US009271420B1

(12) **United States Patent**
Hsiao et al.

(10) **Patent No.: US 9,271,420 B1**
(45) **Date of Patent: Feb. 23, 2016**

(54) **MODULAR POWER DEVICE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/882,208**

(22) Filed: **Oct. 13, 2015**

Related U.S. Application Data

(62) Division of application No. 13/647,385, filed on Oct. 9, 2012, now Pat. No. 9,198,319.

(30) **Foreign Application Priority Data**

Jul. 23, 2012 (TW) .... 101126470 A

(51) **Int. Cl.**
H05K 5/00 (2006.01)
H05K 7/08 (2006.01)
H05K 7/20 (2006.01)
H05K 7/02 (2006.01)

(52) **U.S. Cl.**
CPC ***H05K 7/08*** (2013.01); ***H05K 7/026*** (2013.01); ***H05K 7/2039*** (2013.01); ***H05K 7/2089*** (2013.01)

(58) **Field of Classification Search**
CPC H05K 1/18; H05K 7/1432
USPC 361/753, 783, 761
See application file for complete search history.

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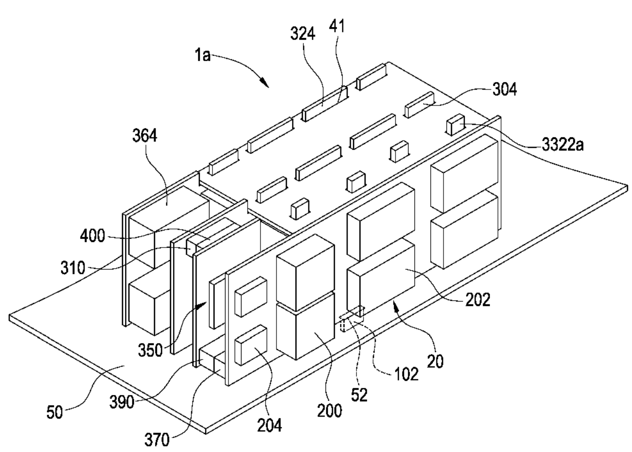
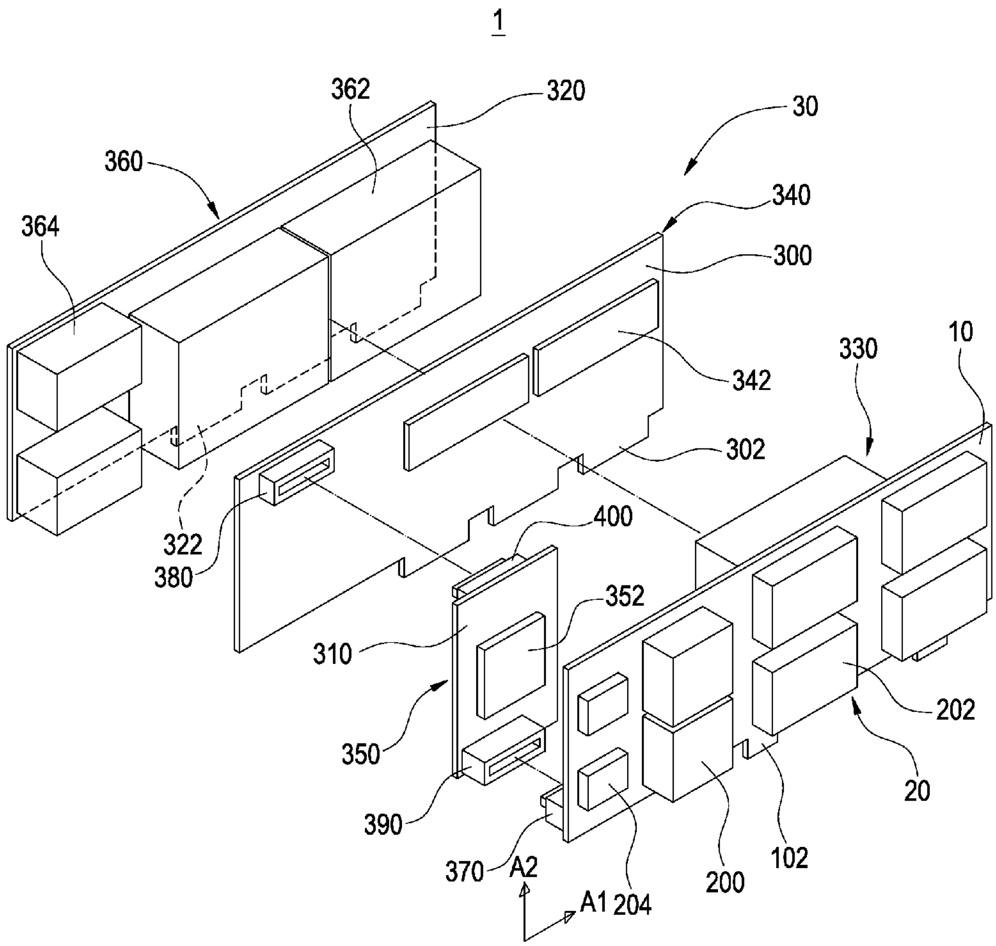
(57) **ABSTRACT**

A modular power device is used for mounting on a main plate. The modular power device includes a first substrate, a driving module, and a converting module. The first substrate has a first axial direction and a second axial direction perpendicular to the first axial direction. The driving module is located on one side of the first substrate, the converting module is located on the other side of the first substrate, and includes a second substrate parallel to the main plate, wherein two opposite sides of the first substrate are inserted into the main plate and the second substrate. A length of the converting module is equal to that of the first substrate in the first axial direction, and a width of the converting module is smaller than a length of the first substrate in the first axial direction.

4 Claims, 12 Drawing Sheets

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A2
A1
204
200

FIG.1

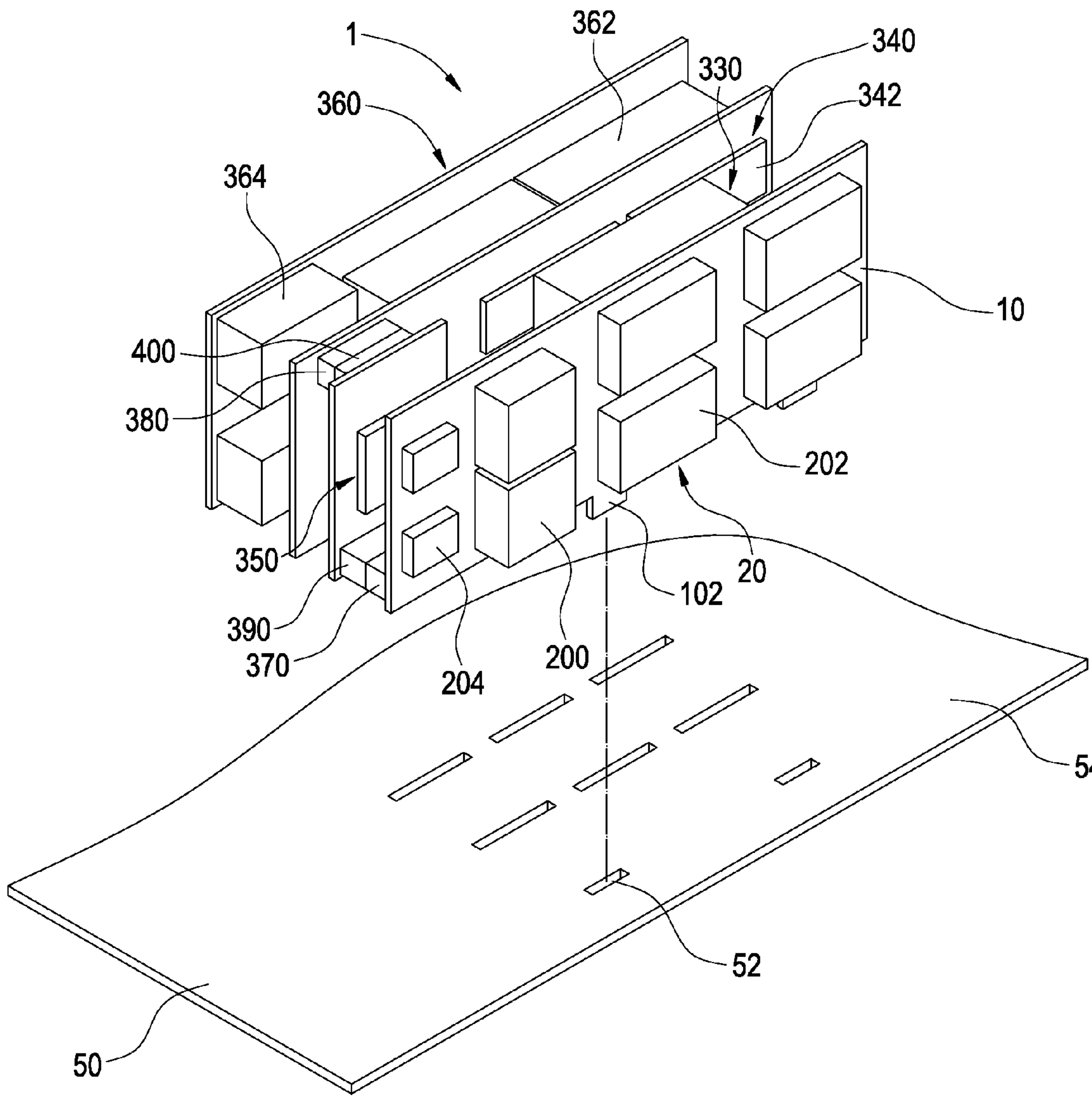
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FIG.2

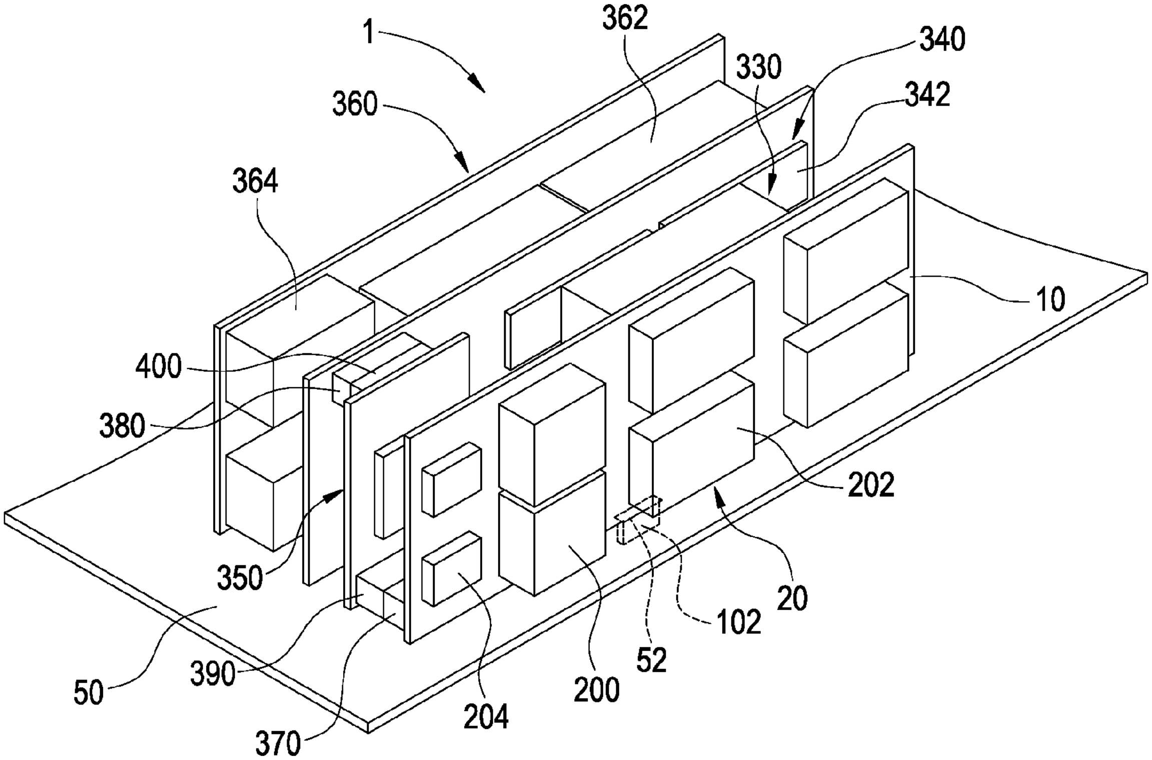
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FIG.3

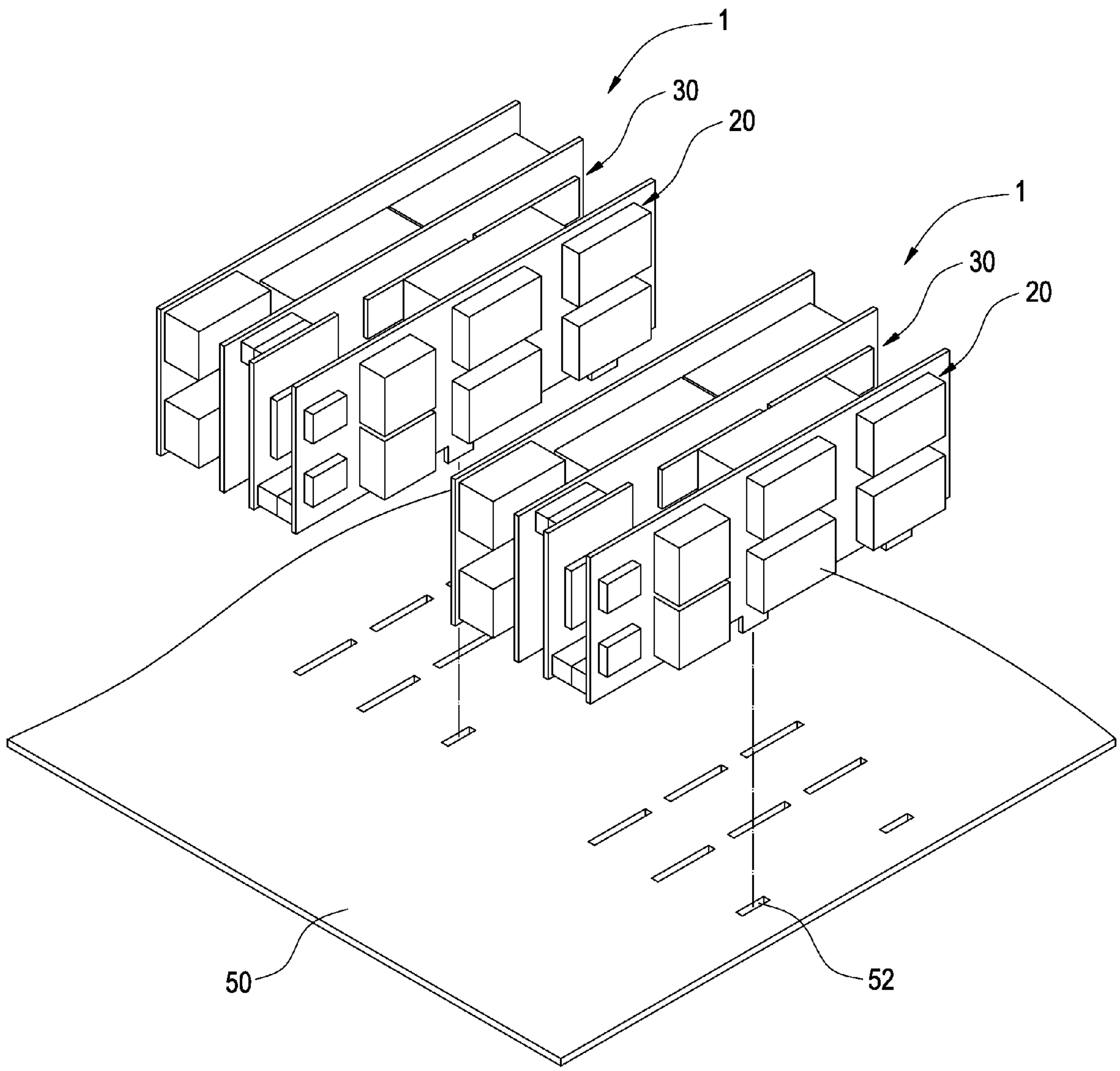
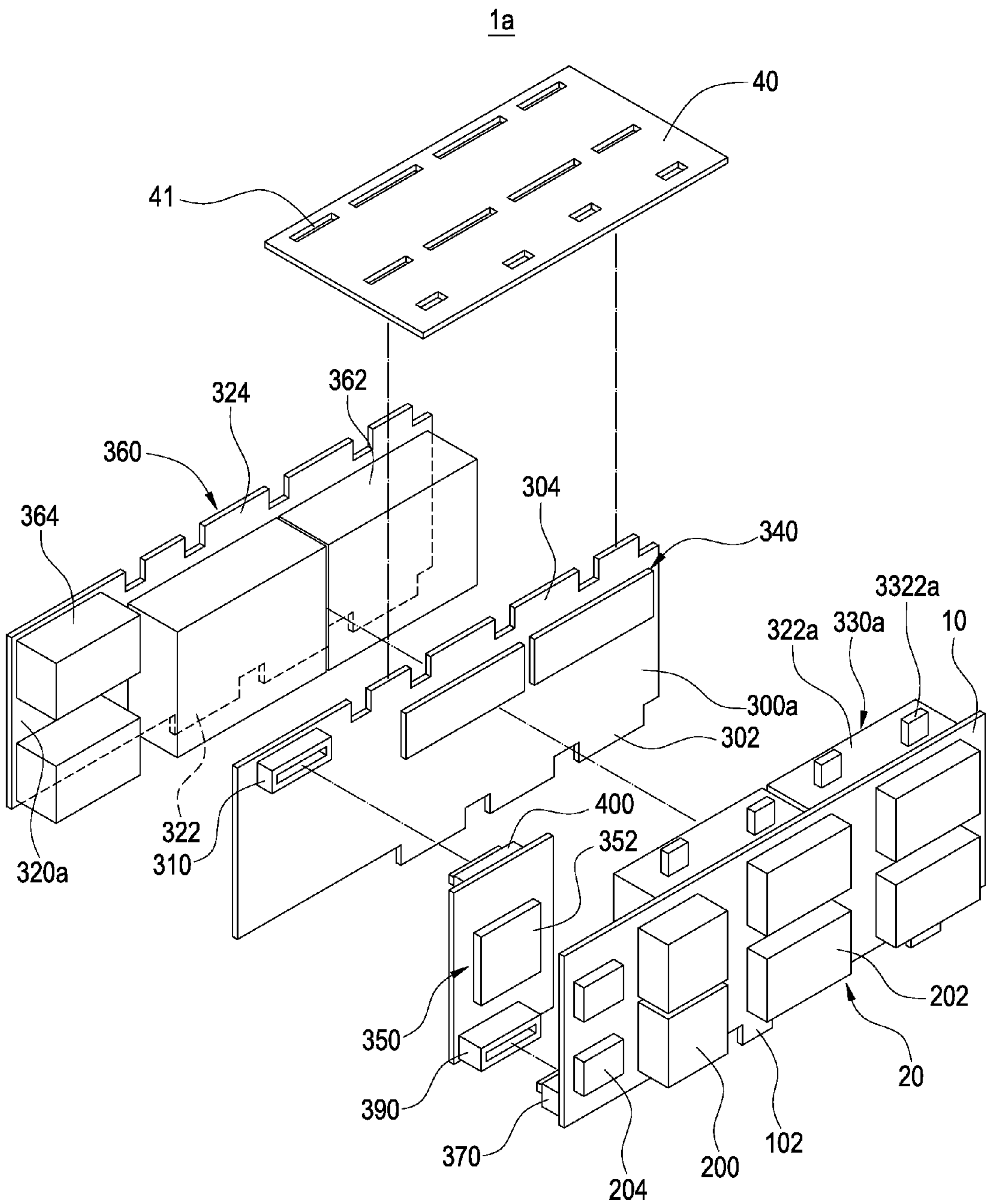


FIG.4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40
41
324
362
360
364
304
340
3322a
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320a
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202
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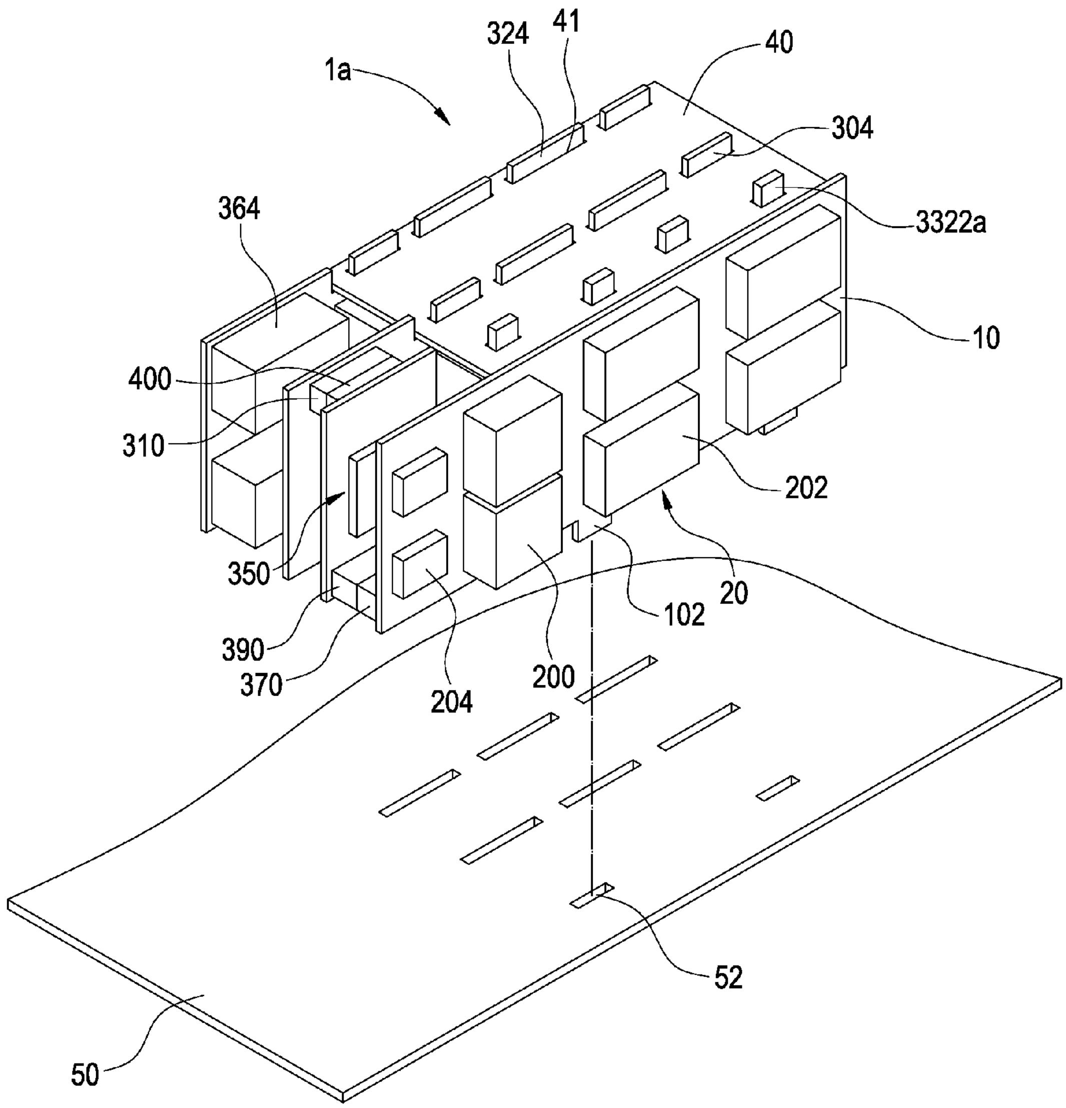
204

FIG.5



1a
324
41
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304
3322a
364
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400
310
202
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390
102
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204
52
50

FIG.6

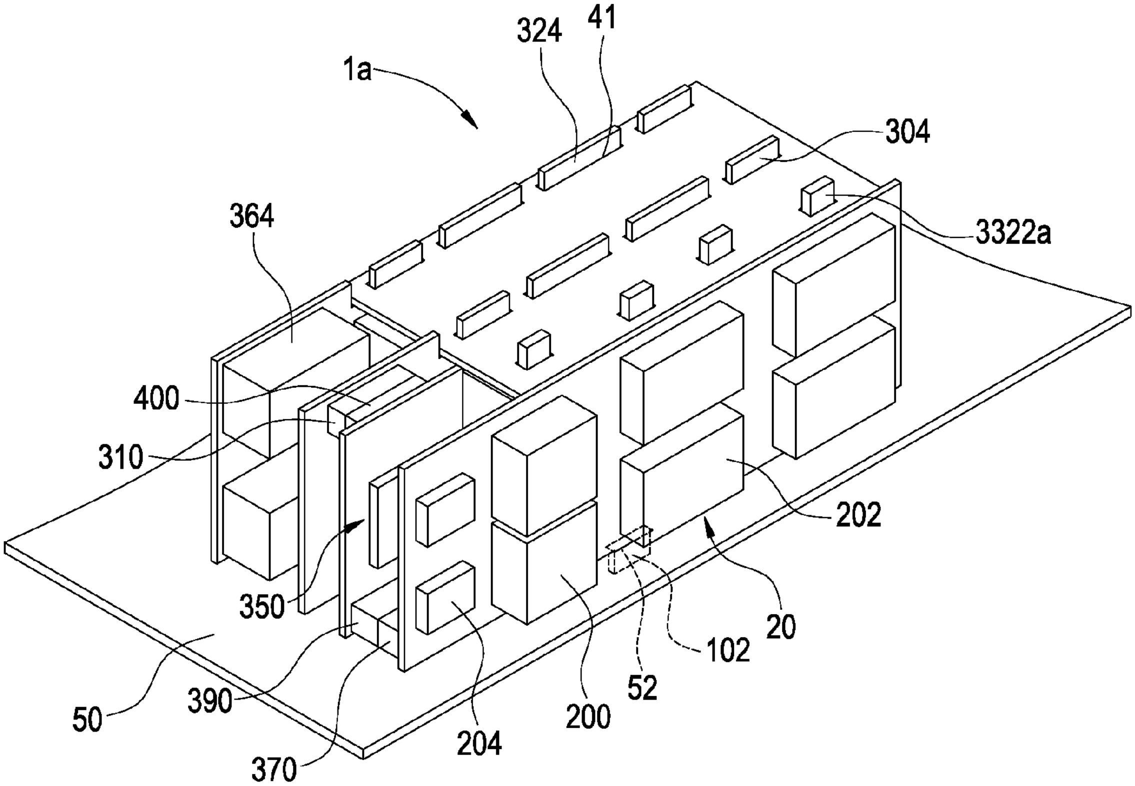
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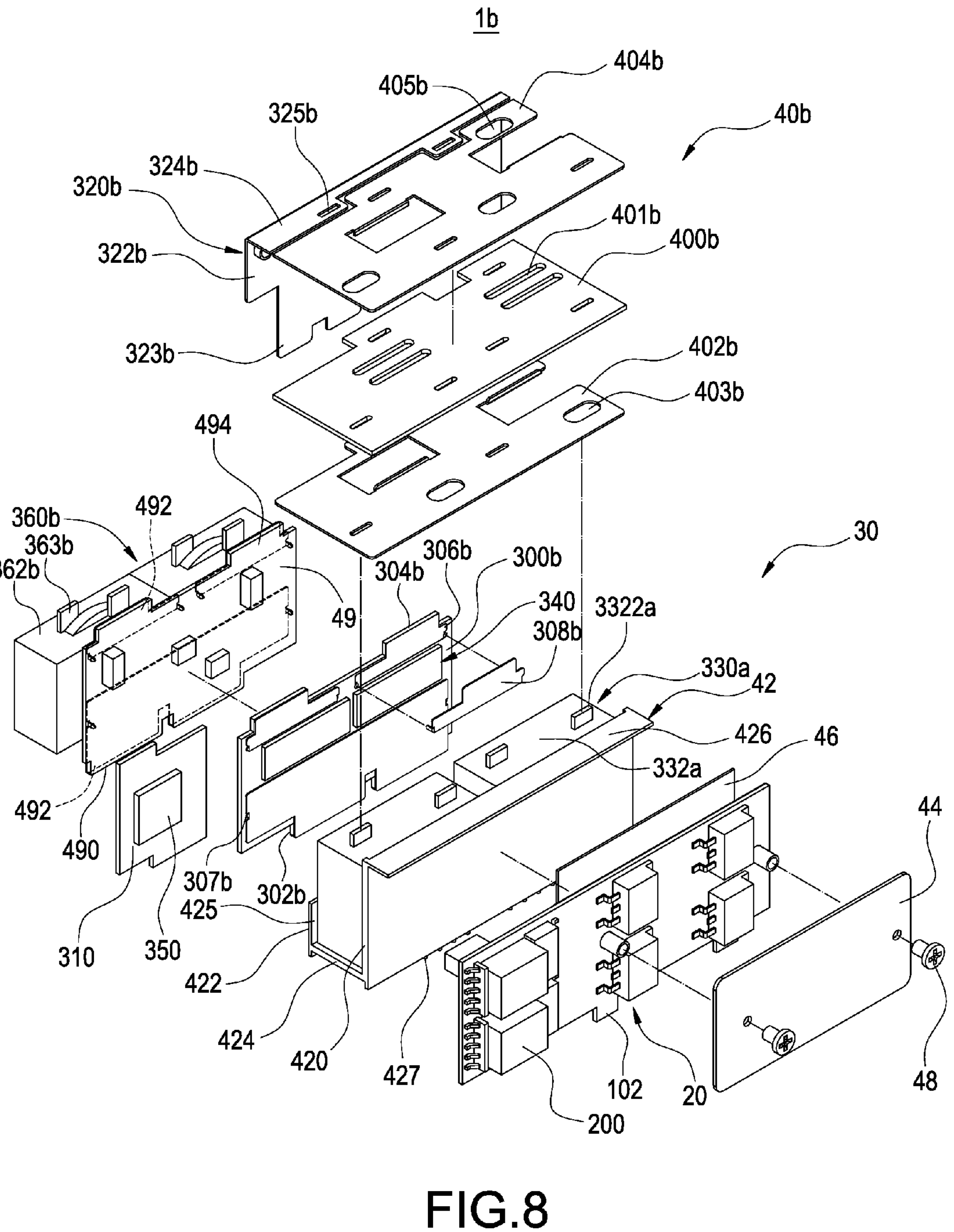
FIG.7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363b
362b
49
304b
306b
300b
340
3322a
308b
330a
42
426
46
332a
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307b
302b
425
310
350
422
424
420
427
102
20
48
200

FIG.8

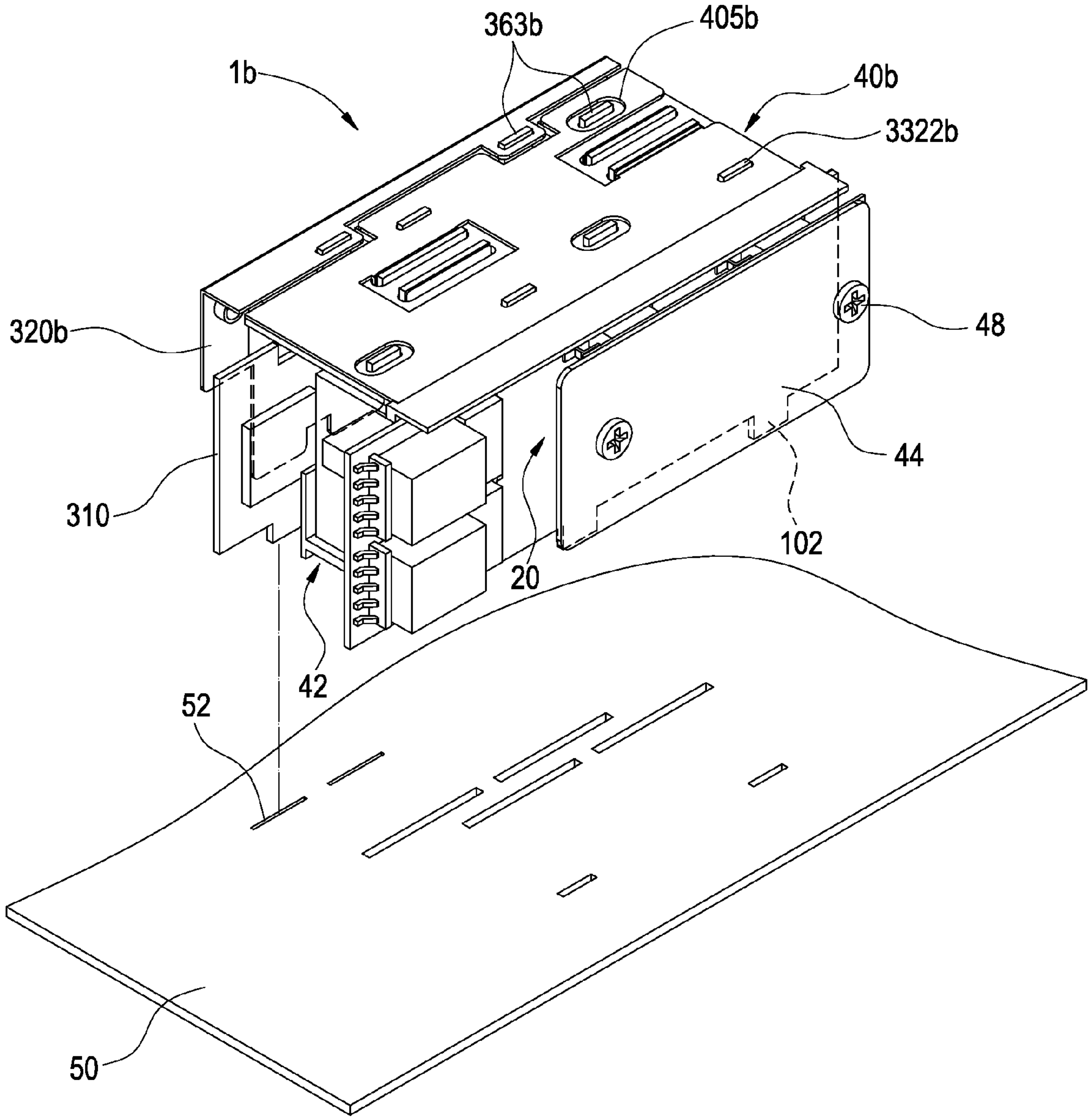
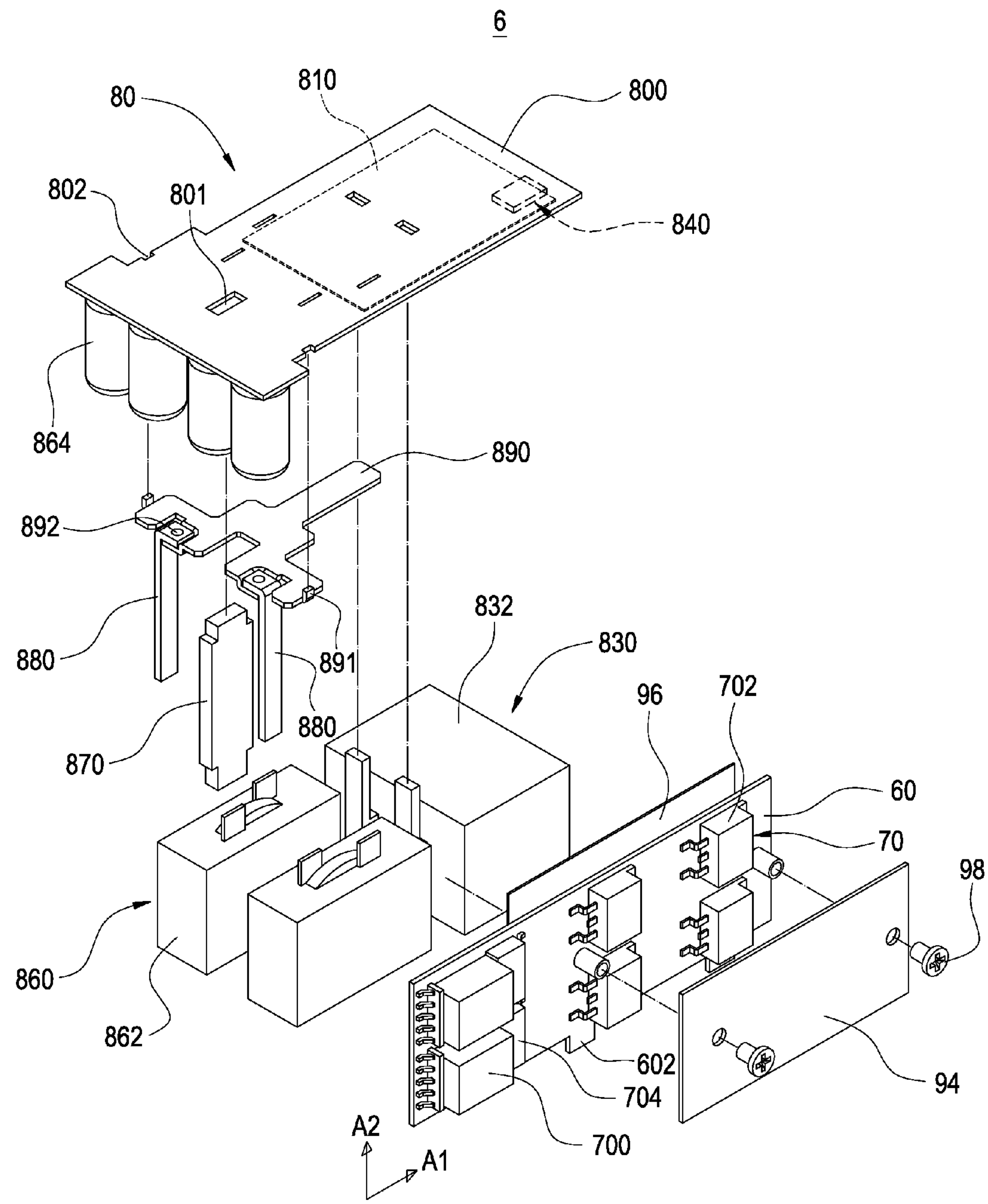


FIG.9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860
862
602
94
704
A2
A1
700

FIG.10

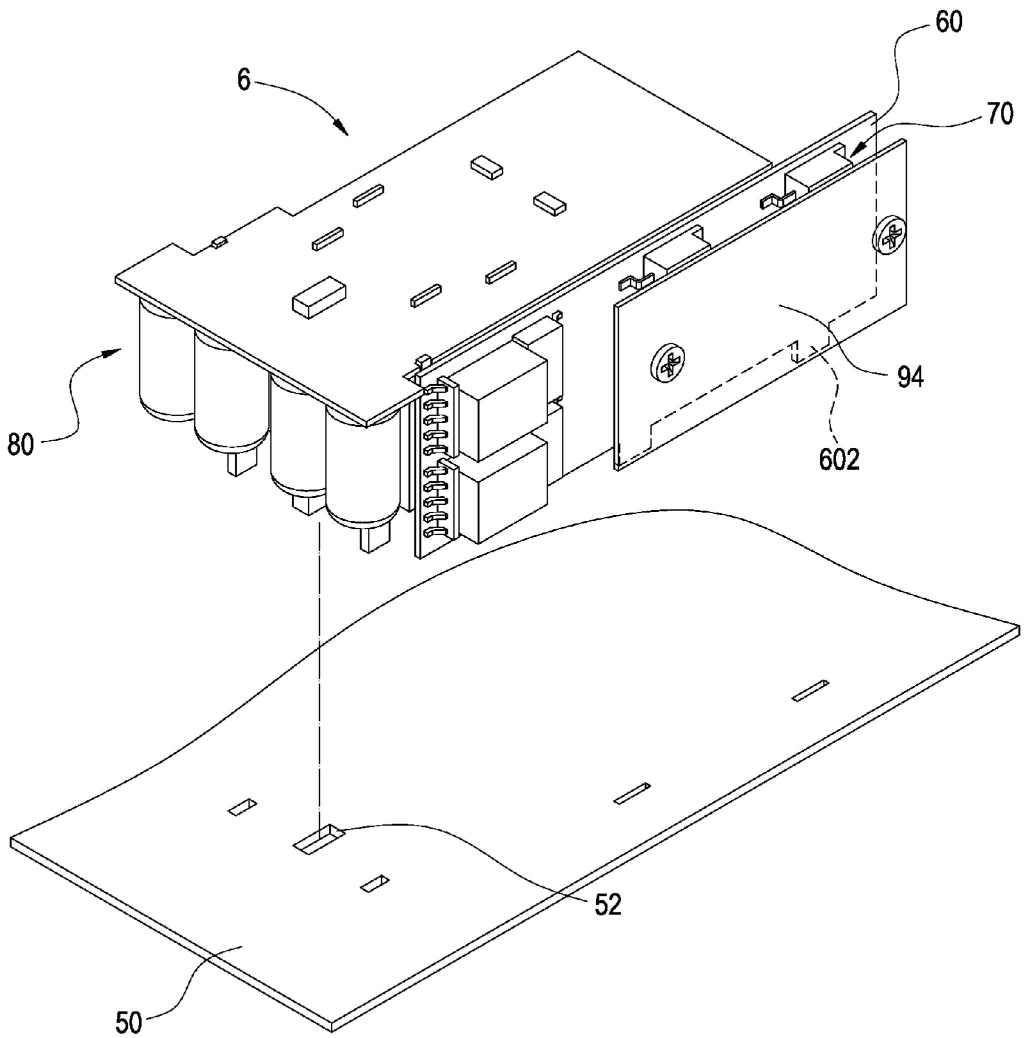

FIG.11

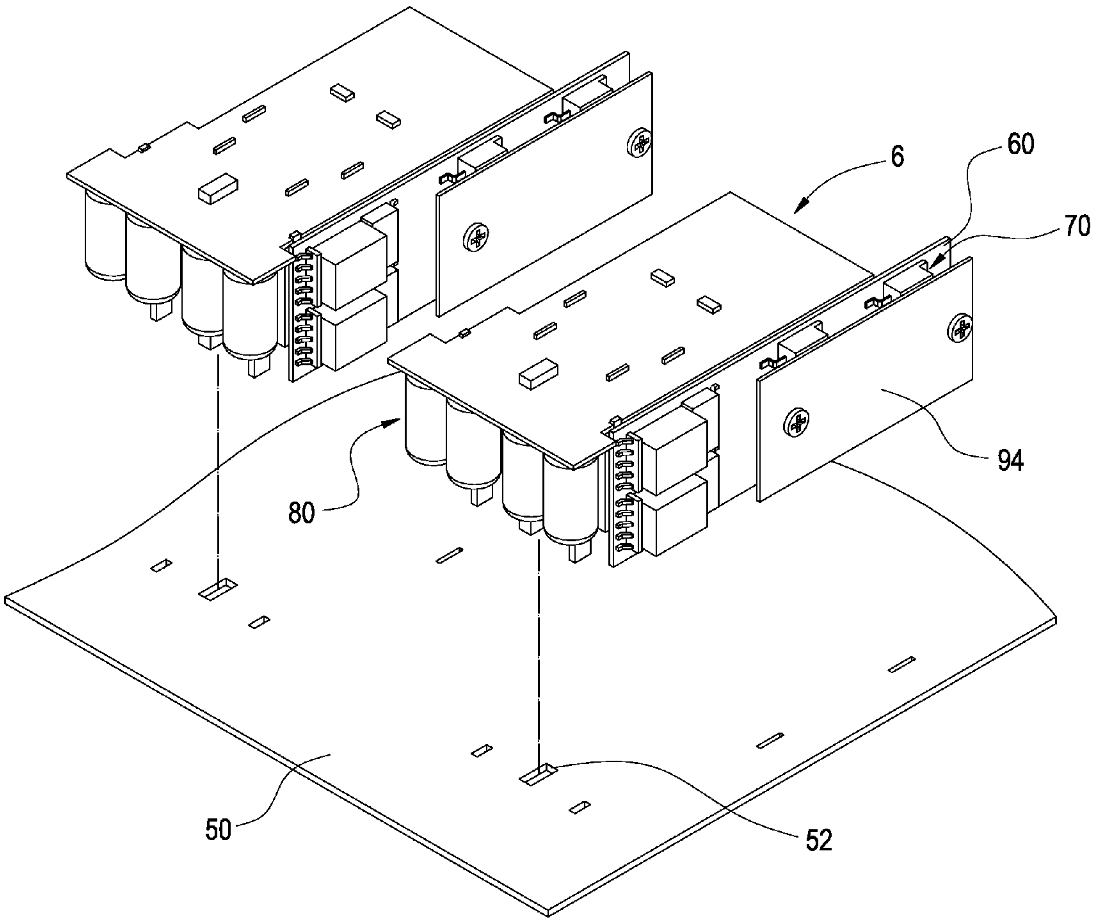

FIG.12

MODULAR POWER DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a division of application Ser. No. 13/647,385 filed on Oct. 9, 2012, which claims priority to Taiwan Application No. 101126470 filed Jul. 23, 2012. The entire disclosure is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a power device. More particularly, the present invention relates to a modular power device.

2. Description of Prior Art

Power supply devices are the essential components of industrial equipment, and are used for converting alternating current (AC) electric power into direct current (DC) electric power or providing functions of bucking or boosting. A conventional power supply device includes a flat circuit board, at least one converter and a plurality of electrical components. The converter and the electrical components are individually placed on the circuit board and electrically connected to thereto via traces formed on the circuit board.

While the demanded functions of industrial equipment increased, the internal devices which are disposed within the industrial equipment are increased accordingly. In order to sufficiently driving the internal devices, the output power of the power supply device must be increased simultaneously. When the outputting power of the power supply device is increased, the tolerance (such as rated working voltage) of the converter and the electronic components may also be increased. The volume of part of electronic component, such as capacitor, is direct proportion to the rated working voltage, namely, the larger rated working voltage and the greater volume. While the electronic components with greater volume are placed on the circuit board, will occupy a lot of space in the circuit board, this becomes the main reason of the high power supply system cannot miniaturization.

SUMMARY OF THE INVENTION

It is an object to provide a modular power device with small volume.

It is another object to provide a power system with the modular power device mentioned above.

According to one aspect of the present invention is used for mounted on a main plate. The module power device comprises a first substrate, a driving module and a converting module. The first substrate has a first axial direction and a second axial direction substantially perpendicular to the first axial direction. The first substrate is inserted into the main plate, such that the second axial direction of the first substrate is perpendicular to the main plate. The driving module is placed on one side of the first substrate and electrically connected to the first substrate. The converting module is located on the other side of the first substrate and electrically connected to the driving module. A length of the converting module is substantially equal to that of the first substrate in the first axial direction, and a width of the converting module is smaller than a length of the first substrate in the first axial direction. The converting module comprises a second substrate, a converting unit, a controlling unit, and an output unit. The second substrate is parallel to the main plate and the other side of the first substrate is inserted into the second substrate.

The converting unit is placed on the second substrate and is electrically connected to the second substrate. The controlling unit is placed on the second substrate and is electrically connected to the second substrate. The outputting unit is placed on the second substrate and is electrically connected to the second substrate.

In the present invention, the first substrate of the modular power device is directly inserted into the main plate and substantially perpendicular to the main plate. The driving module and the converting module are respectively located at two side of the first substrate, and the driving module is directly is placed on first substrate. Thereby, the volume of the modular power device can be substantially reduced, and prevent outputting electric power by interference from inputting electric power. Besides, the route for transmitting current is also reduced.

BRIEF DESCRIPTION OF DRAWING

The features of the invention believed to be novel are set fourth with particularity in the appended claims. The invention itself however may be best understood by reference to the following detailed description of the invention, which describes certain exemplary embodiments of the invention, taken in conjunction with the accompanying drawings in which:

FIG. **1** is a perspective view of a modular power device according to a first embodiment of the present invention.

FIG. **2** is a perspective view of a modular power device and a main plate according to a first embodiment of the present invention.

FIG. **3** is an assemble view of the modular power device and the main board according to the first embodiment of the present invention.

FIG. **4** is a perspective view of a power system according to a first embodiment of the present invention.

FIG. **5** is a perspective view of a modular power device according to a second embodiment of the present invention.

FIG. **6** is a perspective view of a modular power device and a main plate according to a second embodiment of the present invention.

FIG. **7** is an assemble view of the modular power device and the main plate according to the second embodiment of the present invention.

FIG. **8** is a perspective view of a modular power device according to a third embodiment of the present invention.

FIG. **9** is a perspective view of a modular power module and a main plate according to the third embodiment of the present invention.

FIG. **10** is a perspective view of a modular power module according to a fourth embodiment of the present invention.

FIG. **11** is a perspective view of a modular power device and a main plate according to the fourth embodiment of the present invention.

FIG. **12** is a perspective view of a power system according to a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

A preferred embodiment of the present invention will be described with reference to the drawings.

Referring to FIG. **1** to FIG. **3**, FIG. **1** is a perspective view of a modular power device according to a first embodiment of the present invention, FIG. **2** is a perspective view of a modular power module and a main plate according to a first embodiment of the present invention, and FIG. **3** is an assemble view of the module power device and the main plate according to the first embodiment of the present invention. The modular power device **1** is used for mounting on a main plate **50**. The main plate **50** has a plurality of grooves **52** for the modular power device **1** to be inserted therein. The main plate **50** may be a printed circuit board (PCB) or a substrate provided with conductive traces (not shown), and the substrate mentioned above may be copper substrate, aluminum substrate, ceramic substrate or other substrate with good thermal conductivity. However, the main plate **50** may also be combined PCB with copper slice or other material with good electrical conductivity.

The modular power device **1** includes a first substrate **10**, a driving module **20** and a converting module **30**. The driving module **20** is placed on one side of the first substrate **10** and electrically connected to the first substrate **10**. The converting module **30** is located on the other side of the first substrate **10** and electrically connected to the driving module **20**.

The first substrate **10** is a PCB or a substrate provided with conductive traces (not shown). In more particular, the substrate mentioned above may be copper substrate, aluminum substrate, ceramic substrate or other substrate with good thermal conductivity. However, the first substrate **10** may also be combined PCB with copper slice or other material with good electrical conductivity.

The first substrate **10** has a first axial direction **A1** and a second axial direction **A2** substantially perpendicular to the first axial direction **A1**. In this embodiment, the first axial direction **A1** is lengthwise direction of the first substrate **10**, and the second axial direction **A2** is widthwise direction of the first substrate **10**. The first substrate **10** is inserted into the main plate **50**, such that the second axial direction **A2** of the first substrate **10** is substantially perpendicular to a board **54** of the main plate **50**. An end of the first substrate **10** has at least one pillar **102**. The first substrate **10** can include one or more pillars **102**. As non-limiting examples, the first substrate **10** includes two pillars **102**. The pillars **102** are inserted into the grooves **52**, such that the first substrate **10** is substantially perpendicular to the main plate **50** and electrically connected thereto.

The driving module **20** is directly placed on the first substrate **10** and electrically connected thereto for receiving electric power inputting to the modular power device **10** and driving the modular power device **10**. The driving module **20** includes at least one converter **200**, at least one switching component **202** and a plurality of active or passive components **204**. The driving module **20** can include one or more converters **200** and switch components **202**, respectively. As a non-limiting example, the driving module **20** of the modular power device **1** includes two converters **200** and four switch components **202**. In preferably, each switch component **202** is metal-oxide-semiconductor field-effect transistor (MOSFET). The converters **200**, the switching components **202** and the active or passive components **204** collectively construct a driving circuit.

The converting module **30** receives voltage source outputted by the driving module **20** and provides a function of voltage converting for reducing voltage value of the voltage source. A length of the converting module **30** is substantially equal to that of the first substrate **10** in the first axial direction **A1**, and a width of the converting module **30** is smaller than a length of first substrate **10** in the first axial direction **A1**.

The converting module **30** includes a second substrate **300**, a third substrate **310**, a fourth substrate **320**, a converting unit **330**, a controlling unit **340**, a signal-transmitting unit **350**, an outputting unit **360**, a first connector **370**, a second connector **380**, a third connector **390** and a fourth connector **400**.

The converting unit **330** is placed on a board of the first substrate **10** (which is opposite to where the driving module **20** is disposed) and is used for receiving the electric power outputted by the driving module **20**. The converting unit **330** includes at least one converter **332** and multiple active or passive components (not shown) for collectively constructing a power modulating circuit.

The first connector **370** is mounted on the first substrate **10** which is the same side where the converting module **330** is placed, and electrically connected to the first substrate **10**.

The second substrate **300** may be a PCB or a substrate provided with conductive traces (not shown). In more particular, the substrate mentioned above may be copper substrate, aluminum substrate, ceramic substrate or other substrate with good thermal conductivity. However, the second substrate **300** may also be combined PCB with copper slice or other material with good electrical conductivity. In preferably, the second substrate **300** is multi-layer (more than or equal to two layers) circuit board. The second substrate **300** is inserted into the main plate **50** and electrically connected thereto, such that the second substrate **300** is parallel to the first substrate **10**. In addition, one end of the second substrate **300** has at least one pillar **302**. The second substrate **300** can include one or more pillars **302**. As a non-limiting example, the second substrate **300** includes two pillars **302**. The pillars **302** are inserted into the grooves **52**, such that the second substrate **300** is perpendicular to the main plate **50** and electrically connected thereto.

The controlling unit **340** is placed on the second substrate **300** and electrically connected thereto. The controlling unit **340** includes a plurality of controlling components **342**, which can be active or passive components, for collectively constructing a circuit with controllable function. However, the controlling components **342** can be an integrated circuit (IC) with function of control.

The second connector **380** is mounted on the second substrate **300** and electrically connected to the controlling unit **340**. In this embodiment, the second connector **380** is mounted on a lateral side of the second substrate **300** which is faced to where the first substrate **10** is disposed.

The third substrate **310** may be a PCB or a substrate provided with conductive traces (not shown). In more particular, the substrate mentioned above may be copper substrate, aluminum substrate, ceramic substrate or other substrate with good thermal conductivity. However, the third substrate **310** may also be combined PCB with copper slice or other material with good electrical conductivity. The third substrate **310** is disposed between the first substrate **10** and the second substrate **300**, and is parallel to the first substrate **10**. The signal-transmitting unit **350** including a plurality of electronic components **352** for constructing a signal-transmitting circuit is placed on the third substrate **310** and electrically connected thereto.

The third connector **390** is mounted on the third substrate **310** and electrically connected thereto. The third connector **390** is assembled with the first connector **370**, such that the signal-transmitting unit **350** is electrically connected to converting unit **330**.

The fourth connector **400** is mounted on the third substrate **310** and electrically connected thereto. The fourth connector **400** is assembled with the second connector **380**, such that the signal-transmitting unit **359** is electrically connected to the controlling unit **340**.

The fourth substrate **320** may be a PCB or a substrate provided with conductive traces (not shown. In more particular, the substrate mentioned above may be copper substrate, aluminum substrate, ceramic substrate or other substrate with good thermal conductivity. However, the fourth substrate **320** may also be combined PCB with copper slice or other material with good electrical conductivity. The fourth substrate **320** is disposed at one side of the second substrate **300** which is opposite to where the third substrate **310** is disposed, and is substantially parallel to the second substrate **300**. The fourth substrate **320** is inserted into the main plate **50** and electrically connected thereto. One end of the fourth substrate **320** includes at least one pillar **322**.

The fourth substrate **320** can includes one or more pillars **322**. As a non-limiting example, the fourth substrate **320** includes three pillars **322**. The pillars **322** are inserted into the grooves **52**, such that the fourth substrate **320** is perpendicular to the main plate **50** and electrically connected thereto.

The outputting unit **360** including at least one inductor **362** and at least one capacitor **364** is placed on the fourth substrate **320** and electrically connected thereto. The outputting unit **360** can includes one or more inductors **362** and capacitors **364**, respectively. As non-limiting example, the outputting unit **360** includes two inductors **362** and two capacitors **364**. The inductors **362** and the capacitors **364** are collectively constructing a π-type filter for stabilizing outputting current and reducing outputting noise.

In the practical application, the user can adjust the specifications (such as rated working voltage) of the driving module **20**, the converting unit **330**, the controlling unit **340**, the signal-transmitting unit **350** and the outputting unit **360** according to demanded outputting power, and the user can respectively insert the first substrate **10**, the second substrate **300**, the third substrate **310** and the fourth substrate **320** (where the driving module **20**, the converting unit **330**, the controlling unit **340**, the signal-transmitting unit **350** and the outputting unit **360** is disposed) into the main plate **50** and electrically connected to the main plate **50**, and then assemble the first connector **370** and the second connector **380** with the third connector **390** and the fourth connector **400**, respectively, such that the converting unit **330** can electrically connect to the controlling unit **340** via the signal-transmitting unit **350**. Therefore, the electric power inputting from the modular power device **1** can be converted into a demanded electric power, and outputted from the outputting unit **360**. For this result, the modular power device **1** has advantages of easily fabricating and easily modulating specifications.

To sum up, the modular power device **1** has advantage of small volume, and the arrangement of the modular power device **1** can effectively isolate the outputting unit **360** from the converting unit **330**, so as to reduce outputting power by interference from inputting power, and then stabilize outputting electric power. Besides, the space formed between each two substrate allows air flowing therethrough, such that the heat dissipating effect can be enhanced.

Reference is made to FIG. **4**, which is a perspective view of a power system according to a first embodiment of the present invention. The power system includes a main plate **50** and a plurality of modular power devices **1** mentioned above. The modular power devices **1** are mounted on the main plate **50** and electrically connected thereto. In this embodiment, the power system includes, for example, two modular power devices **1**, and the modular power devices **1** electrically connected in parallel are arranged in an alignment manner.

Therefore, when the power system is operated with light load, only one modular power device **1** is activated for reducing outputting electric power. When the power system is operated with heavy load, a plurality of modular power devices **1** are activated to increase outputting electric power. In addition, when activate more modular power devices **1**, the controlling units **340** of the modular power devices **1** can collectively construct the function of phase-shift, such that the effect of power system can be enhanced, and the outputting ripple current is reduced. For this result, the power system can achieve optimal efficiency wherever operating with light load or heavy load, and prevent the problem of pool efficiency of high power system as operating with light load.

Referring to FIG. **5** to FIG. **7**, FIG. **5** is a perspective view of a modular power device according to a second embodiment of the present invention, FIG. **6** is a perspective view of a modular power device and a main plate according to a second embodiment of the present invention, and FIG. **7** is an assemble view of the modular power device and the main plate according to the second embodiment of the present invention. The modular power device **1***a* is similar to the modular power device **1** mentioned above, and the same reference numbers are used in the drawings and the description to refer to the same parts.

The modular power device **1***a* further includes an intermediate plate **40**. The intermediate plate **40** may be a PCB or a substrate provided with conductive traces (not shown). In more particular, the substrate mentioned above may be copper substrate, aluminum substrate, ceramic substrate or other substrate with good thermal conductivity. However, the intermediate plate **40** may also be combined PCB with copper slice or other material with good thermal conductivity. A plurality of accommodating slots **41** are formed on the intermediate plate **40**.

In addition, one end the second substrate **300***a* which is opposite to where the pillars **302** are formed has at least one rib **304**. The second substrate **300***a* can includes one or more ribs **304**. As non-limited example, the second substrate **300***a* includes four ribs **304**. The ribs **304** are inserted into the accommodating slots **41** formed on the intermediate plate **40**, such that the second substrate **300***a* is substantially perpendicular to the intermediate plate **40** and electrically connected thereto.

One end of the fourth substrate **320***a* which is opposite to where the pillars **322** are formed has at least one rib **324**. The fourth substrate **320***a* can includes one or more ribs **324**. As non-limiting example, the fourth substrate **320***a* includes four ribs **324**. The ribs **324** are inserted into the accommodating slots **41**, such that the fourth substrate **320***a* is substantially perpendicular to the intermediate plate **320***a* and electrically connected thereto.

Each converter **332***a* of the converting unit **330***a* has at least one protrusion **3322***a*. The converter can include one or more protrusions **3322***a*. As non-limiting example, each converter **330***a* includes two protrusions **3322***a*. The protrusions **3322***a* are inserted into the accommodating slots **41** of the intermediate plate **40**, and then electrically connect the intermediate plate **40** and the converting unit **330***a*.

Thereby, the controlling unit **340** placed on the second substrate **300***a* and the outputting unit **360** placed on the fourth substrate **320***a* are electrically connected to the converting unit **330***a* and the driving module **20** via the main plate **50** and the intermediate plate **40**. Preferably, the potentials transmitted by the main plate **50** and the intermediate plate **40** are different in level.

The function and relative description of other components of the module power device **1***a* is the same as that of first embodiment mentioned above and are not repeated here, and the modular power device **1***a* can fulfill the functions as the modular power device **1** does.

Besides, a power system may be constructed by the main plate **50** and a plurality of modular power devices **1***a*. The arrangement of the modular power devices **1***a* is the same as the modular power devices **1** mentioned above and its description is not repeated here.

Referring to FIG. **8** and FIG. **9**, FIG. **8** is respectively a perspective view of a modular power device according to a third embodiment of the present invention, and FIG. **9** is an assemble view of a modular power device according to the third embodiment of the present invention. The modular power device **1***b* is similar to the modular power device **1***a* mentioned above, and the same reference numbers are used in the drawings and the description to refer to the same parts.

It should be noted that the second substrate **300***b* is a multi-layer circuit board and a plurality of engaging slots **306***b* are formed thereon for disposing a plurality of electric layers **308***a* therein. Preferably, a plurality of engaging parts **307***b* are respectively formed on a wall of each engaging slot **306***b* for fastening each electric layer **308***b*. Each electric layer **308***b* is made of capper or other material with good electrical conductivity and used as current transmitting routes.

The intermediate plate **40***b* includes a multi-layer circuit board **400***b*, a first metallic layer **402***b* and the second metallic layer **404***b*. Multiple through holes **401***b* are formed on the multi-layer circuit board **400***b*. The first metallic layer **402***b* and the second metallic layer **404***b* are made of copper or other material with good electrical conductivity and used as current transmitting routes.

The first metallic layer **402***b* is attached to a lower surface of the multi-layer circuit board **400***b*, and a plurality of first holes **403***b* corresponding to the through holes **401***b* are formed thereon. The second metallic layer **404***b* is attached to an upper surface of the multi-layer circuit board **400***b*, and a plurality of second holes **405***b* corresponding to the through holes **401***b* are formed thereon.

The protrusions **3322***a* of the converters **332***a* and the ribs **304***b* of the second substrate **300***b* are inserted into the through holes **401***b*, the first holes **403***b* and the second holes **405***b*, and electrically connected to the intermediate plate **40***b*.

The fourth substrate **320***a* includes a flat part **322***b* and a bent part **324***b*. The flat part **322***b* is parallel to the first substrate **10** and has a plurality of pillars **323***b* for inserting into the main plate **50**, such that the firth substrate **320***b* is electrically connected to the main plate **50**. The bent part **324***b* is substantially perpendicular to the flat part **322***b* and a plurality of openings **325***b* are formed thereon. A plurality of pins **363***b* of each inductor **362***b* of outputting unit **360***b* are inserted into the openings **325***b* of the fourth substrate **320***b*, the through holes **401***b* of the intermediate plate **40***b*, the first holes **403***b* and the second holes **405***b*, such that the fourth substrate **320***b* is electrically connected to the intermediate plate **40***b*.

The modular power device **1***b* further comprises a carrier **42**, a first isolating and thermal-dissipating board **44**, a second isolating and thermal-dissipating board **46**, a plurality of fixing component **48** and a fifth substrate **49**. The carrier **42** includes a first board **420**, a second board **422**, a connecting part **424** and a shoulder-part **426**. The first board **420** is disposed adjacent to the first substrate **10**, and the second board **422** is disposed adjacent to the second substrate **300***b*. In his embodiment, the first board **420** and the second board **422** are of rectangular shape, a length of the second board **422** is substantially equal to that of the first board **420**, and a width of the second board **422** is smaller than that of the first board **420**. The connecting part **424** is located at one end of the first board **420** and the second board **422** and connected thereof. The first board **420**, the second board **422** and the connecting part **424** collectively construct an accommodating space **425** for accommodating the converter **332***a* of the converting unit **330***a*, so as to prevent the converters **332***a* from electromagnetic interference produced by the converters **200** of the driving module **20**. The connecting part **424** further includes a plurality of supporting components **427** for inserting into the main plate **50**. The shoulder-part **426** is disposed on one end of the first board **420**, which is opposite to where the connecting part **424** is disposed, and extending toward a direction where the first substrate **10** is disposed for disposing the carrier **42** on the first substrate **10**. The first isolating and thermal-dissipating board **44** is disposed in one side of the first substrate **10**, the second isolating and thermal-dissipating board **46** is disposed on the other side of the first substrate **10**. The fixing component **48** penetrates the first isolating and thermal-dissipating board **44** and is fastened on the second isolating and thermal-dissipating board **46** so as to provide electromagnetic isolating effect and thermal-dissipating effect.

The fifth substrate **49** is disposed at one side of the second substrate **300***b* which is opposite to where the first substrate **10** is disposed. The fifth substrate **49** is a PCB or a substrate provided with conductive traces (not shown). In more particular, the substrate mentioned above may be copper substrate, aluminum substrate, ceramic substrate or other substrate with good thermal conductivity. However, the fifth substrate **49** may also be combined PCB with copper slice or other material with good thermal conductivity. Preferably, the fifth substrate **49** is multi-layer (more than or equal to two layers) circuit board. At least one pillar **490** is formed at one end of the fifth substrate **49**. The fifth substrate **49** can include one or more pillars **490**. As non-limiting example, the fifth substrate **49** includes two pillars **490**. The pillars **490** are inserted into the intermediate plate **40***b* and electrically connected thereto. At least one rib **494** formed on the other end of the fifth substrate **49** is inserted into the main plate **50** and electrically connected to the main plate **50**.

The fifth substrate **49** further includes at least one electric layer **492** for functioning as routes of current transmitting. The controlling unit **340** is simultaneously disposed on the second substrate **300***b* and the fifth substrate **49** and electrically connected thereto. For this result, the controlling elements of the controlling unit **340** can disposed with intervals for enhancing the effect of thermal-dissipation.

The function and relative description of other components of the module power device **1***b* is the same as that of second embodiment mentioned above and are not repeated here, and the modular power device **1***b* can fulfill the functions as the modular power device **1***a* does.

Besides, a power system may be constructed by the main plate **50** and a plurality of modular power devices **1***b*. The arrangement of the modular power devices **1***b* is the same as the modular power devices **1** mentioned above and the description thereof is not repeated here.

Referring to FIG. **10** and FIG. **11**, FIG. **9** is a perspective view of a modular power device and main plate according to a fourth embodiment of the present invention, and FIG. **10** is an assemble view of a modular power device and main plate according to the fourth embodiment of the present invention. The modular power device **6** is used for mounting on a main plate **50**. The main plate **50** has a plurality of grooves **52** through which the modular power device **6** is inserted therein. The main plate **50** may be a printed circuit board (PCB) or a substrate provided with conductive traces (not shown), and the substrate mentioned above may be copper substrate, aluminum substrate, ceramic substrate or other substrate with good thermal conductivity. However, the main plate **50** may also be combined PCB with copper slice or other material with good electrical conductivity.

The modular power device **6** includes a first substrate **60**, a driving module **70** and a converting module **80**. The converting module **70** is placed on one side of the first substrate **60** and electrically connected the first substrate **60**. The converting module **80** is located at the other side of the first substrate **60**, and electrically connected to the driving module **70**.

The first substrate **60** may be a (PCB) or a substrate provided with conductive traces (not shown), and the substrate mentioned above may be copper substrate, aluminum substrate, ceramic substrate or other substrate with good thermal conductivity. However, the first substrate **60** may also be combined PCB with copper slice or other material with good thermal conductivity. The first substrate **60** has a first axial direction A**1** and a second axial direction A**2** substantially perpendicular to the first axial direction A**1**. In this embodiment, the first axial direction A**1** is lengthwise direction of the first substrate **60**, and the second axial direction A**2** is widthwise direction of the first substrate **60**. The first substrate **60** is inserted into the main plate **50**, such that the second axial direction A**2** of the first substrate **60** is substantially perpendicular to a board **54** of the main plate **50**. An end of the first substrate **60** has at least one pillar **602**. The first substrate **60** can include one or more pillars **602**. As non-limiting examples, the first substrate **60** includes two pillars **602**. The pillars **602** are inserted into the grooves **52**, such that the first substrate **60** is substantially perpendicular to the main plate **50** and electrically connected thereto.

The driving module **70** is directly placed on the first substrate **60** and electrically connected thereto. The driving module **70** receives electric power inputting to the modular power device **6** and drives thereof. The driving module **70** includes at least one converter **700**, at least one switch **702** and a plurality of active and passive components **704**. The driving module **70** can include one or more converters **700** and switch components **702**, respectively. As a non-limiting example, the driving module **70** includes two converters **700** and four switches **702**, and each switch **702** is MOSFET. The converters **700**, the switches **702** and the active or passive components **704** collectively construct a driving circuit.

The converting module **80** receives voltage source passing through the driving module **70** and provides the function of voltage converting so as to reduce the voltage value of the voltage source. A length of the converting module **80** is substantially equal to that of the first substrate **60** in the first axial direction A**1**, and a width of the converting module is smaller than a length of the first substrate **60** in the first axial direction A**1**.

The converting module **80** includes a second substrate **800**, at least one conductive layer **810**, a converting unit **830**, a controlling unit **840**, an outputting unit **860**, a first connecting post **870**, two second connecting posts **880** and an electric layer **890**.

The second substrate **800** is disposed opposite to the main plate **50**. The second substrate **800** may be a PCB or a substrate provided with conductive traces (not shown), and the substrate mentioned above may be copper substrate, aluminum substrate, ceramic substrate or other substrate with good thermal conductivity. However, the second substrate **800** may also be combined PCB with copper slice or other material with good thermal conductivity. Preferably, the second substrate **800** is multi-layer (more than or equal to two layers) circuit board.

The conductive layer **810** is made of copper of other material with good electrical conductivity. The conductive layer **810** is attached to the second substrate **800** for functioning as route of current transmission. Preferably, a containing slot (not shown) is formed on the second substrate **800** for containing the conductive layer **810** and fastening the conductive layer **810**.

The converting unit **830**, the controlling unit **840** and the outputting unit **860** are placed on the second substrate **800** and electrically connected thereto. The converting unit **830** receives the power outputted by the driving module **70** and converts the outputted power into a demand voltage value. The converting unit **830** includes at least one converter **832** and a plurality of action or passive components (not shown). The converter **832** and the active or passive components collectively construct a voltage-converting circuit.

The controlling unit **840** is used for controlling the operating state of the modular power device **6**. The controlling unit **840** includes multiple controlling components for constructing a controlling circuit. However, the controlling unit **840** may be a integrate circuit (IC) with controlling function. The outputting unit **860** includes at least one inductor **862** and at least one capacitor **864**. The outputting unit **860** can include one or more inductors **862** and capacitors **864**, respectively. As non-limiting example, the outputting unit **860** includes two inductors **862** and four capacitors **864**. The inductors **862** and the capacitor **864** collectively construct a π-type filter for stabilizing outputting current and reducing outputting noise.

The first connecting post **870** is located between the main plate **50** and the second substrate **800**, and inserted into the grooves **52** of the main plate **50** and the through hole **801** of the second substrate **800**, and electrically connected to the main plate **50** and the second substrate **800**.

The electric layer **980** is made of copper of other material with good electrical conductivity. The electric layer **810** is attached to the second substrate **800** for providing connective path between the outputting unit **860** and the second substrate **800**, and then current can flow between the outputting unit **860** and the second substrate **800**. A plurality of buckles **891** are formed on the electric layer **980**, the buckles **891** are locked on a plurality of positioning slots **802** formed on the second substrate **800** for achieving the effect of position and enhancing the connecting strength of the electric layer **890** and the second substrate **800**. In this embodiment, the electric layer **890** is of T-shape. In the practical application, the profile of the electric layer **890** may be adjusted by demand.

The electric layer **890** is connected to each second post **880** through at least one connecting component **892**. The connecting component **892** is preferably rivet for riveting the electric layer **890** to one end of each second connecting post **880**, such that current can transmit between the electric layer **890** and the second connecting posts **880**. The other end of each second connecting post **880** is inserted into the groove **52** of the main plate **50** and electrically connected to the main plate **50**, such that electric power can transmit between the main plate **50** and the second substrate **800** via second connecting posts **880**. Preferably, the potentials transmitted by the second connecting posts **880** and the first connecting post **870** are different in level.

The modular power device **6** further comprises a first isolating and thermal-dissipating board **94**, a second isolating and thermal-dissipating board **96** and a plurality of fixing components **98**. The first isolating and thermal-dissipating board **94** is disposed in one side of the first substrate **60**, the second isolating and thermal-dissipating board **96** is disposed on the other side of the first substrate **60**. The fixing components **98** penetrate the first isolating and thermal-dissipating board **94** and fastened on the second isolating and thermal-dissipating board **96** so as to provide electromagnetic isolating and thermal-dissipating effect.

To sun up, the modular power device **6** has advantage of small volume and air can flow therein to enhance heat dissipating effect.

In the practical application, the user can adjust the specifications (such as rated working voltage) of the driving module **70**, the converting unit **830**, the controlling unit **840** and the outputting unit **860** according to demanded outputting power. Therefore, the electric power inputting from the modular power device **6** can be converted into a demanded electric power, and output from the outputting unit **860**. For this result, the modular power device **6** has advantages of easily fabricating and easily modulating specifications.

Reference is made to FIG. **12**, which is a perspective view of a power system according to a second embodiment of the present invention. The power system includes a main plate **50** and a plurality of modular power devices **6** mentioned above. The modular power devices **6** are mounted on the main plate **50** and electrically connected thereto. In this embodiment, the power system includes, for example, two modular power devices **6**, and the modular power devices **6** electrically connected in parallel are mounted on the main plate **50** in an alignment manner.

Therefore, when the power system is operated with light load, only one modular power device **6** is activated for reducing outputting electric power. When the power system is operated with heavy load, a plurality of modular power devices **6** are activated to increase outputting electric power. In addition, when activate more modular power devices **6**, the controlling units **840** of the modular power device **6** can collectively construct the function of phase-shift, such that the effect of power system can be enhanced, and the outputting current ripple can be reduced. For this result, the power system can achieve optimal efficiency wherever operating with light load or heavy load, and prevent the problem of pool efficiency of high power system as operating with light load.

Although the present invention has been described with reference to the foregoing preferred embodiment, it will be understood that the invention is not limited to the details thereof. Various equivalent variations and modifications can still occur to those skilled in this art in view of the teachings of the present invention. Thus, all such variations and equivalent modifications are also embraced within the scope of the invention as defined in the appended claims.

What is claimed is:

1. A modular power device is used for mounting on a main plate, the modular power device comprising:

a first substrate having a first axial direction and a second axial direction perpendicular to the first axial direction, one side of the first substrate inserted into the main plate, such that the second axial direction is perpendicular to the main plate;

a driving module placed on one side of the first substrate and electrically connected to the first substrate; and

a converting module located on the other side of the first substrate and electrically connected to the driving module; the converting module comprising:

a second substrate parallel to the main plate and the other side of the first substrate being inserted into the second substrate;

a converting unit placed on the second substrate and electrically connected to the second substrate;

a controlling unit placed on the second substrate and electrically connected to the second substrate; and

an outputting unit placed on the second substrate and electrically connected to the second substrate;

wherein a length of the converting module is substantially equal to that of the first substrate in the first axial, and a width of the converting module is smaller than a length of first axial direction of the first substrate.

2. The modular power device in claim **1**, further comprising a first connecting post inserted into the second substrate and the main plate for electrically connecting the second substrate and the main plate.

3. The modular power device in claim **2**, further comprising:

an electric layer attached to the second substrate and electrically connected to the outputting unit;

at least one second pillar located between the second substrate and the main plate; and

a connecting component for connecting the conductive layer and the second connecting post.

4. The modular power device in claim **1**, further comprising:

a first isolating and thermal-dissipating board disposed at one side of the first substrate;

a second isolating and thermal-dissipating board disposed at the other side of the first substrate; and

a plurality of fixing components penetrating the first isolating and thermal-dissipating board and fastened on the second isolating and thermal-dissipating board.

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