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Peng et al.

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(54) **TRANSFORMER**

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H01F 27/28 (2006.01)
H01F 27/32 (2006.01)

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CPC ***H01F 27/06*** (2013.01); ***H01F 27/24*** (2013.01); ***H01F 27/28*** (2013.01); ***H01F 27/2871*** (2013.01); ***H01F 27/325*** (2013.01)

(58) **Field of Classification Search**
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USPC 336/196, 198, 199, 208
See application file for complete search history.

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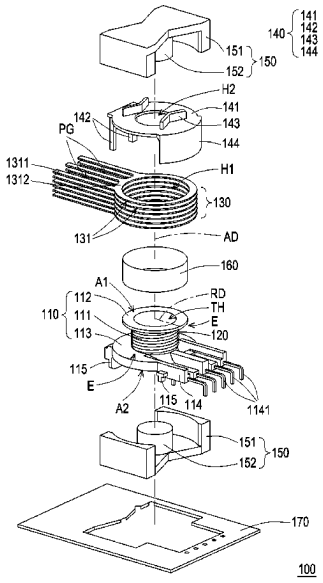
(57) **ABSTRACT**

A transformer including a winding frame, a first coil, a second coil, a locating piece, and two iron core pieces is provided. The winding portion has a through hole. The first baffle and the second baffle are respectively and horizontally extended from two opposite ends of the winding portion. The terminal socket is connected to the second baffle. The first coil is wound on the winding portion and electrically coupled to the terminal socket. The second coil is disposed around the first coil and the two are spaced apart from each other. The second coil has a plurality of copper sheets located between the first baffle and the second baffle. The locating piece is correspondingly disposed on the winding frame to locate the second coil. The two iron core pieces are respectively disposed on the second baffle of the winding frame and the locating piece.

14 Claims, 9 Drawing Sheets



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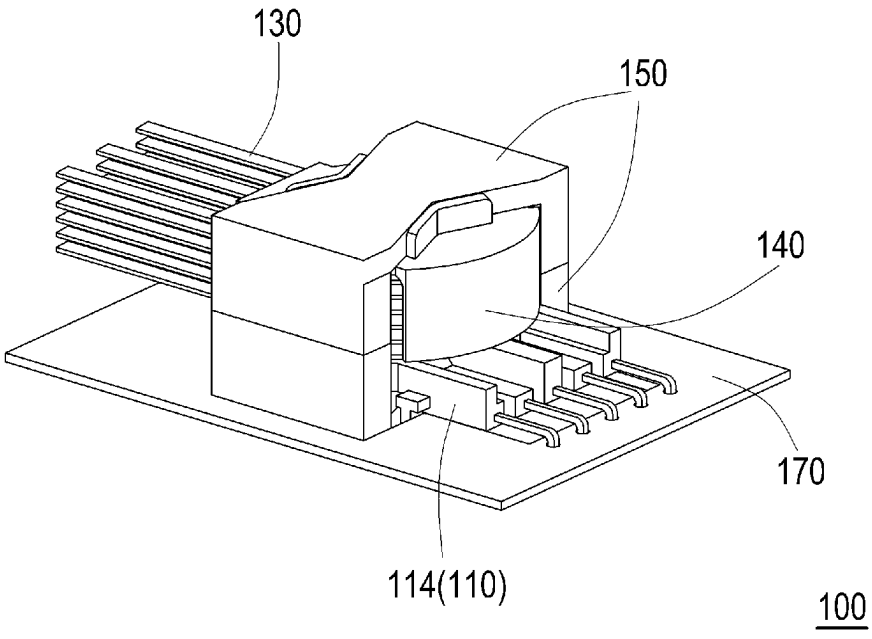

FIG. 1A

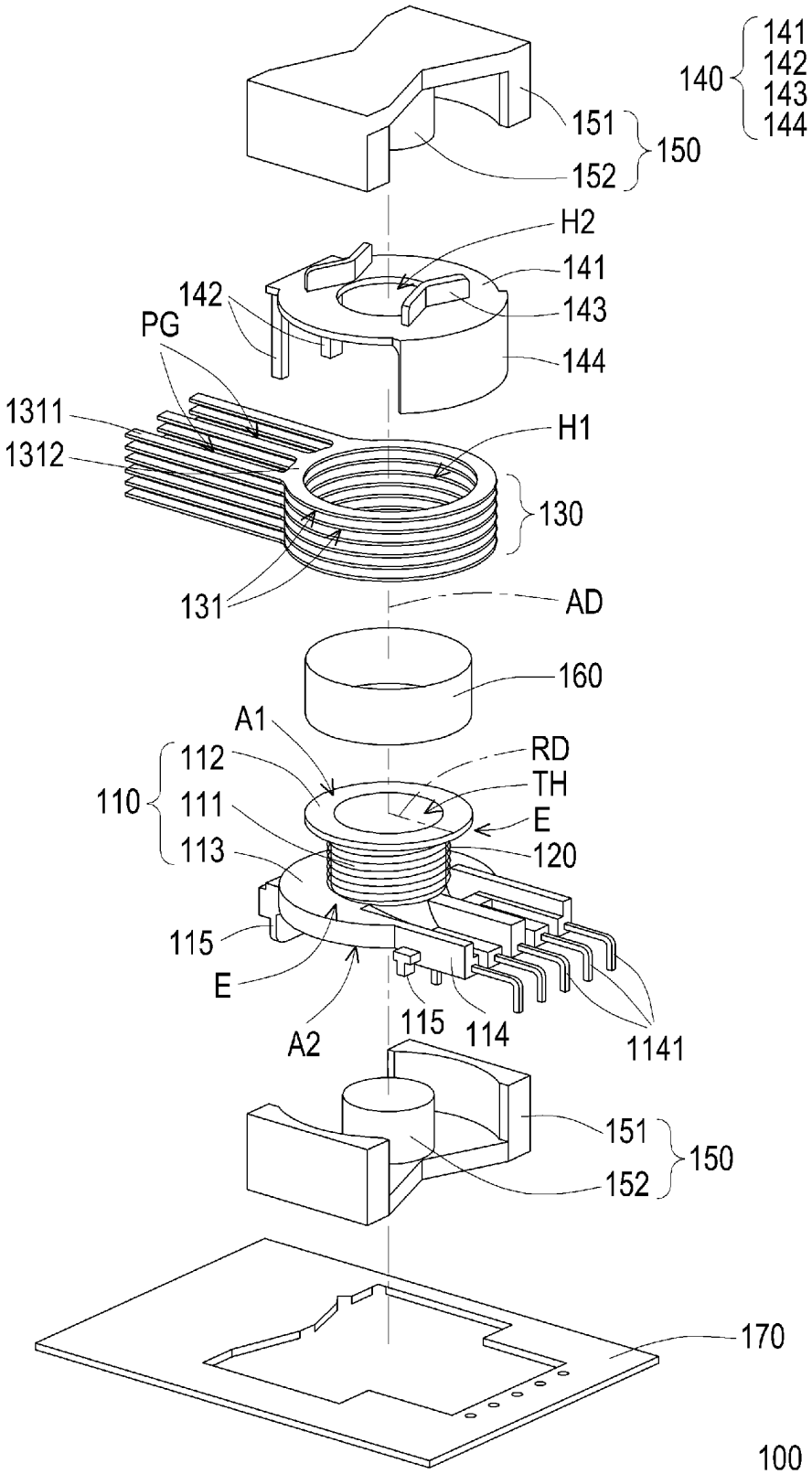
140
141
142
143
144
151
152
150
H2
141
142
143
144
PG
1311
1312
H1
130
131
AD
160
A1
112
110
111
113
RD
TH
E
120
115
E
A2
115
114
1141
151
152
150
170
100

FIG. 1B

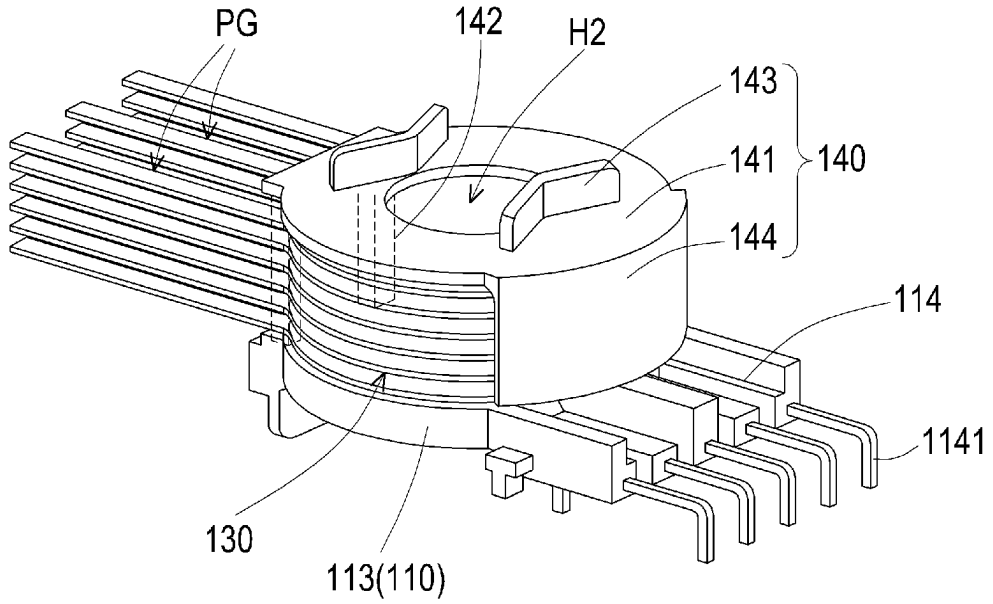
PG
142
H2
143
141
140
144
114
1141
130
113(110)

FIG. 1C

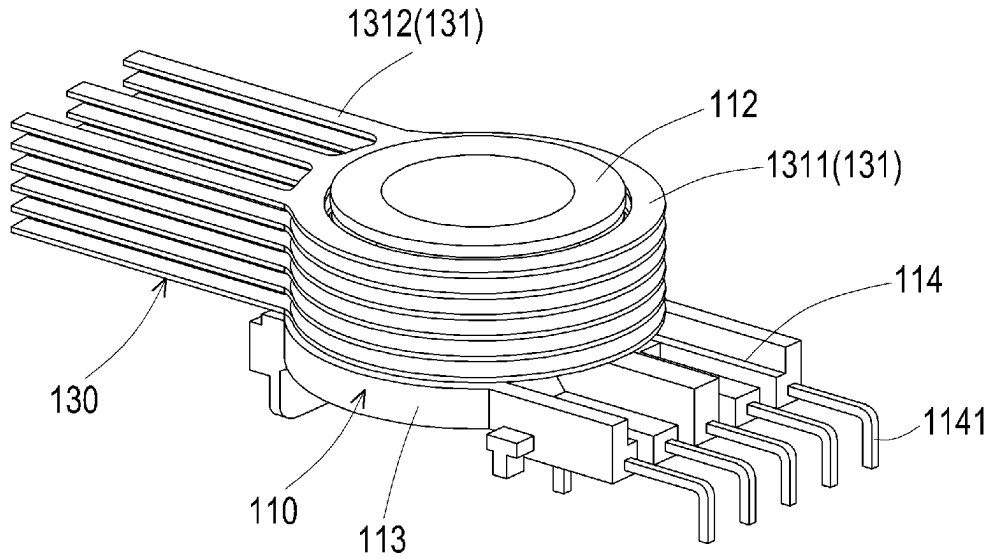
1312(131)
112
1311(131)
114
130
1141
110
113

FIG. 1D

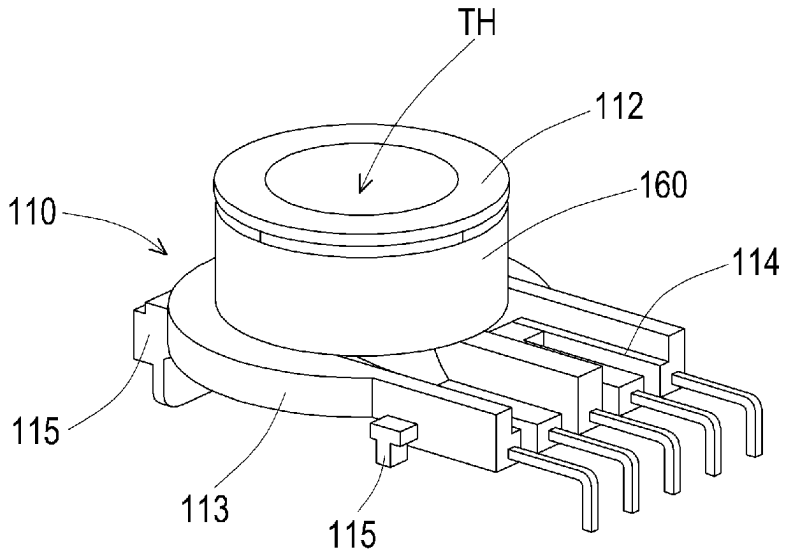

FIG. 1E

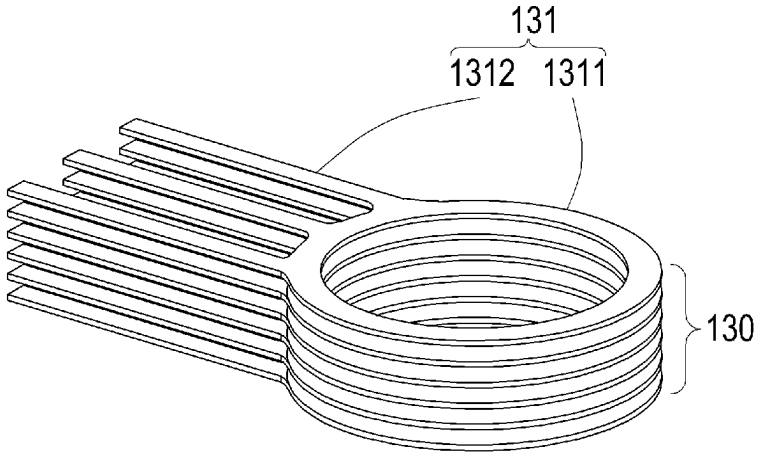

FIG. 1F

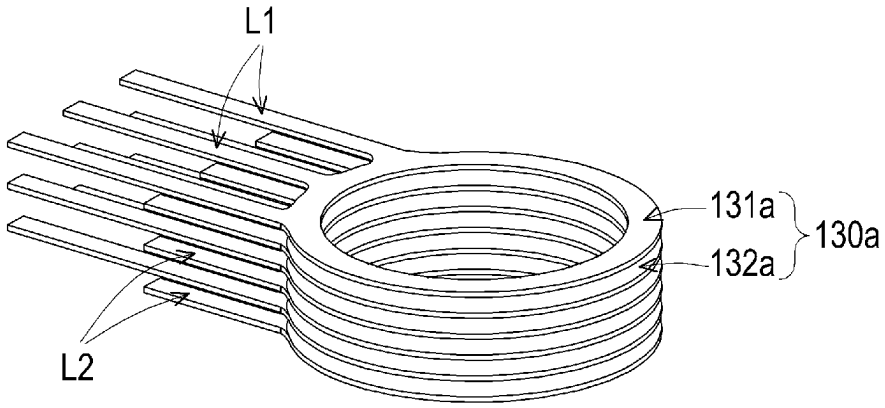

FIG. 2A

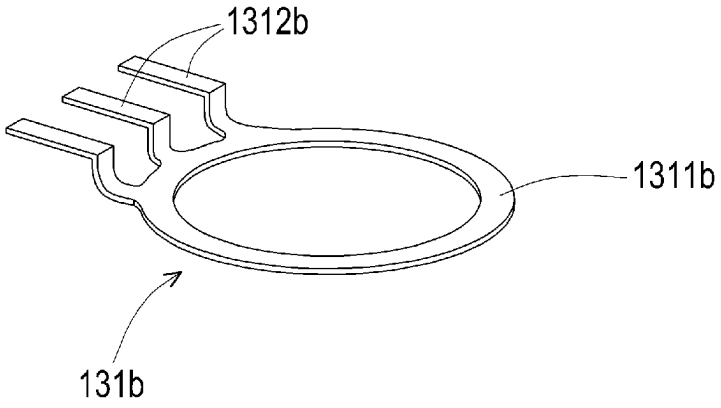

FIG. 2B

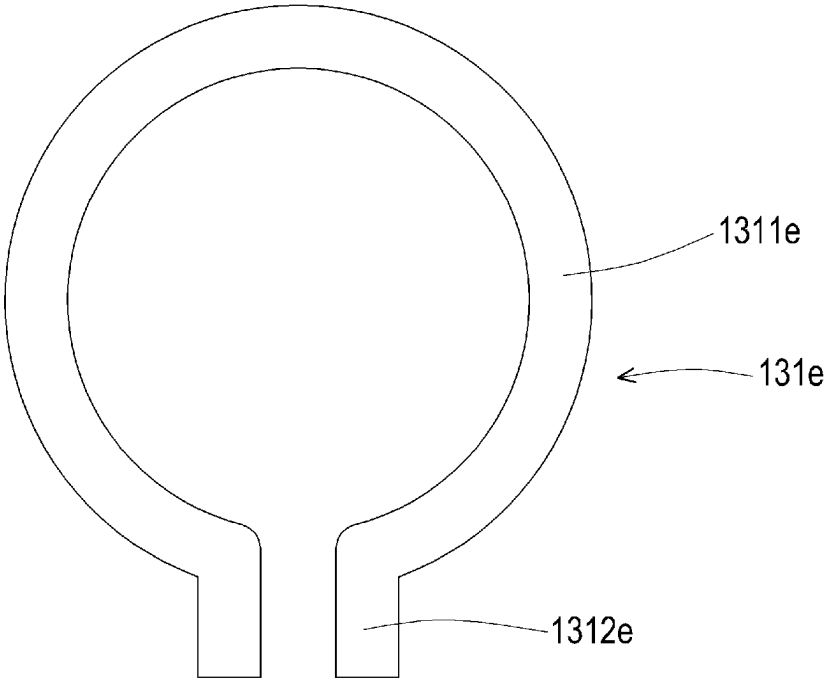

FIG. 2C

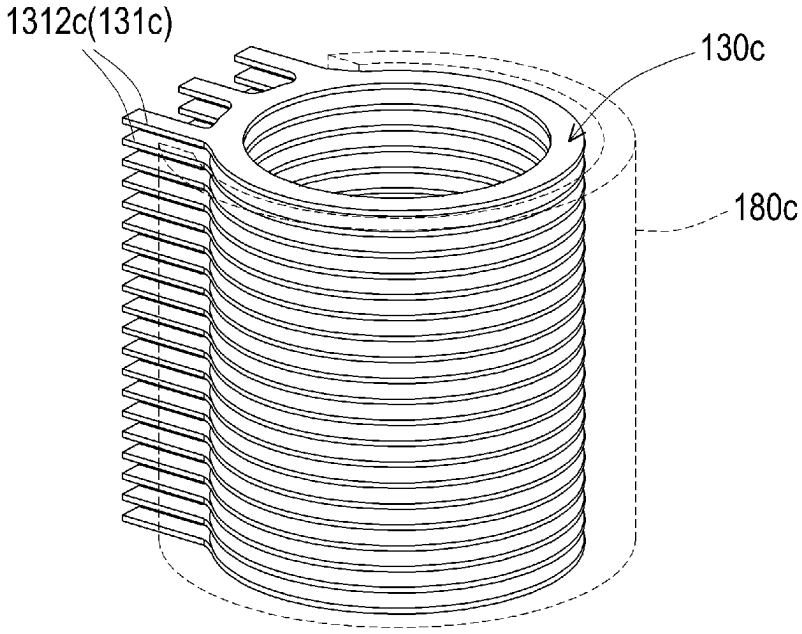

FIG. 3A

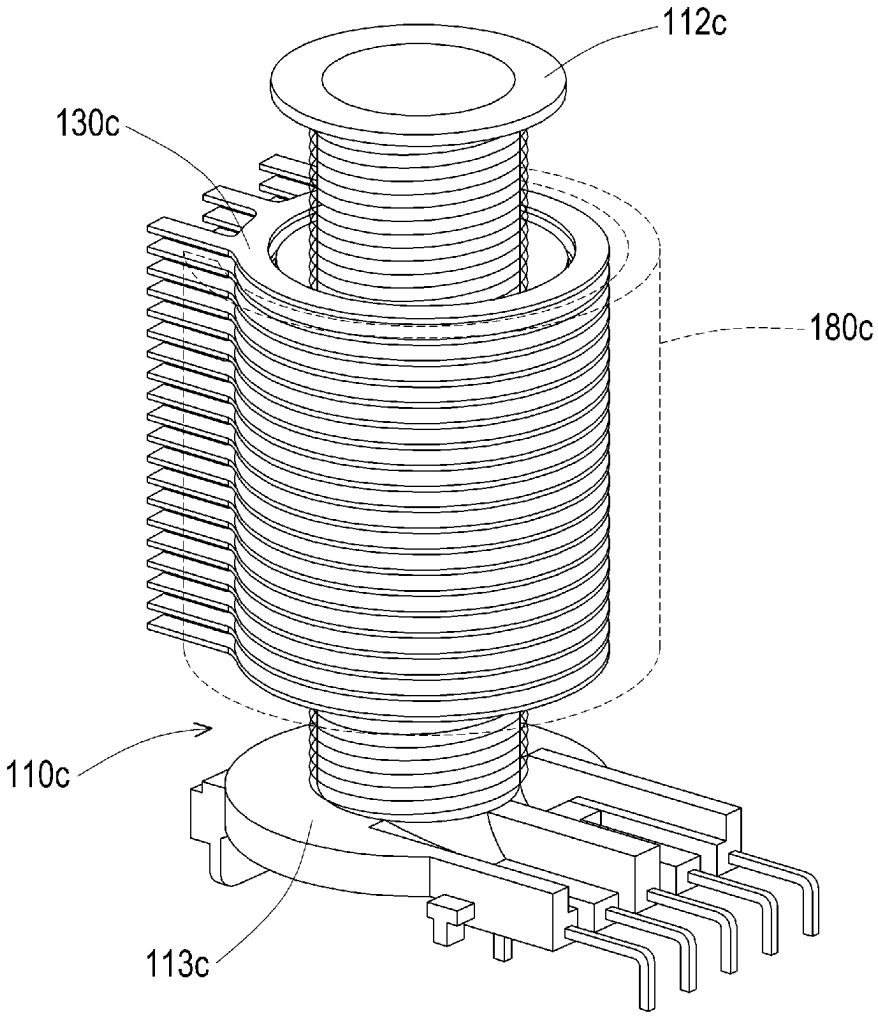

FIG. 3B

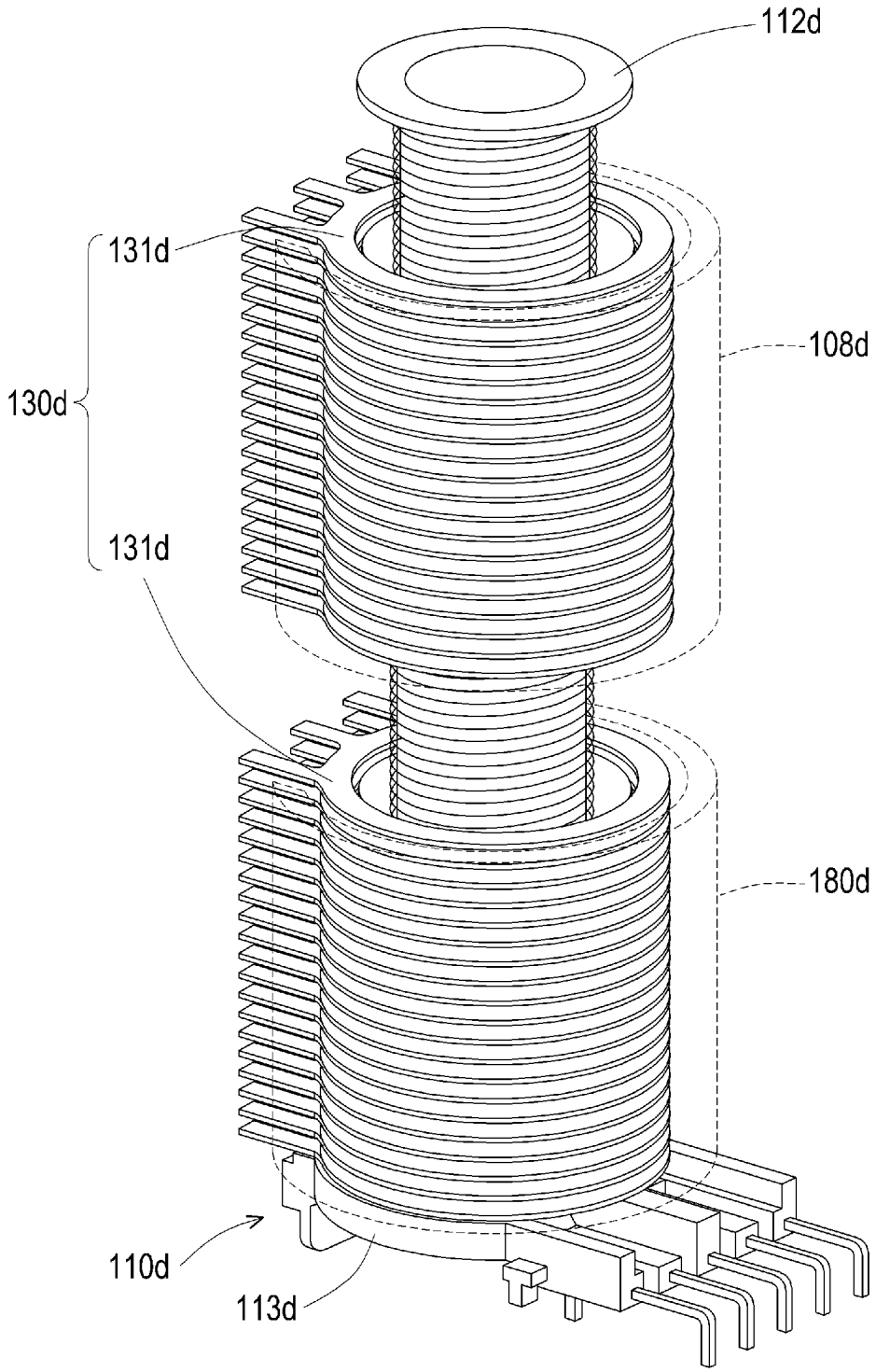

FIG. 4

TRANSFORMER

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the priority benefit of Taiwan application serial no. 110141320, filed on Nov. 5, 2021. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND

Technical Field

The disclosure relates to a transformer, and in particular to a transformer for use in an electronic appliance.

Description of Related Art

Regarding an existing transformer used in a high-wattage electronic appliance, in order to reduce the size and increase the power density, a high-frequency design is usually used for switching frequency, so that a magnetic component with a smaller effective core area may be used in the transformer to reduce the volume of the transformer. An existing high-frequency transformer is an LLC architecture that combines winding and copper sheets. However, the copper sheets of the existing high-frequency transformer are stacked on the upper and lower sides of the winding, so that air gaps exist between the copper sheets and the winding. When the transformer is energized and operated, the air gaps generate magnetic flux leakage and form a magnetic field, thus causing the loss of eddy current.

SUMMARY

The disclosure provides a transformer, which avoids the situation of air gaps being generated between winding and a copper sheet so as to reduce magnetic leakage and eddy current loss.

A transformer of the disclosure includes a winding frame, a first coil, a second coil, a locating piece, and two iron core pieces. The winding frame has a winding portion, a first baffle, a second baffle, and a terminal socket. The winding portion has a through hole. The first baffle and the second baffle are respectively and horizontally extended from two opposite ends of the winding portion. The terminal socket is connected to the second baffle. The first coil is wound on the winding portion and is electrically coupled to the terminal socket. The second coil is disposed around the outside of the first coil and the first coil and the second coil are spaced apart from each other. The second coil has a plurality of copper sheets, located between the first baffle and the second baffle. The locating piece is correspondingly disposed on the winding frame and is used to locate the second coil. The two iron core pieces are respectively disposed on the second baffle of the winding frame and the locating piece, and the two iron core pieces are disposed so as to pass through the through hole of the winding portion.

Based on the above, in the transformer of the disclosure, the first coil is wound on the winding portion, and the second coil is disposed around the outside of the first coil. Therefore, the second coil is wrapped around the periphery of the first coil while the above two are spaced apart from each other instead of being stacked on each other, so that no air gap exists between the second coil and the first coil. Thus, the magnetic leakage phenomenon generated by the transformer after the transformer is energized and operated is avoided, and the loss of eddy current is reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a perspective schematic view of a transformer according to an embodiment of the disclosure.

FIG. **1**B is an exploded schematic view of components of the transformer of FIG. **1**A.

FIG. **1**C is a perspective schematic view of a locating piece of the transformer of FIG. **1**A being engaged with a second coil.

FIG. **1**D is a perspective schematic view of the second coil of the transformer in FIG. **1**A being wrapped around a winding frame.

FIG. **1**E is a perspective schematic view of an insulating layer of the transformer in FIG. **1**A being wrapped around the winding frame.

FIG. **1**F is a perspective schematic view of the second coil of the transformer of FIG. **1**A.

FIG. **2**A is a perspective view of the second coil according to another embodiment of the disclosure.

FIG. **2**B is a perspective view of the second coil according to another embodiment of the disclosure.

FIG. **2**C is a perspective view of the second coil according to another embodiment of the disclosure.

FIG. **3**A is a perspective view of the second coil according to another embodiment of the disclosure combined with a cylindrical housing.

FIG. **3**B is a perspective schematic view of the second coil of FIG. **3**A disposed around the winding frame.

FIG. **4** is a perspective schematic view of the second coil according to another embodiment of the disclosure combined with the cylindrical housing.

DESCRIPTION OF THE EMBODIMENTS

Referring to FIGS. **1**A and **1**B, a transformer **100** of the disclosure includes a winding frame **110**, a first coil **120**, a second coil **130**, a locating piece **140**, and two iron core pieces **150**.

The winding frame **110** has a winding portion **111**, a first baffle **112**, a second baffle **113**, and a terminal socket **114**, and the winding frame **110** is made of an insulating material. The winding portion **111** has a through hole TH and has a hollow tube structure, and the through hole TH penetrates the winding portion **111**. The first baffle **112** and the second baffle **113** are respectively and horizontally extended from two opposite ends E of the winding portion **111**. The terminal socket **114** is connected to the second baffle **113** and has a plurality of electrical terminals **1141**. The electrical terminals **1141** extend from the outer edge of the terminal socket **114** toward the direction away from the winding frame **110**, and the electrical terminals **1141** are bent at 90 degrees relative to the terminal socket **114** to form an L-shaped appearance.

The first coil **120** is wound on the winding portion **111** of the winding frame **110** and is electrically coupled to the electrical terminals **1141** of the terminal socket **114**. The second coil **130** is disposed around the outside of the first coil **120** and the above two are spaced apart from each other; that is, the second coil **130** is wrapped around the periphery of the first coil **120** and the two does not contact each other. The second coil **130** has a plurality of copper sheets **131** located between the first baffle **112** and the second baffle **113**. The locating piece **140** is correspondingly disposed on

the winding frame **110**, and is used to locate the copper sheets **131** of the second coil **130**. The two iron core pieces **150** are respectively disposed on the second baffle **113** of the winding frame **110** and the locating piece **140**, and the two iron core pieces **150** are disposed so as to pass through the through hole TH of the winding portion **111** and are electrically coupled to each other.

Referring to FIGS. **1**C to **1**E, the transformer **100** further includes an insulating layer **160**, wrapped around the outside of the first coil **120** and blocks the second coil **130**, so that the first coil **120** is insulated from the second coil **130**. In other words, the insulating layer **160** is located between the first coil **120** and the second coil **130** to prevent the first coil **120** and the second coil **130** from contacting and conducting each other.

Referring to FIGS. **1**B, **1**D to **1**F, in this embodiment, a first area A**1** of the first baffle **112** is smaller than a second area A**2** of the second baffle **113**. An opening H**1** of the second coil **130** is adapted to pass through the first baffle **112** and the second coil **130** abuts against the second baffle **113**, so that the second coil **130** is wrapped around the winding frame **110** and completely covers the first coil **120**, and the second coil **130** and the first coil **120** overlap each other in a radial direction RD of the winding frame **110**. Based on the assembly method of the first coil **120** (a primary side coil) and the second coil **130** (a secondary side coil) used in this embodiment overlapping in the radial direction RD, no air gap exists between the second coil **130** and the first coil **120**, so the magnetic leakage phenomenon may be reduced.

Referring to FIG. **1**F, each copper sheet **131** of the second coil **130** has an annular main-body **1311** and a plurality of pins **1312**. The pins **1312** extend outward from the annular main-body **1311**, and the pins **1312** are parallel to each other. In this embodiment, the pins **1312** have a linear appearance and are perpendicular to an axial direction AD of the winding frame **110**. The second coil **130** is stacked along the axial direction AD passing through the winding portion **111**, and the pins **1312** jointly form two locating slots PG.

Referring to FIGS. **1**A and **1***i*, the winding frame **110** has two first locating portions **115**, respectively disposed on the second baffle **113** and the terminal socket **114**, and the two first locating portions **115** are engaged with the corresponding one of the iron core pieces **150** to avoid shaking or separation of the winding frame **110** and the corresponding iron core piece **150**.

Referring to FIGS. **1**A and **1**B, the locating piece **140** has a ring plate **141**, two locating mounts **142**, two second locating portions **143**, and a blocking plate **144**. The ring plate **141** has an opening H**2**, aligned with the through hole TH of the winding portion **111**. The two locating mounts **142** are disposed on the outer edge of the ring plate **141** and extend toward the second baffle **113**, and the two second locating portions **143** are disposed on an upper surface TS of the ring plate **141**. The blocking plate **144** is disposed on the outer edge of the ring plate **141** and is opposite to the two locating mounts **142**.

Referring to FIG. **1**C, the two locating mounts **142** are disposed around the two locating slots PG of the second coil **130**, and the two locating mounts **142** are used to limit the pins **1312** of the copper sheets **131**, so as to avoid the situation of the copper sheets **131** being separated from each other and the pins **1312** being misaligned. The two second locating portions **143** are engaged with the corresponding iron core piece **150**. The blocking plate **144** partially encapsulates the second coil **130**. Specifically, through the limiting effect of the blocking plate **144** and the two second locating portions **143**, the annular main-bodies **1311** of the copper sheets **131** may be limited on the second baffle **113**.

Referring to FIGS. **1**A and **1***i*, each of the iron core pieces **150** has a case **151** and a column **152**. The column **152** is disposed in the case **151**, and the column **152** of one iron core piece **150** is disposed so as to pass through the locating piece **140** and enters the through hole TH of the winding frame **110**. The column **152** of another iron core piece **150** is disposed so as to pass through the second baffle **113** and enters the through hole TH of the winding frame **110**. In this embodiment, the number of iron core pieces **150** is two. The two cases **151** of the two iron core pieces **150** are electrically coupled to each other and are wrapped around the outside of the second coil **130**, and the two case **151** are misaligned with the two second locating portions **143** and the blocking plate **144** of the locating piece **140**. The two columns **152** of the two iron core pieces **150** are electrically coupled to each other in the through hole TH, and the two iron core pieces **150** form a loop.

Referring to FIGS. **1**A and **1**B, a circuit board **170** is further included. The circuit board **170** is disposed on the corresponding iron core piece **150** and is electrically coupled to the electrical terminals **1141** of the terminal socket **114**.

FIG. **2**A is a perspective view of the second coil according to another embodiment of the disclosure.

Referring to FIG. **2**A, in this embodiment, a plurality of copper sheets of a second coil **130***a* include at least one first copper sheet **131***a* and at least one second copper sheet **132***a*. A first pin length L**1** of the at least one first copper sheet **131***a* is different from a second pin length L**2** of the at least one second copper sheet **132***a*. In this embodiment, the first pin length L**1** is greater than the second pin length L**2**, and in other embodiments, the first pin length L**1** is smaller than the second pin length L**2**.

Specifically, the second coil of this embodiment has different pin lengths, adapted for electronic appliances of different specifications.

FIG. **2**B is a perspective view of the second coil according to another embodiment of the disclosure.

Referring to FIG. **2**B, in this embodiment, each copper sheet **131***b* of the second coil has an annular main-body **1311***b* and a plurality of pins **1312***b*, and the pins **1312***b* extend from the annular main-body **1311***b* and has a bent appearance.

Specifically, the second coil of this embodiment has pins with a bent appearance, adapted for electronic appliances of different specifications.

FIG. **2**C is a perspective view of the second coil according to another embodiment of the disclosure.

Referring to FIG. **2**C, in this embodiment, each copper sheet **131***e* has an annular main-body **1311***e* and two pins **1312***e*, and the two pins **1312***e* are respectively formed on two ends of the annular main-body **1311***e*, and the two pins **1312***e* are spaced apart from each other.

FIG. **3**A is a perspective view of the second coil according to another embodiment of the disclosure combined with a cylindrical housing. FIG. **3**B is a perspective schematic view of the second coil of FIG. **3**A disposed around the winding frame.

Referring to FIGS. **3**A and **3**B, a cylindrical housing **180***c* is further included, and a second coil **130***c* is disposed in the cylindrical housing **180***c*. Specifically, a plurality of copper sheets **131***c* of the second coil **130***c* are stacked on each other in the cylindrical housing **180***c*, and the copper sheets **131***c* are disposed around a winding frame **110***c* and are located between a first baffle **112***c* and a second baffle **113***c*. A plurality of pins **1312***c* of the copper sheets **131***c* protrude

from the cylindrical housing **180***c*. The cylindrical housing **180***c* is made of an insulating material, so that the magnetic field generated by the second coil **130***c* is concentrated in the cylindrical housing **180***c*, thereby further reducing the magnetic leakage phenomenon.

FIG. **4** is a perspective schematic view of the second coil according to another embodiment of the disclosure combined with the cylindrical housing.

Referring to FIG. **4**, a plurality of cylindrical housings **180***d* are included, and a plurality of copper sheets **131***d* of a second coil **130***d* are respectively disposed in the corresponding cylindrical housings **180***d*. Specifically, the copper sheets **131***d* of the second coil **130***d* are respectively stacked on each other in the cylindrical housings **180***d*, and the copper sheets **131***d* are disposed so as to pass through a winding frame **110***d* and are located between a first baffle **112***d* and a second baffle **113***d*, and the cylindrical housings **180***d* are spaced apart from each other. A plurality of pins **1312***d* of the copper sheets **131***d* respectively protrude from the corresponding cylindrical housing **180***d*. The cylindrical housing **180***d* is made of an insulating material, so that the magnetic field generated by the second coil **130***d* is concentrated in the cylindrical housing **180***d*, thereby further reducing the magnetic leakage phenomenon.

In summary, in the transformer of the disclosure, the first coil is wound on the winding portion, and the second coil is disposed around the outside of the first coil. Therefore, the second coil is wrapped around the periphery of the first coil while the above two are spaced apart from each other instead of being stacked on each other, so that no air gap exists between the second coil and the first coil. Thus, the magnetic leakage phenomenon generated by the transformer after the transformer is energized and operated may be avoided, and the loss of eddy current may be reduced.

Furthermore, in the transformer of the disclosure, the first coil (the primary side coil) thereof may be electrically connected to the circuit board through a plurality of electrical terminals of the terminal socket, and this connection method replaces the existing flying lead connection method; and the second coil (the secondary side coil) thereof has a plurality of copper sheets stacked on each other and is wrapped around the outside the first coil. Compared with the current transformer, the transformer of the disclosure has the technical effect of reducing power consumption and lowering operating temperature.

What is claimed is:

1. A transformer, comprising:

a winding frame, having a winding portion, a first baffle, a second baffle, and a terminal socket, wherein the winding portion has a through hole, the first baffle and the second baffle are respectively extended from two opposite ends of the winding portion, and the terminal socket is connected to the second baffle;

a first coil, wound on the winding portion and electrically coupled to the terminal socket;

a second coil, disposed around the outside of the first coil, wherein the first coil and the second coil are spaced apart from each other, the second coil has a plurality of copper sheets, and the plurality of copper sheets are located between the first baffle and the second baffle;

a locating piece, correspondingly disposed on the winding frame, used to locate the second coil; and

two iron core pieces, respectively disposed on the second baffle of the winding frame and the locating piece, wherein the two iron core pieces are disposed so as to pass through the through hole of the winding portion,

wherein the locating piece has a ring plate, two locating mounts, two second locating portions, and a blocking plate, wherein the ring plate has an opening, aligned with the through hole of the winding portion, the two locating mounts are disposed on an outer edge of the ring plate and extend toward the second baffle, the two second locating portions are disposed on an upper surface of the ring plate, and the blocking plate is disposed on the outer edge of the ring plate and is opposite to the two locating mounts.

2. The transformer according to claim **1**, wherein the winding frame has two first locating portions, respectively disposed on the second baffle and the terminal socket, and the two first locating portions are engaged with the corresponding iron core piece.

3. The transformer according to claim **1**, wherein the two locating mounts are disposed so as to pass through the second coil, the two second locating portions are engaged with the corresponding iron core piece, and the blocking plate partially encapsulates the second coil.

4. The transformer according to claim **1**, further comprising an insulating layer, wrapped around the outside of the first coil and blocking the second coil, so that the first coil is insulated from the second coil.

5. The transformer according to claim **1**, wherein each of the copper sheets has an annular main-body and a plurality of pins, the plurality of pins extend outward from the annular main-body, and the plurality of pins are parallel to each other.

6. The transformer according to claim **5**, wherein the plurality of copper sheets of the second coil are stacked on each other along an axial direction passing through the winding portion, and the plurality of pins jointly form two locating slots.

7. The transformer according to claim **1**, wherein the copper sheets comprise at least one first copper sheet and at least one second copper sheet, and a first pin length of the at least one first copper sheet is different from a second pin length of the at least one second copper sheet.

8. The transformer according to claim **1**, wherein each of the copper sheets has an annular main-body and a plurality of pins, and the pins extend from the annular main-body and have a bent appearance.

9. The transformer according to claim **1**, wherein two pins are respectively formed on two ends of each of the copper sheets, and the two pins are spaced apart from each other.

10. The transformer according to claim **1**, wherein each of the iron core pieces has a case and a column, and the column is disposed in the case, wherein the column of one of the iron core pieces is disposed so as to pass through the locating piece and enters the through hole of the winding frame, wherein the column of another one of the iron core pieces is disposed so as to pass through the second baffle and enters the through hole of the winding frame, and the two cases of the two iron core pieces are electrically coupled to each other and are wrapped around the outside of the second coil.

11. The transformer according to claim **1**, wherein a first area of the first baffle is smaller than a second area of the second baffle.

12. The transformer according to claim **1**, further comprising a circuit board, disposed on the corresponding iron core piece and electrically coupled to the terminal socket.

13. The transformer according to claim **1**, further comprising a cylindrical housing, wherein the second coil is disposed in the cylindrical housing, wherein each of the copper sheets has a plurality of pins, and the pins of the copper sheets protrude from the cylindrical housing.

14. The transformer according to claim 1, further comprising a plurality of cylindrical housings, wherein the copper sheets of the second coil are respectively disposed on the corresponding cylindrical housings.

* * * * *