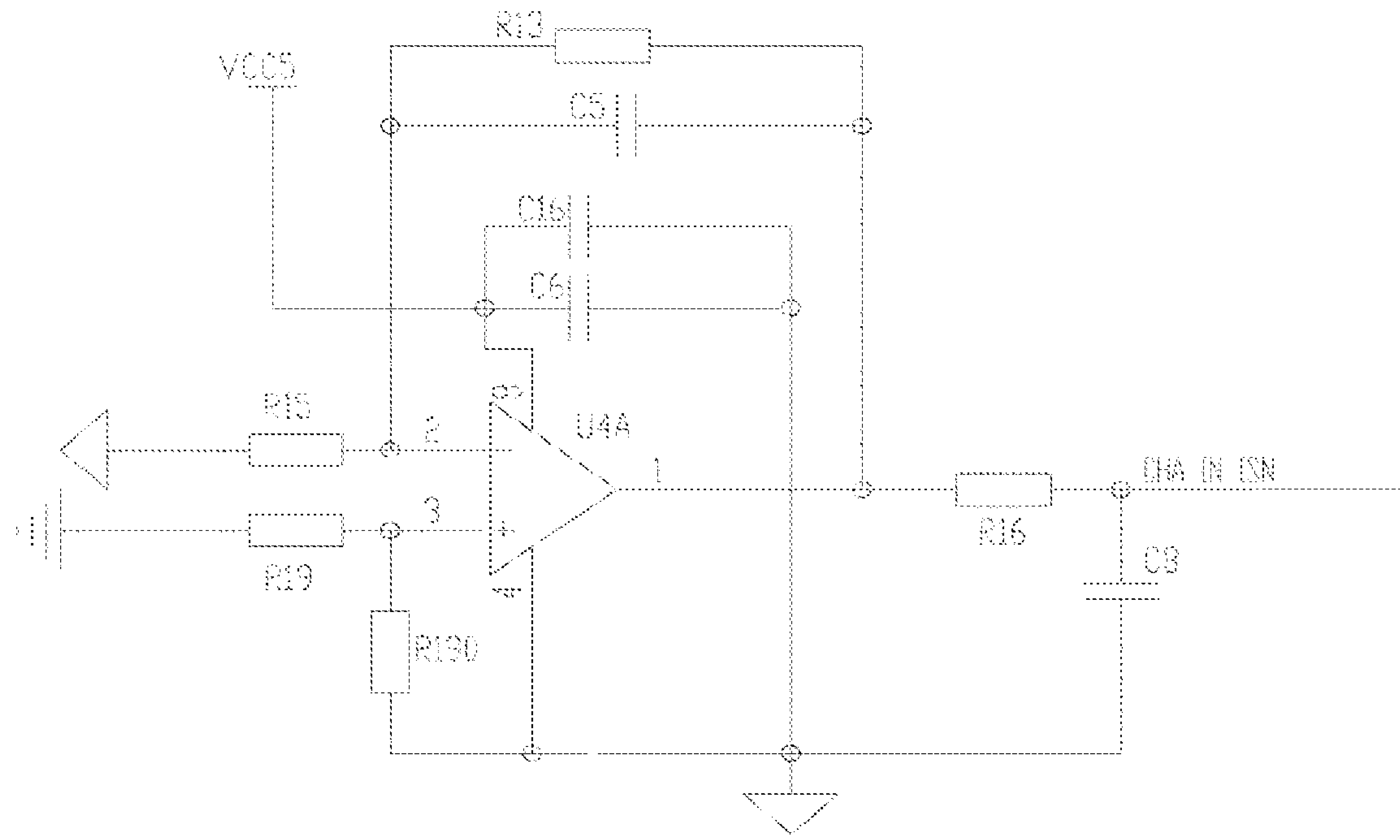
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C5
C16
C6
R15
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U4A
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CHA_IN_ISN
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R16
C8
R19
R190

Fig. 9

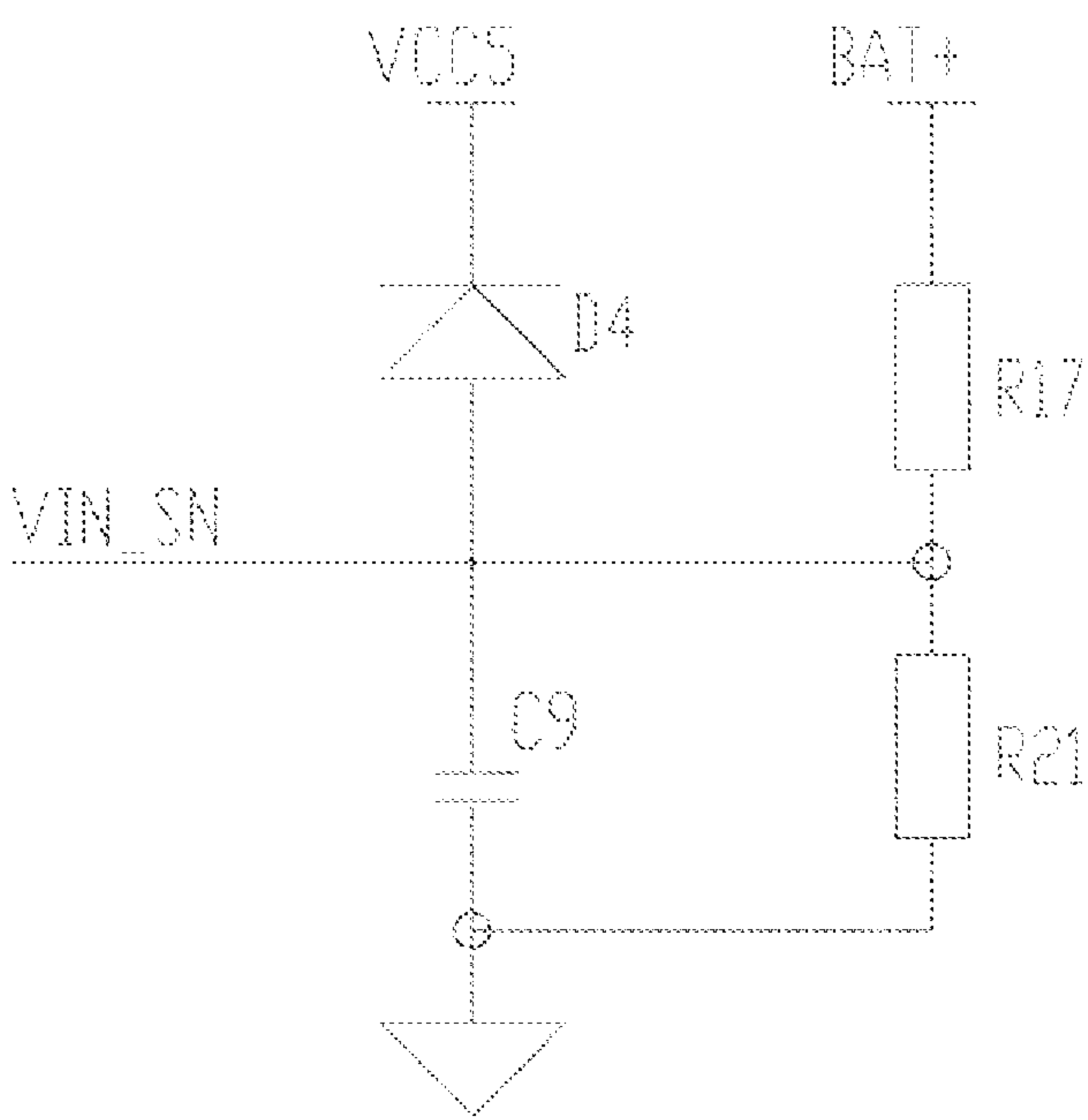
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Fig. 10

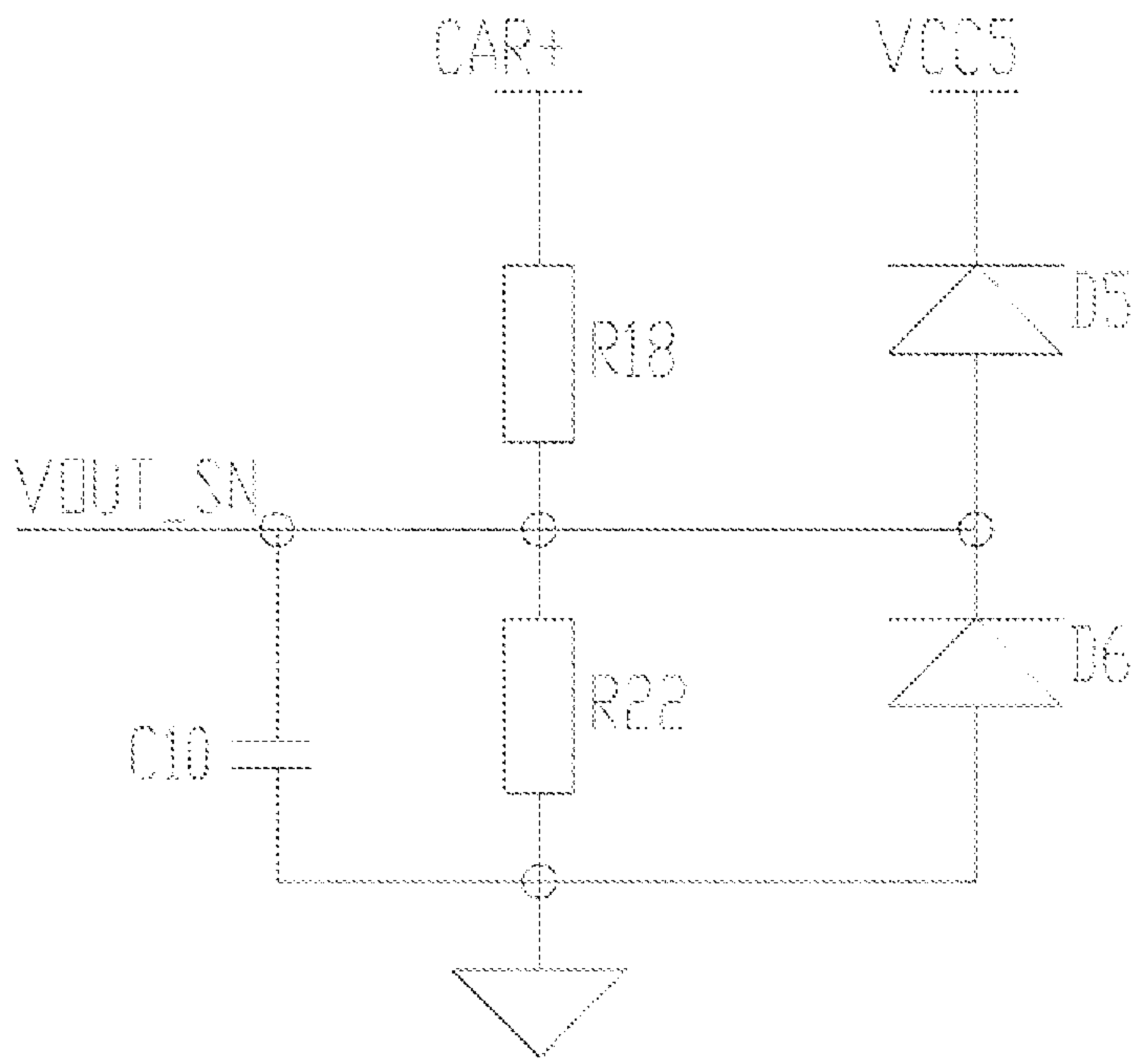

Fig. 11

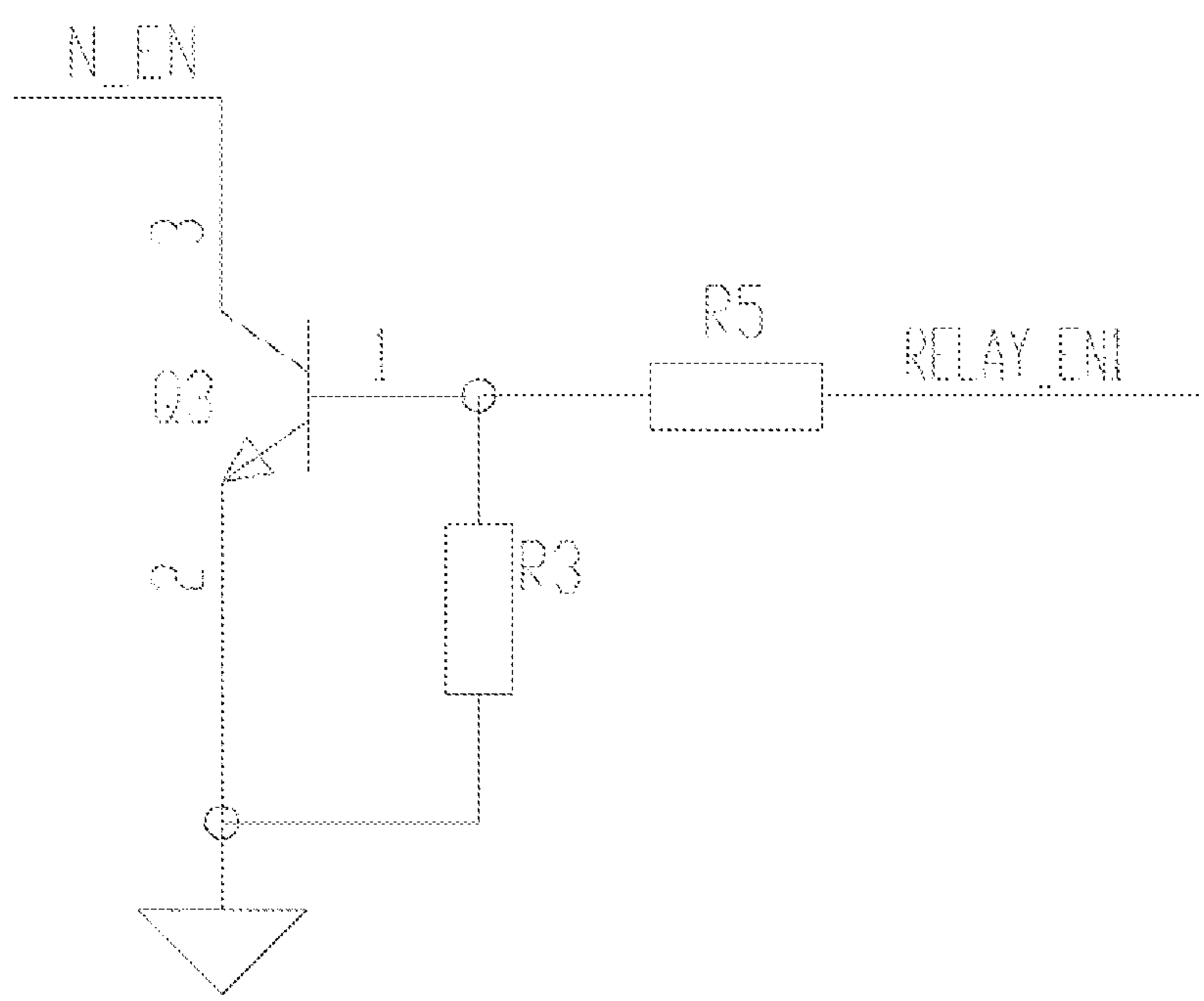

Fig. 12

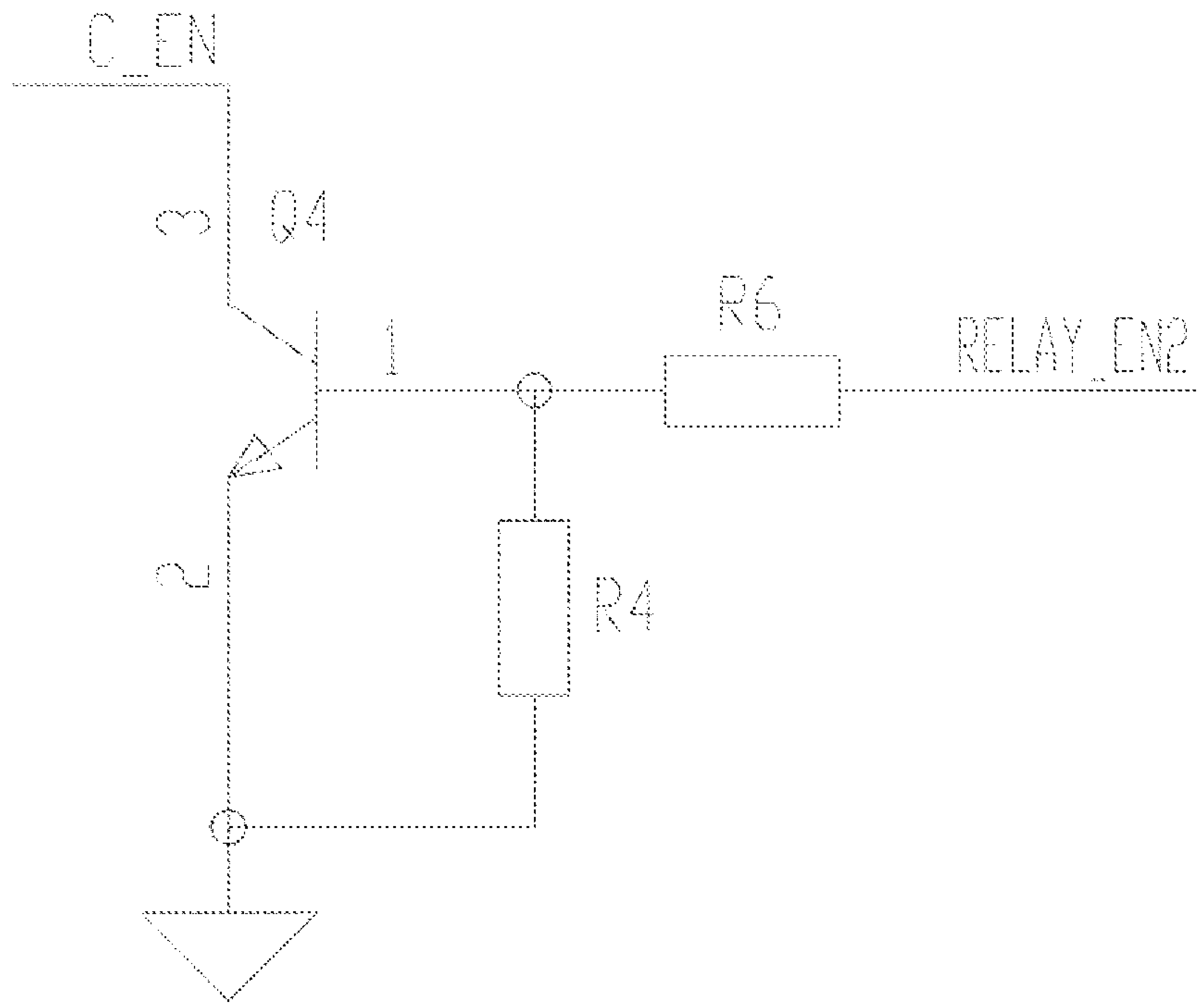

Fig. 13

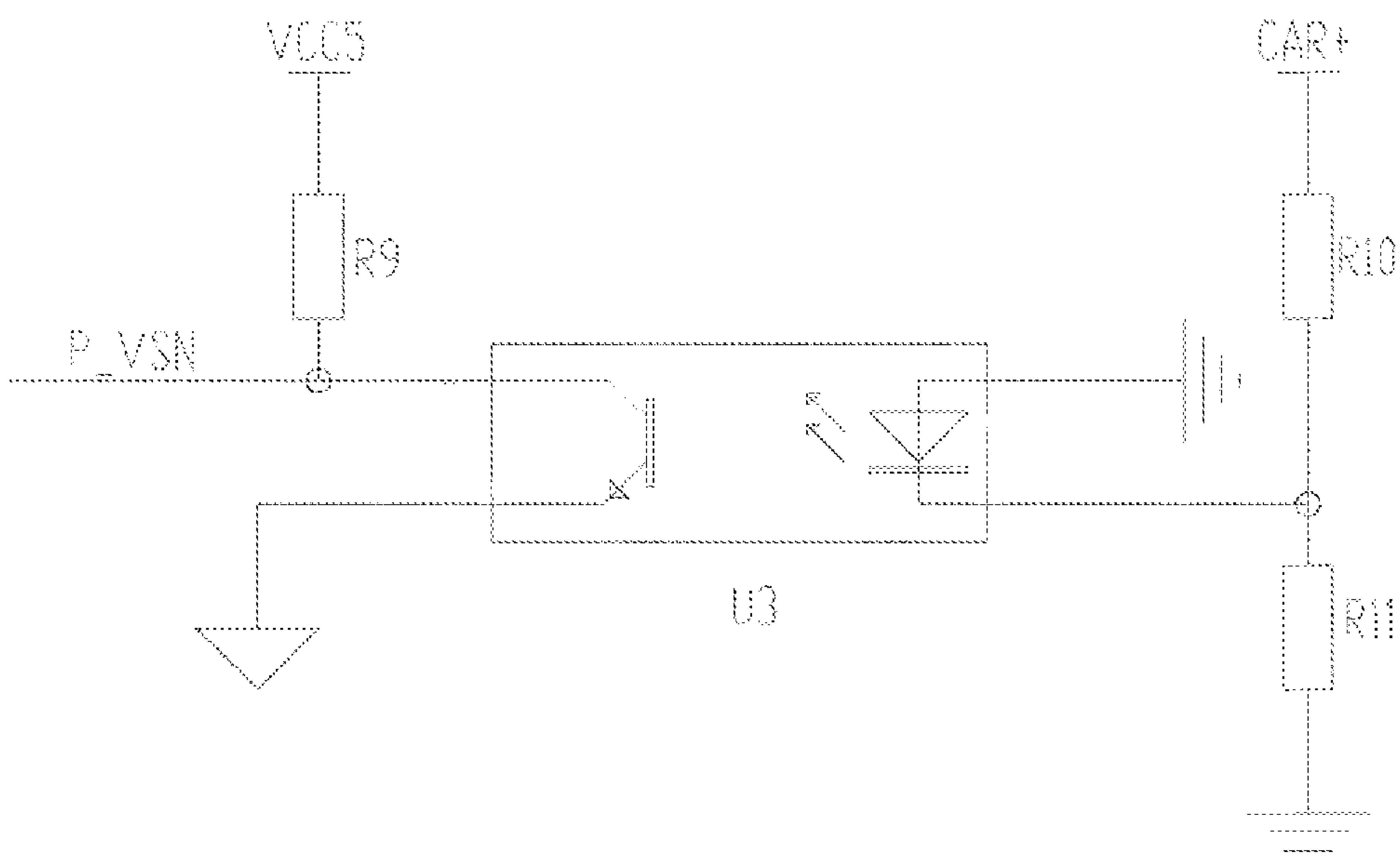

Fig. 14

BATTERY CLAMP

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS REFERENCE TO PRIORITY

This application *is an application for reissue of U.S. Pat. No. 10/148,105 ("the '105 patent), filed Aug. 23, 2016, which* claims priority to Chinese Patent Application No. 201620692248.3 filed Jun. 30, 2016. [This application] *The '105 patent* also claims priority to Chinese Patent Application No. 201610506106.8 filed Jun. 30, 2016. [This application] *The '105 patent* further claims priority to Chinese Patent Application No. 201610506137.3 filed Jun. 30, 2016. The disclosure of these applications are incorporated by reference herein in its entirety.

TECHNICAL FIELD

The present invention relates to the technical field of electronic battery and charging control and, in particular, to a battery clamp.

BACKGROUND

Nowadays the technology of applying a high power lithium battery to an emergency power supply is gradually developing. A high power lithium battery has many advantages, such as a long service life, less pollution, small size and good portability etc. However, a lithium battery may have some defects in real-life applications. For example, when being used for starting a vehicle, the starting electric current of a lithium battery could be very large (up to 1000 A). In addition, improper uses, e.g., high temperature and over-charging or over-discharging, will result in battery bulge of an emergency power supply, or even an explosion, which may cause personal injury and property loss, Although certain smart battery clamps can accommodate a large electric current during the starting of a vehicle, they cannot adjust operating modes of a battery clamp based on the actual operating condition of a starting power supply.

Therefore, its desired to provide a novel battery clamp. The aforesaid problems can be solved by establishing a communication connection between the novel battery clamp and a starting power supply.

SUMMARY

The purpose of the present invention is to provide a battery clamp, which aims to solve the aforementioned problems of a lithium battery in an external power supply e.g. battery bulge or explosion resulted from improper uses.

In order to solve the aforesaid problems, the present invention provides a battery clamp, comprising: a control device, comprising: a housing; a master-control board mounted within the housing; and connectors disposed at one side of the housing, and being electrically connected to the master-control board, comprising: at least a first and second electrode connectors, which are connected to an external power supply for receiving power, and at least one communication connector connected to the external power supply for receiving status information of the external power supply, and sending the status information to the master-control board; a first and second wire clamps, one ends of the first and second wire clamps are configured to receive power from the external power supply via the control device, and the other ends of the first and second wire clamps are connected to an external device for supplying power to the external device; wherein the control device is configured to control power supply from the external power supply to the external device based on the status information.

Preferably, the control device is configured to allow the power supply from the external power supply to the external device when the status information is normal, wherein the status information comprises at least one of the following: temperature, voltage of a battery unit of the external power supply.

Preferably, the master-control board comprises: a first and second voltage input ports electrically connected to the first and second electrode connectors respectively; a communication port electrically connected to the communication connector; a first and second voltage output ports electrically connected to the first and second wire clamps for supplying power to the external device via the first and second wire clamps; a switch control unit for controlling connection between the first voltage input port and the first voltage output port; and a master-control circuit unit connected to the communication port for obtaining the status information of the external power supply; wherein the master-control circuit unit is configured to control the switch control unit based on the status information of the external power supply, thereby controlling connection on/off between the first voltage input port and the first voltage output port.

Preferably, the master-control circuit unit further comprises: an electric current detection unit for detecting electric current from the external power supply to the external device; a voltage detection unit for detecting voltage of the external power supply and the external device; and wherein the master-control circuit unit is configured to compare the electric current value and the voltage value with a predefined electric current range and a predefined voltage range respectively, thereby controlling the switch control unit.

Preferably, the voltage detection unit comprises: a first voltage detection unit for detecting voltage value of the external power supply; and a second voltage detection unit for detecting voltage value of the external device

Preferably, the master-control circuit unit further comprises: an indicator light circuit unit connected to the master-control chip unit for indicating operating status of the control device.

Preferably, the master-control circuit unit further comprises: a buzzing circuit unit connected to the master-control chip unit for alerting users about abnormal condition.

Preferably, the communication connector is disposed between the first and second electrode connectors.

Preferably, the housing comprises an upper piece and a lower piece, which are removably connected together, and the master-control board is mounted on the lower piece.

Preferably, one side of the upper piece is provided with openings for indicator lights and buttons.

The battery clamp is configured to build a communication connection between the communication connector and an external power supply, by which status information of the external power supply can be transmitted. Based on the status information, detected electric current and voltage value, the power supply from an external power supply to an external device can be controlled, thereby effectively solving the problems of a lithium battery in an external power supply e.g. battery bulge or explosion resulted from improper uses.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to clearly understand the technical solution in the embodiments of the present invention, drawings that used for the embodiments or prior art will be briefly introduced below. Obviously, the drawings described below are merely some embodiments of the present invention. For a person skilled in the art, other drawings can be obtained according to these drawings below without any inventive effort.

FIG. **1** is a diagram illustrating a battery clamp in connection with an external power supply and an external device according to one embodiment of the present invention.

FIG. **2** is a structure diagram of a battery clamp according to one embodiment of the present invention.

FIG. **3** is a structure diagram illustrating a control device of a battery clamp according to one embodiment of the present invention.

FIG. **4** is a diagram illustrating a circuit module of a master-control board according to one embodiment of the present invention.

FIG. **5** is a circuit diagram illustrating voltage input ports, voltage output ports and a communication ports of a master-control board according to one embodiment of the present invention.

FIG. **6** is a diagram illustrating a module of a master-control circuit unit according to one embodiment of the present invention.

FIG. **7** is a circuit diagram illustrating a power control unit of a master-control circuit unit according to one embodiment of the present invention.

FIG. **8** is a circuit diagram illustrating a master-control chip unit of a master-control circuit unit according to one embodiment of the present invention.

FIG. **9** is a circuit diagram illustrating an electric current detection unit of a master-control circuit unit according to one embodiment of the present invention.

FIG. **10** is a circuit diagram illustrating a first voltage detection unit of voltage detection units of a master-control circuit unit according to one embodiment of the present invention.

FIG. **11** is a circuit diagram illustrating a second voltage detection unit of voltage detection units of a master-control circuit unit according to one embodiment of the present invention.

FIG. **12** is a circuit diagram illustrating a first connection unit of a switch control unit according to one embodiment of the present invention.

FIG. **13** is a circuit diagram illustrating a second connection unit of a switch control unit according to one embodiment of the present invention.

FIG. **14** is a circuit diagram illustrating an anti-inverse detection unit according to one embodiment of the present invention.

DETAILED DESCRIPTION

The present invention is further described below along with the drawings and embodiments, in order to clearly understand the purpose, technical solution and advantage thereof.

FIG. **1** is a diagram illustrating a battery clamp **100** in connection with an external power supply **200** and an external device **300** according to one embodiment of the present invention.

As shown in FIG. **1**, the connection between the battery clamp **100** and the external power supply **200** comprises a power connection, by which the battery clamp **100** can obtain power supply from the external power supply **200**. Generally, the power connection is implemented by a pluggable interface.

The connection between the battery clamp **100** and the external power supply **200** also comprises a communication connection, by which the battery clamp **100** can obtain status information of the external power supply **200**. The communication connection can be wired connections, such as via a serial interface, or can be wireless connections, such as via Bluetooth, NFC, Wi-Fi etc.

As shown in FIG. **1**, the battery clamp **100** is configured to use a power connection for supplying power to the external device **300**.

FIG. **2** is a structure diagram of the battery clamp **100** according to one embodiment of the present invention.

As shown in FIG. **2**, the battery clamp **100** comprises a control device **1** and wire clamps **2**. One side of the control device **1** is provided with connectors **10**, and the other side is provided with wires **20**. The control device **1** and the wire clamps **2** are connected via the wires **20**. The wire clamps **2** comprises a first and second wire clamps **21**, **22** representing an positive and negative electrodes respectively.

The wire clamps **2** are connected to the external device **300** for supplying power to it. For example, when the external power supply **200** is an emergency starting power supply and the external device **300** is a vehicle, the emergency starting power supply **200** is connected to the vehicle **300** via the battery clamp **100** for starting the vehicle **300**.

FIG. **3** is a structure diagram illustrating a control device of the battery clamp **100** according to one embodiment of the present invention.

As shown in FIG. **3**, the control device **1** comprises: a housing **11**, a master-control board **12** and connectors **10**. The housing **11** comprises an upper piece **111** and a lower piece **112** which are removably connected together.

The master-control board **12** is mounted within the housing **11**. Specifically, the master-control board **12** is mounted on the lower piece **112**.

The connectors **10** are disposed at one side of the housing **11**, and are electrically connected to the master-control board **12**.

The connectors **10** comprise a positive electrode connector **101**, a negative electrode connector **102** and a communication connector **103**. According to one embodiment of the present invention, the communication connector **103** is disposed between the positive electrode connector **101** and the negative electrode connector **102**.

The positive and negative electrode connectors **101**, **102** are connected to the external power supply **200** for receiving power supply.

A communication connection between the battery clamp **100** and the external power supply is built via the communication connector **103**. The battery clamp **100** can obtain status information of the external power supply **200** via the communication connector **103**, thereby monitoring and managing the external power supply **200** to prevent bulge or explosion of the external power supply **200**.

According to one embodiment of the present invention, the control device **1** is configured to allow the power supply from the external power supply **200** to the external device **300** when the status information is normal.

According to one embodiment of the present invention, the status information of the external power supply **200** comprises at least one of the following: temperature, voltage of a battery unit of the external power supply **200**.

According to one embodiment of the present invention, the master-control board **12** of the control device **1** comprises voltage input ports BATs, voltage output ports CARs, a communication port COM, a switch control unit K**1**, and a master-control circuit unit **128**.

FIG. **4** is a diagram illustrating a circuit module of the master-control board **12** according to one embodiment of the present invention.

As shown in FIG. **4**, the master-control board **12** comprises: voltage input ports BATs (including a positive voltage input port BAT+ and a negative voltage input port BAT−), voltage output ports CARs (including a positive voltage output port CAR+ and a negative voltage output port CAR−), a communication port COM, a switch control unit K**1** and a master-control circuit unit **128**.

As discussed above, the positive and negative electrode connectors **101**, **102** are connected to the external power supply **200** for receiving power supply. The positive voltage input port BAT+ and the negative voltage input port BAT− are electrically connected to the electrode connectors **101**, **102** respectively, i.e. the voltage input ports BATs are electrically connected to the external power supply **200**, for receiving power supply from the external power supply **200**.

As discussed above, the control device **1** is connected to the wire clamps **2** via the wires **20**, and the wire clamps **20** are connected to the external device **300** for supplying power via the wire clamps **20**. The positive voltage output port CAR+ and the negative voltage output port CAR− are electrically connected to the first and second wire clamps **21**, **22** respectively, i.e. the voltage output ports CARs are electrically connected to the external device **300**, for supplying power to the external device **300**.

The positive voltage input port BAT+ is connected to the positive voltage output port CAR+ via the switch control unit K**1**. The switch control unit K**1** is configured to control connection on/off between the positive voltage input port BAT+ and the positive voltage output port CAR+.

The switch control unit K**1** is connected to and controlled by the master-control circuit unit **128**.

The master-control circuit unit **128** is connected to the communication port COM for receiving status information of the external power supply **200**.

The master-control circuit unit **128** is also connected to the positive voltage input port BAT+ or the positive voltage output port CAR+ for detecting voltage values of them, i.e. detecting voltage values of the external power supply **200** or the external device **300**.

The master-control circuit unit **128** is also connected to two grounding ports GND and PGND for detecting an electric current value from the external power supply **200** to the external device **300**.

Based on the status information, the master-control circuit unit **128** can control the switching on/off of the switch control unit K**1**, thereby controlling the power supply from the external power supply **200** to the external device **300**.

Similarly, based on the voltage values or electric current values detected by the master-control circuit unit **128**, the master-control circuit unit **128** can control the switching on/off of the switch control unit K**1**, thereby controlling the power supply from the external power supply **200** to the external device **300**.

FIG. **5** is a circuit diagram illustrating voltage input ports BATs, voltage output ports CARs, a communication port COM and a switch control unit K**1** of the master-control board **12** of the battery clamp **100**.

As shown in FIG. **5**, the voltage input ports BATs of the master-control board **12** comprises a positive voltage input port BAT+ and a negative voltage input port BAT−. The voltage output ports CARs of the master-control board **12** comprises a positive voltage output port CAR+ and a negative voltage output port CAR−.

The voltage input ports BATs are electrically connected to the electrode connectors. Specifically, the positive voltage input port BAT+ is electrically connected to the positive electrode connector **101** for receiving a positive output voltage from the external power supply **200**; the negative voltage input port BAT− is electrically connected to the negative electrode connector **102** for receiving a negative output voltage from the external power supply **200**.

The voltage output ports CARs are electrically connected to the wire clamps **20**. Specifically, the positive voltage output port CAR+ is electrically connected to the first wire clamp **21** and the negative voltage output port CAR− is electrically connected to the second wire clamp **22** for supplying power to the external device **300**.

In addition, FIG. **5** further illustrates the communication port COM and the switch control unit K**1** of the master-control board **12**.

The communication port COM is electrically connected to the communication connector **103**.

The positive voltage input port BAT+ is connecter to the positive voltage output port CAR+ by the switch control unit K**1**.

The switch control unit K**1** is also connected to the master-control circuit unit **128** via two input ports N_EN and C_EN, and is controlled by the master-control circuit unit **128**. The master-control circuit unit **128** is connected to the switch control unit K**1** for controlling the switching on/off of the switch control unit K**1** based on status information of an external power supply.

When the switch control unit K**1** is off, the positive voltage input port BAT+ is disconnected from the positive voltage output port CAR+, which means the power supply provided by the external power supply **200** is also disconnected from the external device **300**. When the switch control unit K**1** is on, the positive voltage input port BAT+ connects with the positive voltage output port CAR+, which means the power supply from the external power supply **200** is provided to the external device **300**.

In another embodiment of the present invention, the master-control circuit unit **128** further comprises an electric current detection unit **1283**, voltage detection units **1282** and a master-control chip unit **1281**. The master-control circuit unit **128** is connected to the communication port COM for obtaining status information of the external power supply **200**.

The master-control circuit unit **128** further comprises a power control unit for supplying the obtained external power to the electric current detection unit **1283**, the voltage detection units **1282** and the master-control chip unit **1281**.

FIG. **6** is a diagram illustrating a module of a master-control circuit unit **128** according to one embodiment of the present invention.

As shown in FIG. **6**, the master-control circuit unit **128** comprises a master-control chip unit **1281**, an electric current detection unit **1283** and voltage detection units. The voltage detection units further comprises a first voltage detection unit **12821** and a second voltage detection unit **12822**.

Input ports of the first and second voltage detection unit **12821** and **12822** are connected to the positive voltage input port BAT+ and the positive voltage output port CAR+ respectively, thereby detecting voltages of the positive voltage input port BAT+ and positive voltage output port CAR+, i.e. detecting voltages of the external power supply **200** and the external device **300**. Output ends of the first and second voltage detection unit **12821** and **12822** are connected to the master-control chip unit **1281** for delivering the detected voltage values to the master-control chip unit **1281**.

Input ports of the electric current detection unit **1283** are connected to two grounding ports GND and PGND for detecting an electric current value from the external power supply **200** to the external device **300**. An output port of the electric current detection unit **1283** is connected to the master-control chip unit **1281** for delivering the detected electric current value to the master-control chip unit **1281**.

The master-control chip unit **1281** is connected to the switch control unit K**1**, and is configured to control the switching on/off of the switch control unit k**1** based on the detected electric current or voltage value, thereby controlling the power supply from the external power supply **200** to the external device **300**.

FIGS. **7-11** are example circuit diagrams illustrating a power control unit, a master-control chip unit **1281**, an electric current detection unit **1283**, and voltage detection units **1282** respectively.

FIG. **7** is a circuit diagram illustrating a power control unit according to one embodiment of the present invention.

As shown in FIG. **7**, the circuit of the power control unit comprises a power control chip U**1**, a plurality of capacitors, and two diodes.

The power control unit is respectively connected to the positive voltage input port BAT+ and the positive voltage output port CAR+ by the two diodes.

The power control unit is provided with a voltage output port VCC**5**. The voltage output port VCC**5** is connected to VCC**5** ports of the electric current detection unit **1283**, the voltage detection units **1282**, the master-control chip unit **1281** and an anti-inverse detection unit etc. for providing a drive voltage.

FIG. **8** is a circuit diagram illustrating a master-control chip unit **1281** according to one embodiment of the present invention.

As shown in FIG. **8**, the master-control chip unit **1281** comprises a control chip U**2**.

The 11^{th} pin of the control chip U**2** is connected to a communication port COM for communicating between the battery clamp **100** and the external power supply **200**.

The control chip U**2** is also provided with a programming port ICPCK. The programming port ICPCK, which is also powered by the voltage output port VCC**5** of the power control unit, is used for programming relevant control program on the control chip U**2**, thereby storing instruction and data on the chip in advance.

FIG. **9** is a circuit diagram illustrating an electric current detection unit **1283** according to one embodiment of the present invention.

As shown in FIG. **9**, the electric current detection unit **1283** comprises an amplifier U**4**A, and relevant capacitors and resistors

The electric current detection unit **1283** is powered by the voltage output port VCC**5** of the power control unit. Input ports thereof are connected to two grounding ports GND and PGND for detecting an electric current value of the voltage input ports BATs or the voltage output ports CARs, i.e. the electric current value from the external power supply **200** to the external device **300**.

The electric current detection unit **1283** is also connected to the master-control chip unit **1281**. Specifically, an output port CHA IN ISN of the electric current detection unit **1283** is connected to the 16^{th} pin of CHA IN ISN of the control chip U**2** for delivering a detected electric current value to the control chip U**2**.

According to one embodiment of the present invention, after obtaining a detected electric current value from the external power supply **200** to the external device **300**, the master-control chip unit **1281** is configured to compare the detected electric current value with a predefined electric current range, i.e. a protection threshold of starting electric current, which is stored in the master-control chip unit **1281** in advance. If the detected electric current value exceeds the predefined electric current range, the master-control chip unit **1281** will switch off the switch control unit K**1** by means of a pre-stored control program. Correspondingly, the power supply from the external power supply **200** to the external device **300** will be switched off as well. On the contrary, if the detected electric current value does not exceed the predefined electric current range, the power supply from the external power supply **200** to the external device **300** would be sustained.

TABLE 1

Parameters with regard to different types of external power supply

Type of battery module	Operating voltage	Low voltage alert threshold	Protection threshold of starting electric current
3C lithium cobalt oxide	8.1-12.6 v	Voltage of one battery unit is below 2.7 v	550 A
4F lithium iron phosphate	8-14.6 v	Voltage of one battery unit is below 2.0 v	600 A
4C lithium cobalt oxide	10.8-16.8 v	Voltage of one battery unit is below 2.7 v	600 A

For example, as shown in Table 1, when the external power supply **200** is 3C lithium cobalt oxide, the predefined electric current range can be 0-550 A. If an electric current value from the external power supply **200** to the external device **300**, which is obtained by the master-control chip unit **1281**, exceeds 550 A, the master-control chip unit **1281** will switch off the switch control unit K**1**. Correspondingly, the power supply from the external power supply **200** to the external device **300** will be switched off as well. On the contrary, if the detected electric current value is below 550 A, the power supply from the external power supply **200** to the external device **300** would be sustained. Same rules would be applicable when types of the external power supply **200** are 4F lithium iron phosphate and 4C lithium cobalt oxide.

In one embodiment of the present invention, the status information, predefined current range and predefined voltage range are stored in the control chip U**2** in advance.

In another embodiment of the present invention, the voltage detection units **1282** are connected to the master-control chip unit **1281**. The voltage detection units **1282** are configured to detect voltage of the positive voltage input port BAT+ or the positive voltage output port CAR+, i.e. voltage of the external power supply **200** or the external device **300**, and to send a detected voltage value to the master-control chip unit **1281**.

In another embodiment of the present invention, the voltage detection units **1282** comprises a first and second voltage detection units.

FIGS. **10** and **11** are circuit diagrams illustrating a first and second voltage detection units respectively.

As shown in FIG. **10**, the first voltage detection unit comprises a diode as well as relevant capacitors and resistors. A power port VCC**5** of the first voltage detection unit is connected to the voltage output port VCC**5** of the power control unit via the diode. An input port BAT+ of the first voltage detection unit is connected to the positive voltage input port BAT+. An output port VIN_SN of the first voltage detection unit is connected to the 19^{th} pin of VIN_SN of the control chip U**2** for detecting voltage value of the positive voltage input port BAT+, and then delivers the detected voltage value to the control chip U**2**.

As shown in FIG. **11**, the second voltage detection unit comprises two diodes as well as relevant capacitors and resistors. A power port VCC**5** of the second voltage detection unit is connected to the voltage output port VCC**5** of the power control unit via the diodes. An output port CAR+ of the second voltage detection unit is connected to the positive voltage output port CAR+. An output port VOUT_SN of the second voltage detection unit is connected to the 17^{th} pin of VOUT_SN of the control chip U**2** for detecting voltage value of the positive voltage output port CAR+, and then delivers the detected voltage value to the control chip U**2**.

According to one embodiment of the present invention, after obtaining a voltage value of the positive voltage input port BAT+ or the positive voltage output port CAR+, the master-control chip unit **1281** is configured to compare the detected voltage value with a predefined voltage range, i.e. range of operating voltage, which is stored in the master-control chip unit **1281** in advance. If the detected voltage value is beyond the predefined voltage range, the master-control chip unit **1281** will switch off the switch control unit K**1** by means of a pre-stored control program. Correspondingly, the power supply from the external power supply **200** to the external device **300** will be switched off as well. On the contrary, if the detected voltage value is not beyond the predefined voltage range, the power supply from the external power supply **200** to the external device **300** would be sustained.

For example, as shown in Table 1, when the external power supply **200** is 3C lithium cobalt oxide, the predefined voltage range can be 8.1-12.6V. If a voltage value of the positive voltage input port BAT+ or the positive voltage output port CAR+ obtained by the master-control chip unit **1281** is 13V, which is beyond the predefined voltage range, the master-control chip unit **1281** will switch off the switch control unit K**1**. Correspondingly, the power supply from the external power supply **200** to the external device **300** will be switched off as well. On the contrary, if a voltage value of the positive voltage input port BAT+ or the positive voltage output port CAR+ is 12V, which is within the predefined voltage range, the power supply from the external power supply **200** to the external device **300** would be sustained. Same rules would be applicable when types of the external power supply **200** are 4F lithium iron phosphate and 4C lithium cobalt oxide.

In one embodiment of the present invention, the switch control unit K**1** further comprises a first and second connection units.

FIGS. **12** and **13** are circuit diagrams illustrating a first and second connection units of the switch control unit K**1** according to one embodiment of the present invention. The switch control unit K**1** is connected to the control chip U**2** by the first and second connection units.

As shown in FIGS. **12** and **13**, the 9^{th} pin of RELAY_EN1 and the 14^{th} pin of RELAY_EN2 of the control chip U**2** are connected to the two input ports N_EN and C_EN of the switch control unit K**1** respectively. The control chip U**2** is configured to control switching on/off of the switch control unit K**1** by the two pins.

According to one embodiment of the present invention, after obtaining status information of the external power supply, the control chip U**2** of the master-control chip unit **1281** can obtain temperature of a battery unit. Then the control chip U**2** is configured to compare the detected temperature with a predefined temperature threshold, which is stored in the master-control chip unit **1281** in advance. If a temperature value of a battery unit exceeds the predefined temperature threshold, the control chip U**2** will switch off the switch control unit K**1** by means of a pre-stored control program. Accordingly, the power supply from the external power supply **200** to the external device **300** will be switched off as well. On the contrary, if a temperature value of a battery unit does not exceed the predefined temperature threshold, the power supply from the external power supply **200** to the external device **300** would be sustained.

According to another embodiment of the present invention, after obtaining status information of the external power supply, the control chip U**2** of the master-control chip unit **1281** can obtain a voltage difference of any two of battery units. Then the control chip U**2** is configured to compare the voltages difference between any two of battery units with a predefined voltage difference, which is stored in the master-control chip unit **1281** in advance. If a voltage difference of any two of battery units exceeds the predefined voltage difference of any two of battery units, the control chip U**2** will switch off the switch control unit K**1** by means of a pre-stored control program. Correspondingly, the power supply from the external power supply **200** to the external device **300** will be switched off as well. On the contrary, if a voltage difference of any two of battery units does not exceed the predefined voltage difference of any two of battery units, the power supply from the external power supply **200** to the external device **300** would be sustained.

In one embodiment of the present invention, the switch control unit K**1** comprises a relay switch.

In one embodiment of the present invention, the master-control circuit unit **128** further comprises an anti-inverse detection unit.

FIG. **14** is a circuit diagram illustrating an anti-inverse detection unit according to one embodiment of the present invention. The anti-inverse detection unit is connected to the master-control chip unit **1281** and the positive voltage output port CAR+ for detecting whether a user has inversely connected the first and second wire clamps **21** and **22**.

As shown in FIG. **14**, the anti-inverse detection unit comprises a photocoupling chip U**3** as well as relevant capacitors and resistors. An output port VCC**5** of the anti-inverse detection unit is connected to the output port VCC**5** of the power control unit for supplying power to the anti-inverse detection unit. A detecting port of the anti-inverse detection unit is connected to the positive voltage output port CAR+ for detecting whether a user has inversely connected the first and second wire clamps **21** and **22**. An output port P_VSN of the anti-inverse detection unit is connected to the 10^{th} pin of P_VSN of the control chip U**2** for delivering a level signal to the control chip U**2**.

When the first wire clamp **21** is normally connected to the external device **300**, the detecting port of the anti-inverse detection unit is a positive voltage. Correspondingly, a luminous diode in the photocoupling chip U**3** is not conductive, and the output port P_VSN of the anti-inverse detection unit will output a high level. When the first wire clamp **21** is inversely connected to the external device **300**, the detecting port of the anti-inverse detection unit is a negative voltage. Correspondingly, the luminous diode in the photocoupling chip U**3** will be conductive and luminous, and the output port P_VSN of the anti-inverse detection unit will output a low level.

If the 10^{th} pin of P_VSN of the control chip U**2** detects a low level, the wire clamps are proved to be inversely connected. Accordingly, the control chip U**2** will switch off the switch control unit K**1**, and the power supply from the external power supply **200** to the external device will be switched off as well. If the 10^{th} pin of P_VSN of the control chip U**2** detects a high level, the wire clamps are proved to be normally connected. Accordingly, the power supply from the external power supply **200** to the external device will be sustained.

In one embodiment of the present invention, the master-control circuit unit **128** further comprises an indicator light circuit unit, which is connected to the master-control chip unit **1281**. The indicator light circuit unit comprises two LED with different colors for indicating normal or abnormal conditions of the control device.

In one embodiment of the present invention, the master-control circuit unit **128** further comprises a buzzing circuit unit, which is connected to the master-control chip unit **1281**. The buzzing circuit unit mainly comprises a loudspeaker for alerting a user about abnormal conditions.

To sum up, a communication connection between the battery clamp **100** and the external power supply **200** can be built for obtaining status information of the external power supply **200**. The status information comprises temperature of battery units, or a voltage difference of any two of battery units of the external power supply. Meanwhile, the battery clamp **100** has functions of electric current or voltage detection and anti-inverse detection etc. Therefore, the battery clamp **100** can effectively solve the problems of a lithium battery in the external power supply **200** e.g. battery bulge or explosion resulted from improper uses.

Although the aforesaid embodiments are preferred in the present invention, none of them shall be regarded as a limitation. Any modifications, improvements, or equivalents within spirit or scope of the preset invention fall into the protection scope of the present invention.

What is claimed is:

1. A battery clamp for delivering an instantaneous starting current from an external power supply to an external device, the battery clamp comprising:

a control device, comprising:

a housing;

a master-control board mounted within the housing; [and

connectors disposed at one side of the housing, and being electrically connected to the master-control board, comprising:]

at least a first and second electrode connectors, which are *configured to be* connected to an external power supply for receiving power, and

at least one communication connector *configured to be* connected to the external power supply for receiving status information of the external power supply, and sending the status information to the master-control board; *and*

a first and second wire clamps, each having an end configured to receive power from the external power supply via the control device, and another end connected to the external device for supplying power to the external device;

wherein the control device is configured to control power supply from the external power supply to the external device based on the status information.

2. The battery clamp of claim **1**, wherein the control device is configured to allow the power supply from the external power supply to the external device when the status information is normal, wherein the status information comprises at least one of the following: temperature, voltage of a battery unit of the external power supply.

3. The battery clamp of claim **1**, wherein the master-control board comprises:

a first and second voltage input ports electrically connected to the first and second electrode connectors respectively;

a communication port electrically connected to the communication connector;

a first and second voltage output ports electrically connected to the first and second wire clamps for supplying power to the external device via the first and second wire clamps;

a switch control unit for controlling connection between the first voltage input port and the first voltage output port; and

a master-control circuit unit connected to the communication port for obtaining the status information of the external power supply;

wherein the master-control circuit unit is configured to control the switch control unit based on the status information of the external power supply, thereby controlling connection on/off between the first voltage input port and the first voltage output port.

4. The battery clamp of claim **3**, wherein the master-control circuit unit further comprises:

an electric current detection unit for detecting electric current from the external power supply to the external device;

a voltage detection unit for detecting voltage of the external power supply and the external device; and

wherein the master-control circuit unit is configured to compare the electric current value and the voltage value with a predefined electric current range and a predefined voltage range respectively, thereby controlling the switch control unit.

[**5**. The battery clamp of claim **4**, wherein the voltage detection unit comprises:

a first voltage detection unit for detecting voltage value of the external power supply; and

a second voltage detection unit for detecting voltage value of the external device.]

6. The battery clamp of claim **4**, wherein the master-control circuit unit further comprises:

an indicator light circuit unit connected to [the] *a* master-control chip unit for indicating operating status of the control device.

7. The battery clamp of claim **4**, wherein the master-control circuit unit further comprises:

a buzzing circuit unit connected to [the] *a* master-control chip unit for alerting users about abnormal condition.

[**8**. The battery clamp of claim **1**, wherein the communication connector is disposed between the first and second electrode connectors.]

[**9**. The battery clamp of claim **1**, wherein the housing comprises an upper piece and a lower piece, which are removably connected together, and the master-control board is mounted on the lower piece.]

[**10**. The battery clamp of claim **9**, wherein one side of the upper piece is provided with openings for indicator lights and buttons.]

11. The battery clamp of claim 4, wherein the predefined electric current range is from 0 A to about 600 A.

12. The battery clamp of claim 4, wherein the predefined voltage range is from about 8V to about 17V.

13. The battery clamp of claim 4, wherein the voltage detection unit comprises:

a first voltage detection unit for detecting voltage value of the external power supply; and

a second voltage detection unit for detecting voltage value of the external device.

14. The battery clamp of claim 1, wherein the communication connector is disposed between the first and second electrode connectors.

15. The battery clamp of claim 1, wherein the housing comprises an upper piece and a lower piece, which are removably connected together, and the master-control board is mounted on the lower piece.

16. The battery clamp of claim 15, wherein one side of the upper piece is provided with openings for indicator lights and buttons.

17. The battery clamp of claim 1, wherein the at least one communication connector comprises a wired connector.

18. The battery clamp of claim 17, wherein the wired connector comprises a series interface connector.

19. The battery clamp of claim 1, wherein the at least one communication connector comprises a wireless connector.

20. The battery clamp of claim 19, wherein the wireless connector comprises at least one of a Bluetooth connector, an NFC connector, and a Wi-Fi connector.

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