



US00RE47423E

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

(10) **Patent Number: US RE47,423 E**
(45) **Date of Reissued Patent: Jun. 4, 2019**

(54) **INTEGRATED POWER-CONVERTING MODULE**

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(21) Appl. No.: **15/704,007**

(Continued)

(22) Filed: **Sep. 14, 2017**

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Reissue of:

(64) Patent No.: **9,559,609**
Issued: **Jan. 31, 2017**
Appl. No.: **14/694,949**
Filed: **Apr. 23, 2015**

(57) **ABSTRACT**

(51) **Int. Cl.**
H02K 11/00 (2016.01)
H02M 1/14 (2006.01)
(Continued)

An integrated power-converting module includes a bobbin, a primary coil, a magnetic core assembly, and a plurality of power-converting units. The bobbin includes a main body, a plurality of winding portions and a plurality of receiving portions, and the winding portions and the receiving portion are arranged in a staggered manner. The primary coil is wound on the winding portions and the magnetic core assembly is assembled with the bobbin. Each power-converting unit includes a circuit board, a rectifier, and a filter, the rectifier and the filter are placed on a base portion of the circuit board and electrically connected thereto. An extending portion of the circuit board connect to the base portion is inserted into a slot formed within the receiving portion, and a penetrating hole formed on the extending portion is aligned with and communicated with a first channel formed on the main body.

(52) **U.S. Cl.**
CPC **H02M 7/08** (2013.01); **H02M 1/14** (2013.01); **H02M 3/28** (2013.01); **H02M 7/003** (2013.01); **H02M 2001/009** (2013.01)

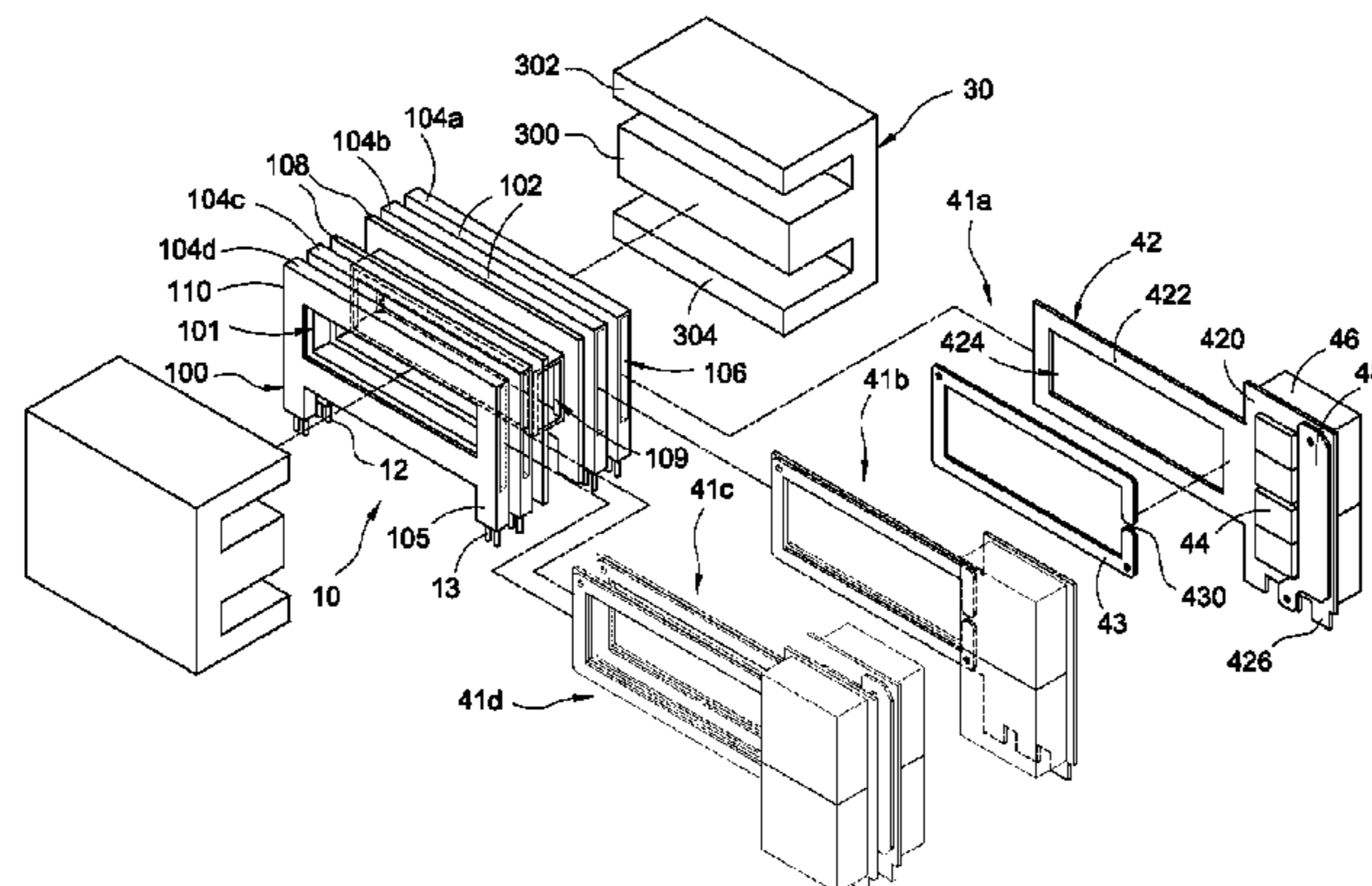
(58) **Field of Classification Search**
CPC H02M 7/08; H02M 1/14; H02M 7/003; H02M 3/28; H02M 2001/009
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9 Claims, 6 Drawing Sheets



- (51) **Int. Cl.**
H02M 7/08 (2006.01)
H02M 7/00 (2006.01)
H02M 3/28 (2006.01)
H02M 1/00 (2006.01)

- (58) **Field of Classification Search**
 USPC 310/71, 68 R, 68 D, 194, 201, 208;
 363/125, 126, 7, 15, 34, 21.06
 See application file for complete search history.

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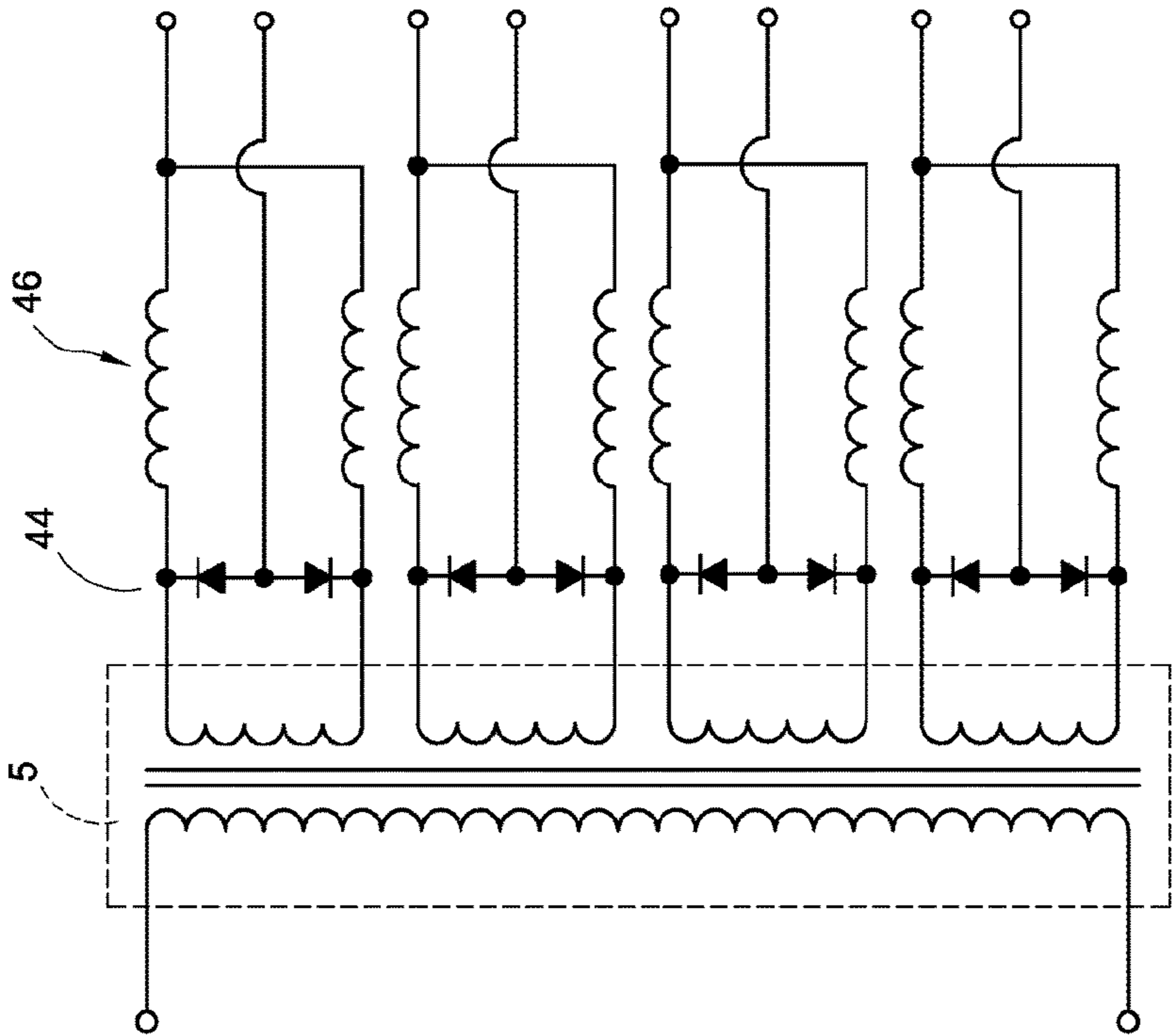


FIG.1

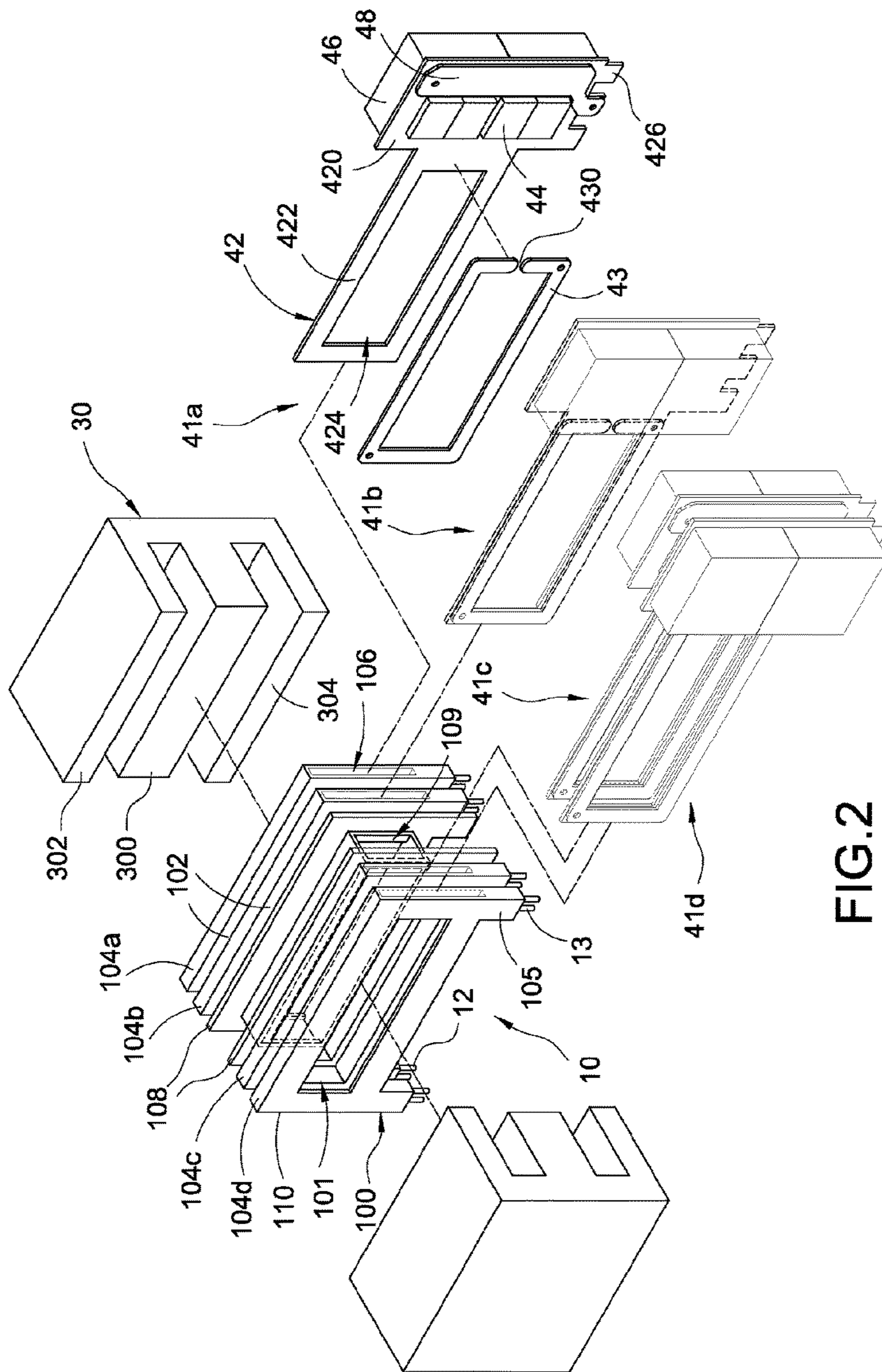


FIG. 2

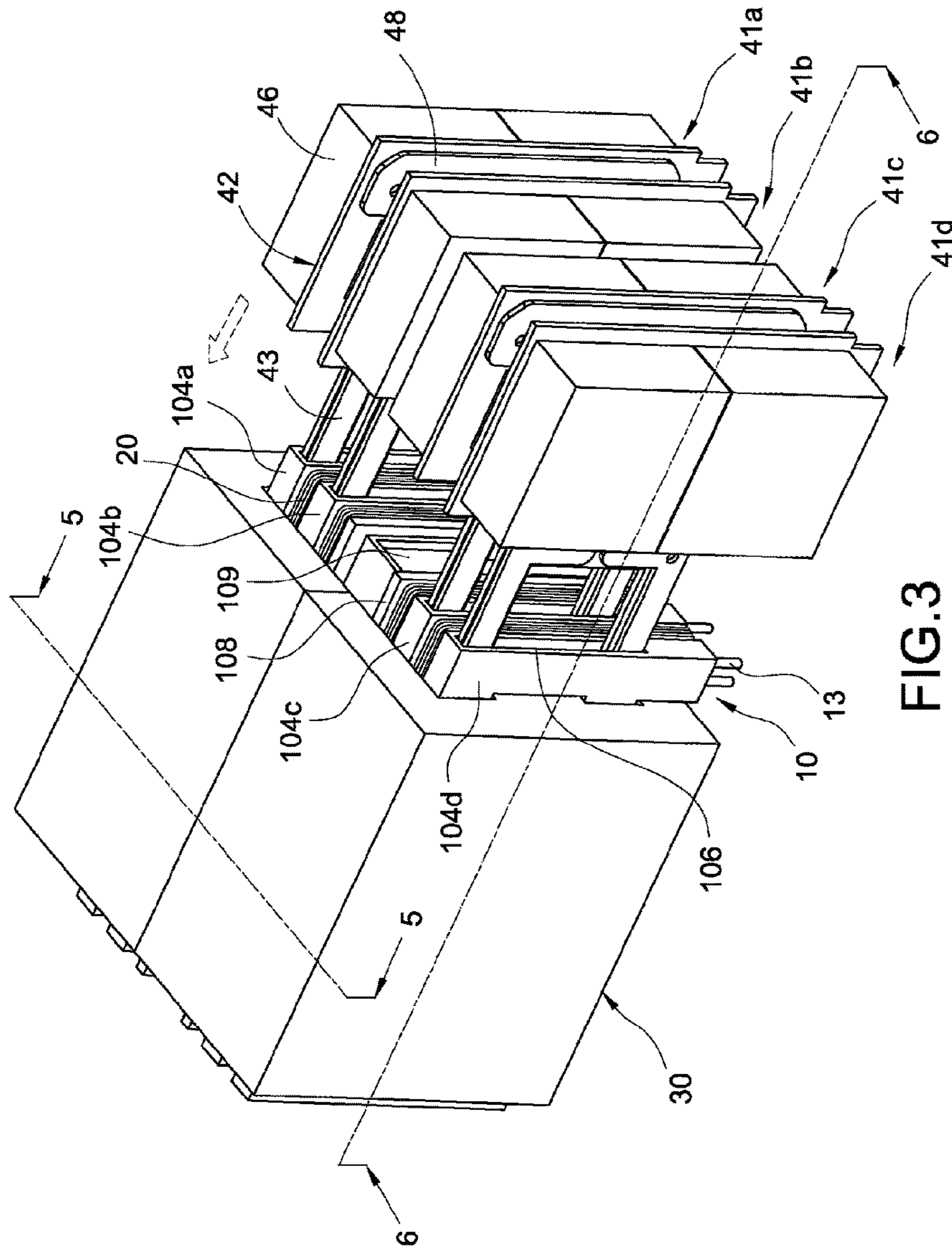


FIG.3

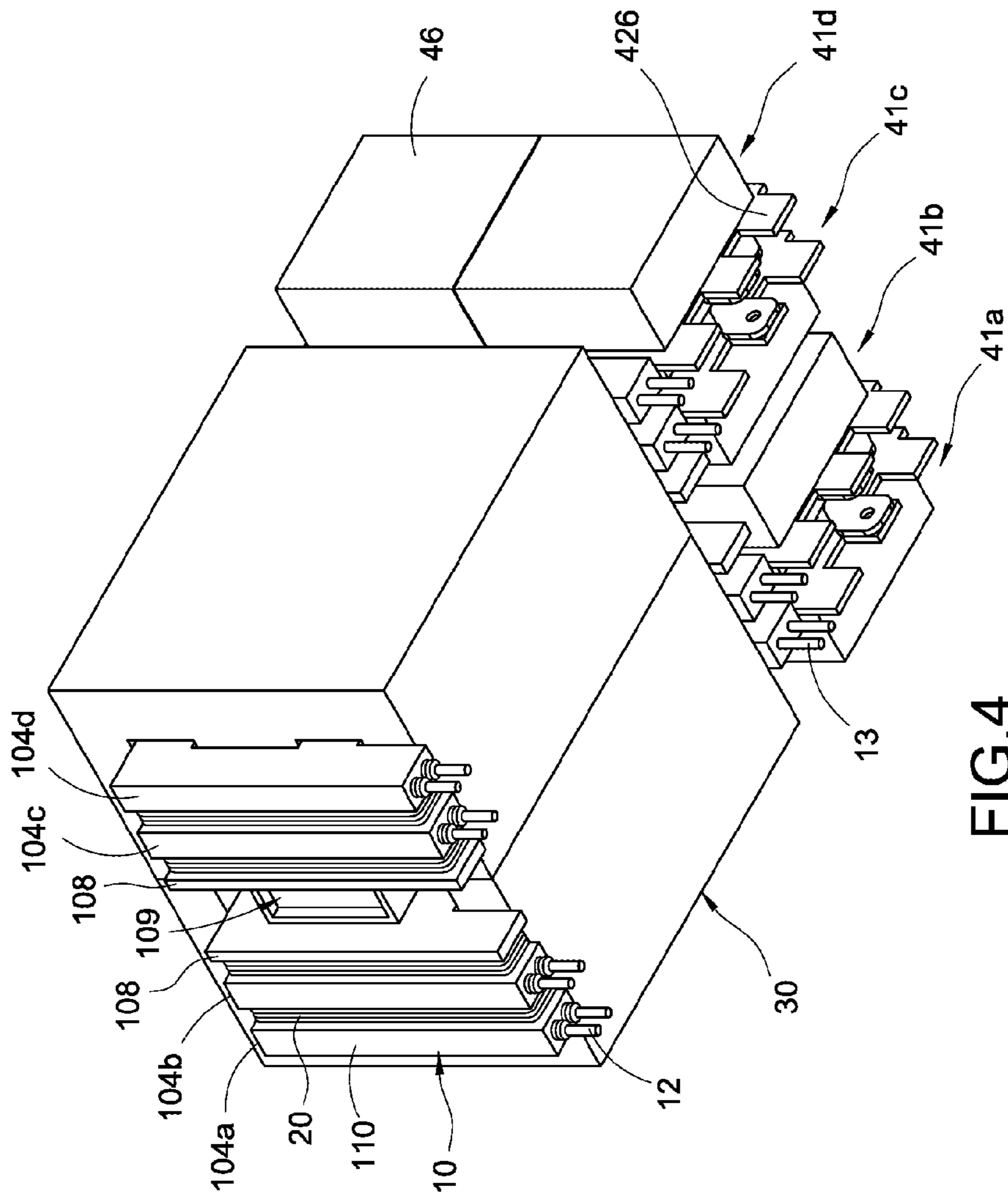


FIG. 4

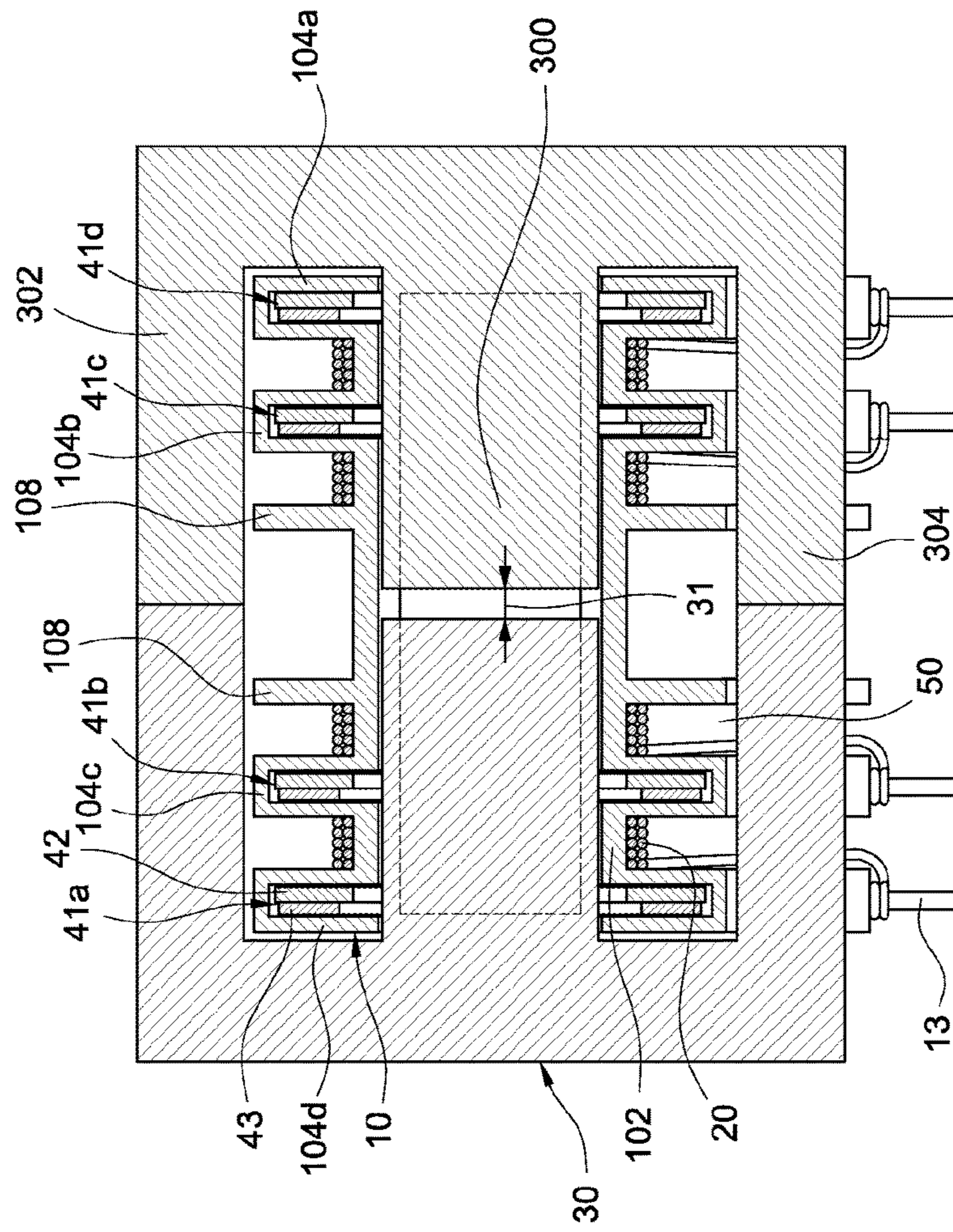


FIG. 5

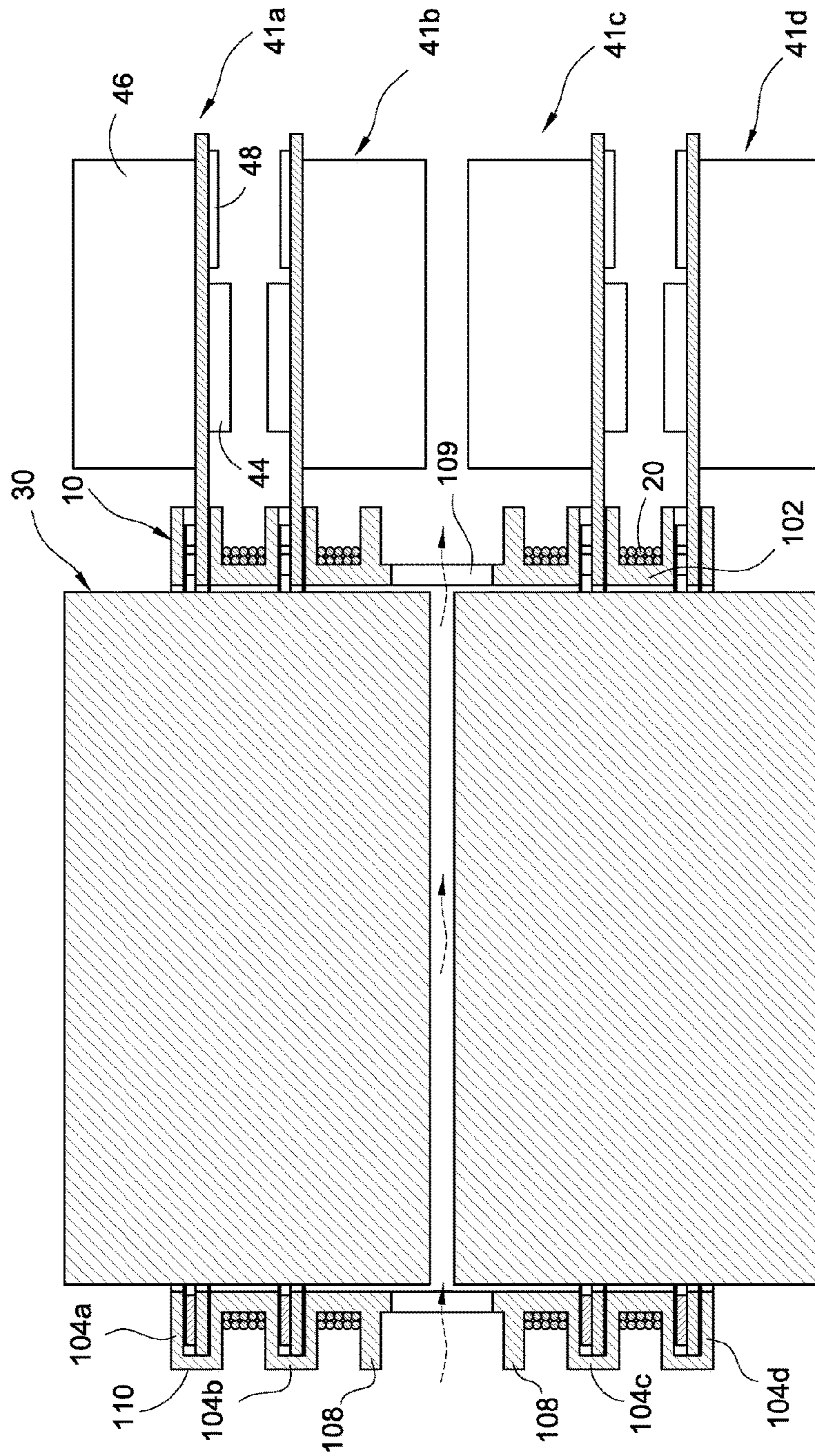


FIG.6

INTEGRATED POWER-CONVERTING MODULE

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.

This application is a reissue of the patent application Ser. No. 14/694,949, now U.S. Pat. No. 9,559,609.

BACKGROUND OF THE INVENTION

Field of the Invention

The present disclosure relates to a power-converting module. More particularly, the present disclosure relates to an integrated power-converting module.

Description of Related Art

Electric power is used in almost all electronic devices, and it is the core and can affect performance thereof.

The demands for electric power follow the trend towards downsizing, high efficiency, and lower cost as energy saving and carbon reduction keeps promoting. A conventional power converter includes a flat circuit board, at least one transformer, and a plurality of electrical components, and the converter and the electrical components are individually placed on the circuit board for electrically connecting each other via traces formed on the circuit board. In such manner, the transformer and electrical components occupy a lot of space in the circuit board, this becomes the main obstacle of the high power converter to achieve miniaturization. Therefore, there is a need of providing an integrated power-converter in order to obviate the drawbacks encountered in the prior art.

SUMMARY OF THE INVENTION

According to one aspect of the present invention, an integrated power-converting module electrically connected to a direct current (DC) electric power includes a bobbin, at least one primary coil, a magnetic core assembly, and a plurality of power-converting units. The bobbin includes a main body, a plurality of winding portions, and a plurality of receiving portions. The main body includes a channel, and the winding portions and the receiving portions are respectively connected to the main body and arranged in a stagger manner. Each of the receiving portions has a slot communicating with the first channel. The primary winding is wound on the winding portions. The magnetic core assembly is assembled with the bobbin and partially received in the first channel.

The power-converting units are arranged in a parallel manner, and each of the power-converting units includes a circuit board, a rectifier, and a filter. The circuit board has a base portion and an extending portion connected to the base portion and including a penetrating hole. When the extending portion is inserted into the slot, the penetrating hole is aligned with the first channel and communicating therewith. The circuit board has two opposite surfaces, the rectifier is placed on one of the surfaces and electrically connected to the circuit board, and the filter is placed on the other surface of the circuit board and electrically connected to the rectifier.

When the DC electric power is conducted to the integrated power-converting module, the magnetic core assembly generates electromagnetic induction with the primary coil and the copper foils or electrically conductive sheets placed on the extending portions of the circuit boards, so that the copper foils or electrically conductive sheets respectively generate an outputting voltage.

BRIEF DESCRIPTION OF DRAWING

The features of the invention believed to be novel are set forth 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 an exemplary embodiment of the invention, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a circuit diagram of an integrated power-converting module according to the present invention;

FIG. 2 is an exploded view of the integrated power-converting module according to the present invention;

FIG. 3 is a partially assembled view of the integrated power-converting module according to the present invention;

FIG. 4 is an assembled view of the integrated power-converting module according to the present invention;

FIG. 5 is a sectional view of the integrated power-converting module along line 5-5 shown in FIG. 3.

FIG. 6 is a sectional view of the integrated power-converting module along line 6-6 shown in FIG. 3.

DETAILED DESCRIPTION OF THE INVENTION

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

Reference is made to FIG. 1, which is a circuit diagram of an integrated power-converting module according to the present invention. The integrated power-converting module having functions of changing voltage, rectification, and filtration, and includes a transformer 5, a plurality of rectifiers 44, and a plurality of filter 46. The rectifier 44 and the filters 46 are electrically connected to a secondary side of the transformer 5. The rectifier 44 receives the converted electric power outputted from the secondary side of the transformer 5 and converts the converted electric power from alternative current (AC), which periodically reverse direction, to direct current (DC), which flow in only one direction. The filter 46 is configured to remove the unwanted AC components (or called ripple) of the rectifier 44 output, thus the integrated power-converting module can output a smooth and steady DC.

Reference is made to FIG. 2 and FIG. 3, which are respectively an exploded view and an assembled view of the integrated power-converting module according to the present invention. The integrated power-converting module includes a bobbin 10, at least one primary coil 20, a magnetic core assembly 30, and a plurality of power-converting units 41a~41d.

The bobbin 10 includes a main body 100, a plurality of winding portions 102, and a plurality of receiving portions 104a~104d. The main body 100 includes a first channel 101. The amount of the receiving portions 104a~104b is the same as that of the winding portions 102. The receiving portions 104a~104d are arranged in a parallel manner, and the winding portions 102 and the receiving portions 104a~104d are arranged in a stagger manner.

The main body **100** further includes a second channel **109** communicating with the first channel **101** and substantially perpendicular thereto.

The bobbin **10** of the present invention includes four receiving portions **104a~104d** arranged at two opposite sides of the second channel **109**. In particular, the receiving portions **104a** and **104b** are arranged at one side of the second channel **109**, and the receiving portions **104c** and **104d** are arranged at the other side thereof. The winding portions **102** also arranged at the opposite sides of the second channel **109**, and the winding portions **102** and the receiving portions **104a~104d** are arranged in staggered manner.

Each of the receiving portions **104a~104d** including a slot **106** communicating with the first channel **101** and a sidewall **110** disposed opposite to the power-converting units **41a~41d** and enclose the slot **106**.

Each of the receiving portions **104a~104d** further includes two protrusions **105** arranged on the bottom and far away from each other. An extending direction of the protrusions **105** is substantially perpendicular to the opening direction of the slots **106**. The power-converting module further includes a plurality of electrically conductive terminals **12** and a plurality of fixing members **13**, the electrically conductive terminals **12** are connected to the protrusions **105** far away from the power-converting units **41a~41b**, and the fixing members **13** are connected to the protrusions **105** close to the power-converting units **41a~41d**.

The primary coil **20** is electrically connected to the electrically conductive terminals **12** and is wound on the winding portions **102** in S-shaped, and initial end of the primary coil **20** is connected to one of the electrically connective terminal **12**, and a terminal end of the primary coil **20** is connected to the other electrically connected terminal **12**, as shown in FIG. 3. The primary coil **20** is a primary winding of the integrated power-converting module.

The main body **100** further includes a plurality of spacers **108** arranged between the second channel **109** and the receiving portions **104b** and **104c** close to the second channel **109** for spacing the second channel **109** and the receiving portions **104b** and **104c**.

The magnetic core assembly **30** is assembled with the bobbin **102** and partially inserted into the first channel **101**. The magnetic core **30** can be assembled by two E-shaped magnetic cores, and each magnetic core includes a central leg **300** and two lateral legs **302** and **304** arranged at two opposite sides of the central leg **300** and connected thereto. When the magnetic core assembly **30** is assembled with the bobbin **102**, the top surfaces of the lateral leg **302** and **304** are contacted with each other, the central leg **300** is received within the first channel **101**, and an air gap **31** is formed between the top surface of the central legs **300** and within the second channel **109**, as shown in FIG. 5, and then an effect of energy storage is achieved. It should be noted that if the primary coil **20** does not wind on above the air gap **31**, an eddy current loss can then be effectively reduce.

Besides, when the magnetic core assembly **30** is assembled with the bobbin **102**, there are air passages **50** allowing vapor flowing therethrough exist, and the air passages **50** are formed between the lateral lags **302** and **304** of each of the magnetic core and the main body **100**. Thus the integrated power-converting module has a good thermal dissipating effect.

The power-converting units **41a~41d** are arranged in a parallel manner and each of the power-converting units **41a~41d** includes a circuit board **42**, a rectifier **44**, and a filter **46**.

The circuit board **42** includes a base portion **420** and an extending portion **422** connected to the base portion **420**. The base portion **420** and the extending portion **422** are both placed with copper foil, and an electrically connected sheet **43** is placed on the extending portion **422** and attached to the copper foil formed thereon, thus the electrically conductive sheet **43**, the rectifier **44**, and the filter **46** can be electrically connected to each other. As shown in the FIG. 2, a profile of the base portion **420** is substantially of rectangular, and a plurality of connecting terminals **426** are connected to the bottom of each of the base portions **420**.

A penetrating hole **424** is formed on the extending portion **422** so that a profile of the extending portion **422** is ring shape and corresponding to that of the receiving portions **104a~104d**, and when the extending portions **422** are inserted into the receiving portions **104a~104d**, the penetrating hole **424** of each extending portion **422** is aligned with and communicating with the first channel **101**. The extending portions **422** are configured to transit alternative current to the rectifiers **44**.

The power-converting unit **41a~41d** can further includes the electrically conductive sheets **43** placed on each of the extending portions **423** and attached on the copper foil. A profile of the electrically conductive sheet **43** is corresponding to that of the extending portion **423** and has an opening **430**, thus the electrically conductive sheets **43** is of C-shaped. The electrically conductive sheets **43** configured to conduct current can be made of tinned copper for providing a good electrical conduction and thermal dissipation.

In the present invention, the primary coil **20** wound on the winding portion **102**, the magnetic core assembly **30** assembled with the bobbin **10**, the extending portions **422** where placed with copper foil (and the electrically conductive sheet **43**) and inserted into the slots **106** of the bobbin **10**, collectively construct the transformer **5** shown in FIG. 1.

The rectifier **44** is placed on one surface of the base portion **420** of the circuit boards **42**, and the filter **46** is placed on the other surface of the base portion **420** thereof. The rectifier **44** can be synchronous rectifier composed of four metal-oxide-semiconductor field-effect transistors (MOSFETs). Each of the power-converting units **41a~41d** further includes a electrically conductive plate **48** placed on the base portion **420**, and the electrically conductive plate **48** and the rectifier **44** are placed on the same surface. The filter **46** is, for example, choke.

The surface of the power-converting unit **41b** placed with the filter **46** faces the surface of the power-converting unit **41c** placed with the filter **46**, which means that the filters **46** of the two power-converting units **41b** and **41c** close to the second channel **109** face each other, and the length of two filters **46** aforementioned is substantially equal to the width of the second channel **109**.

Moreover, the surface of the circuit board **42** of the power-converting unit **41a** placed with the rectifier **44** faces the surface of the circuit board **42** of the power-converting unit **41b** placed with the rectifier **44**. In the other words, two power-converting units **41a** and **41b** (or **41c** and **41d**) arranged at the same side of the second channel **109** face each other. In such manner, the integrated power-converting module is compact since the power-converting units **41a~41d** are tightly arranged.

The integrated power-converting module of the present invention having circuit diagram shown in FIG. 1 and

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arrangement shown in FIG. 2 and FIG. 6, which has advantage of compact and eddy current loss and switching loss can be effectively reduced.

The integrated power-converting module can be mounted on a circuit main board, in the other words, the circuit main board is disposed below the integrated power-converting module. The fixing members 13 is inserted into the circuit main board, so that the integrated power-converting module can stand on the circuit main board to prevent the integrated power-converting module from tilt caused by heavy weight. It should be noted that if the integrated power-converting module includes both the fixing members 13 and the electrically conductive terminals 12, the electrically conductive terminals 12 can be disposed at the bottom of the receiving portions 104a~104d, and the primary coil 30 can be connected to the electrically connected terminals 12 and electrically connected to the circuit main board via the electrically connected terminals 12. The fixing members 13 are disposed at the bottom of the receiving portions 104a~104d where the electrically conductive terminal is not disposed, such that the integrated power-converting module can stand firmly on the circuit main board. If the integrated power-converting module only includes the fixing members 13, the fixing members 13 are disposed at the bottom of the receiving portions 104a~104d, and the primary coil 20 wound on the bobbin 10 is directly connected to the circuit main board (by fly line connection). In the practical application, the arrangement of the electrically connective terminals 12 and the mixing member 13 can be adjusted based on the different situations.

The integrated power-converting module of the present invention for outputting multiple direct current electric powers integrates secondary windings (the copper foil or electrically conductive sheet 43 formed on the extending portions 422), the rectifier 44, and the filter 46 into one circuit board 42, which is assembled with the bobbin 10 by inserting the extending portions 422 into the receiving portions 104a~104d respectively. Thus it is compact and easily to manufacture and assemble.

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. An integrated power-converting module electrically connected to a direct current electric power, the integrated power-converting module comprising:

a bobbin comprising a main body, a plurality of winding portions, and a plurality of receiving portions, the main body having a first channel and a second channel communicating with the first channel and perpendicular to the first channel, the winding [parts] portions and the receiving [portion] portions arranged in a staggered manner, each receiving portion having a slot communicating with the first channel;

a primary coil wound on the winding portions;

a magnetic core assembly assembled with the bobbin and partially received in the first channel; and

a plurality of power-converting units arranged in a parallel manner and each of the power-converting units comprising:

a circuit board having a base portion and an [expending] extending portion connected to the base portion,

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a penetrating hole and a secondary winding formed on the [expending] extending portion, wherein the extending [portions are] portion is respectively inserted into the [slots] slot, and the penetrating hole is corresponding to and communicating with the first channel;

a rectifier placed on one of surfaces of the base portion and electrically connected to the circuit board; and a filter placed on the other surface of the base portion opposite to where the rectifier placed on and electrically connected to the rectifier,

wherein when the direct current electric power is conducted to the primary coil, the magnetic core assembly generates electromagnetic induction, and a converted power is generated [on] by the secondary windings of the power-converting units, wherein the filters of two power-converting units disposed on two opposite sides of and most close to the second channel face each other.

[2. The integrated power-converting module in claim 1, wherein the main body further comprising second channel communicating with the first channel and perpendicular to the first channel, wherein the filters of two power-converting units disposed two opposite sides of and most close to the second channel faces each other.]

3. The integrated power-converting module in claim [2] 1, wherein the magnetic core assembly comprises two magnetic cores, each magnetic core comprising a central leg, the central [legs are] leg is inserted into the second channel, and an air gap is formed between top surfaces of the central [cores] legs and within the second channel, and a plurality of gas passages are formed between the magnetic core assembly, the main body, and the primary coil wound on the winding portions.

4. The integrated power-converting module in claim [2] 1, wherein the winding portions arranged on the opposites sides of the second [channel] channel by a prescribed amount, and the receiving portions arranged in the opposite sides of the second channel by the prescribed amount, and the winding portions and the receiving portions are arranged in a staggered manner.

5. The integrated power-converting module in claim 4, wherein the rectifiers of two [adjacent] power-converting units arranged at one side of the second channel face each other.

6. The integrated power-converting module in claim 1, wherein each of the [converting] power-converting unit further comprises an electrically conductive plate placed on the base portion of the circuit board, the electrically conductive plate and the rectifier are placed on the same side of the base portion.

7. The integrated power-converting module in claim [2] 1, further comprising a plurality of spacers arranged between the second channel and the receiving portions and parallel to the receiving portions.

8. The integrated power-converting module in claim 1, wherein each of the receiving portion further comprises a side-wall disposed opposite to the power-converting unit and enclosing the slot.

9. The integrated power-converting module in claim 1, further comprising a plurality of fixing members disposed on a bottom of the receiving portions.

10. The integrated power-converting module in claim 1, further comprising an electrically conductive sheet attached on the extending portion of the circuit board.