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(54) **TRANSFORMER AND SHIELDING STRUCTURE**

(57) A transformer and a shielding structure (5) are provided. The transformer comprises a primary conductive unit (2), a secondary conductive unit (3), a core assembly (4), and a shielding structure (5), wherein the secondary conductive unit (3) is electromagnetically coupled to the primary conductive unit (2). At least one shielding portion (52) of the shielding structure (5) is disposed between at least one main winding (21) of the primary conductive unit (2) and the secondary conductive unit (3). Arranging the bent shielding structure (5) between the primary conductive unit (2) and the secondary conductive unit (3) forms a shield and reduce electromagnetic interference.

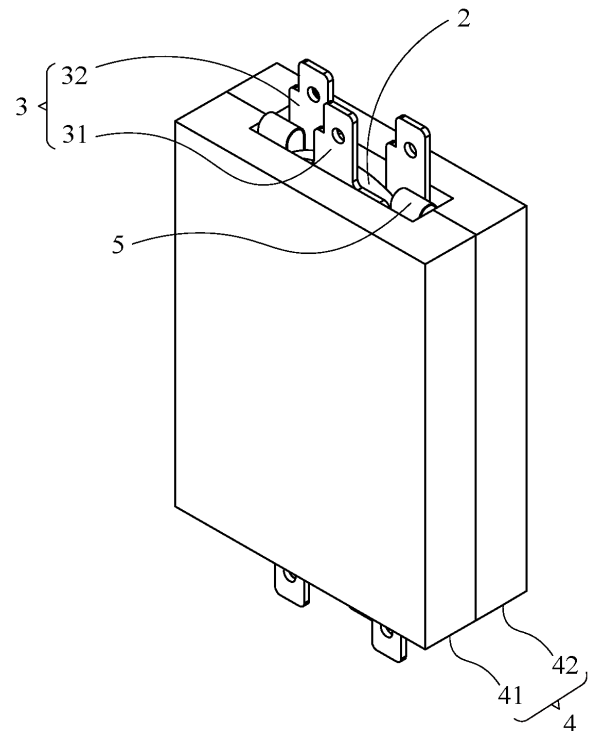


FIG. 1

Description

FIELD OF INVENTION

[0001] The present disclosure relates to a transformer and a shielding structure, and more particularly to a transformer and shielding structure of bobbin-less interleaved type.

BACKGROUND OF INVENTION

[0002] During operation, a power supply's high-frequency switching action causes its transformer to produce multi-harmonic noise, resulting in electromagnetic interference (EMI). To mitigate the conducted or radiated EMI, it's common practice to incorporate a shielding copper foil (simply "shielding") between the transformer's primary and secondary sides. The shielding is then grounded to effectively eliminate the unwanted noise.

[0003] However, for bobbin-less interleaved transformers, the secondary side typically employs copper sheets to improve efficiency due to high-current output. Nevertheless, wrapping the copper sheets with tape is insufficient to meet the reinforced insulation distance required by safety standards, making it difficult to connect the shielding copper foil in parallel with the ground of the primary side. As a result, the shielding copper foil connected to the ground of the secondary side fails to provide effective shielding performance.

[0004] As a result, it is necessary to provide a transformer and a shielding structure to solve the problems existing in the conventional technologies, as described above.

SUMMARY OF INVENTION

[0005] The object of the present disclosure is to provide a transformer and a shielding structure that can form a shield to reduce electromagnetic interference by positioning the bent shielding structure between a primary conductive unit and a secondary conductive unit.

[0006] According to the aforementioned object, a transformer is provided. The transformer comprises: a primary conductive unit comprising at least one main winding; a secondary conductive unit disposed alternately with the primary conductive unit; a core assembly comprising a protrusion and an accommodating space, wherein the main winding and the secondary conductive unit are disposed in the accommodating space and wound around the protrusion; and a shielding structure comprising a plurality of bending portions and a plurality of shielding portions, wherein two adjacent shielding portions extend from two ends of a corresponding bending portion, respectively; at least one shielding portion of the shielding structure is disposed between at least one main winding of the primary conductive unit and the secondary conductive unit.

[0007] According to an embodiment of the present

disclosure, the secondary conductive unit comprises two metal sheets; at least one main winding of the primary conductive unit is disposed between the two metal sheets; at least one shielding portion of the shielding structure is disposed between the corresponding main winding and the corresponding metal sheet.

[0008] According to an embodiment of the present disclosure, the secondary conductive unit comprises a plurality of metal sheets; the plurality of main windings of the primary conductive unit are disposed between the metal sheets; the plurality of shielding portions of the shielding structure are respectively disposed between the corresponding main windings and the corresponding metal sheets.

[0009] According to an embodiment of the present disclosure, each metal sheet comprises a shoulder, two extension portions and an opening; the two extension portions are respectively connected to opposite sides of the shoulder; the opening is formed between the two extension portions; the two shielding portions are located respectively on opposite sides of the opening.

[0010] According to an embodiment of the present disclosure, the metal sheets are arranged alternately so that the openings of two adjacent metal sheets are oriented in opposite directions; the metal sheets with openings oriented in a first direction are connected in parallel; the metal sheets with openings oriented in a second direction are connected in parallel; the first direction is opposite to the second direction.

[0011] According to an embodiment of the present disclosure, at least one bending portion of the shielding structure extends across the shoulder of the corresponding metal sheet.

[0012] According to an embodiment of the present disclosure, at least one bending portion of the shielding structure extends across the corresponding main winding.

[0013] According to an embodiment of the present disclosure, a projection area of the shielding portions of the shielding structure, when projected onto the corresponding metal sheet, covers the two extension portions of the metal sheet.

[0014] According to an embodiment of the present disclosure, the plurality of bending portions of the shielding structure are respectively located on a first side and a second side of the openings of the metal sheets; the bending portions located on the first side correspond to the bending portions located on the second side.

[0015] According to an embodiment of the present disclosure, the plurality of shielding portions located on the first side correspond to the plurality of shielding portions located on the second side.

[0016] According to the aforementioned object, a shielding structure is provided. The shielding structure is disposed in a transformer comprising a primary conductive unit and a secondary conductive unit disposed alternately with the primary conductive unit, wherein the shielding structure comprises: a plurality of bending por-

tions; and a plurality of shielding portions, wherein two adjacent shielding portions respectively extend from two ends of a corresponding bending portion; wherein at least one shielding portion of the shielding structure is disposed between at least one main winding of the primary conductive unit and the secondary conductive unit.

[0017] According to an embodiment of the present disclosure, the shielding structure comprises a starting end and an ending end; the starting end and the ending end are respectively electrically connected to an external component.

[0018] According to an embodiment of the present disclosure, the shielding structure is an elongated strip formed by an insulating layer covering a conductive sheet.

[0019] According to an embodiment of the present disclosure, the shielding structure is an elongated strip formed by a plurality of conductive wires arranged in parallel.

[0020] According to an embodiment of the present disclosure, the secondary conductive unit comprises at least one metal sheet; the metal sheet comprises a shoulder, two extension portions and an opening; the two extension portions are respectively connected to opposite sides of the shoulder; the opening is formed between the two extension portions; a width of the shielding structure is greater than or equal to a width of the corresponding extension portion.

[0021] As described above, the present disclosure arranges the shielding structure in a bent configuration between the primary conductive unit and the secondary conductive unit, thereby forming shielding between the two conductive units to reduce electromagnetic interference and prevent excessive induced voltage. It can enhance the stability and safety of the power supply system. Furthermore, the shielding structure can be preassembled with the metal sheets, thereby shortening the manufacturing process.

DESCRIPTION OF DRAWINGS

[0022]

FIG. 1 is a schematic diagram of a transformer according to an embodiment of the present disclosure.

FIG. 2 is a schematic diagram of an exploded view of FIG. 1.

FIG. 3 is a partial schematic diagram of the transformer of FIG. 1.

FIG. 4 is a cross-sectional view of FIG. 1.

FIG. 5 is a partial schematic diagram of a shielding structure of the transformer of FIG. 1.

FIG. 6 is a schematic diagram of a shielding structure of a transformer according to another embodiment of the present disclosure.

FIG. 7 is a schematic diagram of a transformer according to an embodiment of the present disclosure.

FIG. 8 is a schematic diagram of an exploded view of FIG. 7.

FIG. 9 is a partial schematic diagram of the transformer of FIG. 7.

FIG. 10 is a cross-sectional view of FIG. 7.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0023] In order to make the above and other purposes, features, and advantages of the present disclosure more comprehensible, preferred embodiments of the present disclosure will be described below in detail together with the attached drawings. It should be noted that the drawings are simplified schematic diagrams and therefore only show the components and combination relationships related to the present disclosure to provide a clearer description of the basic structure or implementation method of the present disclosure, while the actual components and layout may be more complicated. Additionally, for the purpose of illustration, the components shown in the drawings of the present disclosure are not drawn to scale in terms of actual number, shape, or size. The detailed proportions can be adjusted according to design requirements.

[0024] Please refer to FIG. 1, a schematic diagram of a transformer according to an embodiment of the present disclosure is illustrated. The transformer comprises a primary conductive unit 2, a secondary conductive unit 3, a core assembly 4 and a shielding structure 5. The detailed structure, assembly relationship and operation principle of each component will be described in detail below.

[0025] Please refer to FIG. 1, FIG. 2, and FIG. 3, wherein FIG. 2 illustrates a schematic diagram of an exploded view of FIG. 1 and FIG. 3 illustrates a partial schematic diagram of the transformer of FIG. 1. The secondary conductive unit 3 is disposed alternately with the primary conductive unit 2. Specifically, the primary conductive unit 2 comprises a main winding 21, and the secondary conductive unit 3 comprises two metal sheets 31 and 32. The main winding 21 of the primary conductive unit 2 is arranged between the two metal sheets 31, 32 (the secondary conductive unit 3 and the primary conductive unit 2 are arranged alternately). The core assembly 4 has a protrusion 41 and an accommodating space 42 corresponding to the shape of the main winding 21 and the two metal sheets 31, 32 to accommodate the main

winding 21 and the two metal sheets 31, 32 (the main winding 21 and the secondary conductive unit 3 are arranged in the accommodating space 42). The main winding 21 and the secondary conductive unit 3 are wound around the protrusion 41 of the core assembly 4 (the protrusion 41 of the core assembly 4 passes through the main winding 21 and the two metal sheets 31, 32).

[0026] In the embodiment, the main winding 21 is formed by winding a conductive material. According to actual needs, the conductive wire is spirally wound with a specific number of turns, and a through hole is formed in the center of the main winding 21. The two ends of the conductive wire extend outward from the periphery of the main winding 21, and the starting end and the ending end of the conductive wire serve as pins (not shown). In addition, the core assembly 4 is made of magnetic conductive material, wherein the core assembly 4 comprises a first iron core 43 and a second iron core 44, wherein the first iron core 43 and the second iron core 44 are provided with a protrusion 41, and the protrusion 41 is configured to pass through the main winding 21 and the metal sheets 31, 32. The first iron core 43 and the second iron core 44 cover at least one portion of the primary conductive unit 2 and at least one portion of the secondary conductive unit 3 to form an electromagnetic circuit, so that the primary conductive unit 2 and the secondary conductive unit 3 are electromagnetically coupled.

[0027] Please refer to FIG. 3 and FIG. 4, wherein FIG. 4 illustrates a cross-sectional view of FIG. 1. The shielding structure 5 comprises a plurality of bending portions 51 and a plurality of shielding portions 52. Two adjacent shielding portions 52 respectively extend from two ends of a corresponding bending portion 51 in the same direction. The shielding portion 52 of the shielding structure 5 is disposed between the main winding 21 of the primary conductive unit 2 and the secondary conductive unit 3. Specifically, two adjacent shielding portions 52 of the shielding structure 5 are respectively attached to opposite sides of the main winding 21, so that the two adjacent shielding portions 52 are respectively located between the main winding 21 and the corresponding metal sheets 31, 32. Furthermore, the shielding structure 5 further comprises a starting end 54 and an ending end 55. The starting end 54 and the ending end 55 are respectively connected to two pins to be electrically connected to an external component, such as a circuit board (not shown).

[0028] In the embodiment, as shown in FIG. 2, the starting end 54 and the ending end 55 of the shielding structure 5 respectively correspond to a first segment D1 and a second segment D2 of a U-shaped metal sheet 31. The first segment D1 and the second segment D2 of the U-shaped metal sheet 31 are fitted to the shielding portions 52. The shielding structure 5 extends from the starting end 54 in a first direction (upward) and passes through a gap between the first segment D1 of the metal sheet 31 and the main winding 21. The shielding structure

5 is bent at one end of the main winding 21 and then extends in a second direction (downward) and passes through a gap between the main winding 21 and the first section D1 of the metal sheet 32. The shielding structure 5 is bent at one end of the first section D1 of the metal sheet 32 and extends along the first direction. The shielding structure 5 then extends by a U-shaped shielding portion 53 and wraps around the second section D2 of the metal sheet 32 and extends along the second direction. The shielding structure 5 is bent at one end of the second section D2 of the metal sheet 32 and extends along the first direction to pass through a gap between the second section D2 of the metal sheet 32 and the main winding 21. The shielding structure 5 is bent at one end of the main winding 21 and then extends along the second direction to pass through a gap between the main winding 21 and the second section D2 of the metal sheet 31. Finally, the shielding structure 5 extends to the ending end 55.

[0029] Please refer to FIG. 5, a partial schematic diagram of a shielding structure of the transformer of FIG. 1 is illustrated. In the embodiment, the shielding structure 5 is an elongated strip formed by a plurality of conductive wires arranged in parallel, and then the shielding structure 5 is bent to form the bending portions 51 and the shielding portions 52, but there may be other implementations, for example, the shielding structure 5 is an elongated strip formed by an insulating layer covering a conductive sheet. It should be noted that the shielding structure 5 of the present disclosure can be pre-processed and combined with the metal sheets 31, 32, and then inserted into the core assembly 4, which can effectively shorten the process.

[0030] As shown in FIG. 2, in the embodiment, the two metal sheets 31, 32 are, for example, U-shaped. When the first iron core 43 and the second iron core 44 are assembled, both ends of the metal sheets 31, 32 are exposed outside the core assembly 4, and both ends of the two metal sheets 31, 32 are used to be electrically connected to a circuit board or an external component (not shown). Specifically, each metal sheet 31, 32 comprises a shoulder A, two extension portions B, and an opening C, wherein the two extension portions B are respectively connected to opposite sides of the shoulder A, the opening C is formed between the two extension portions B, and the two shielding portions 52 are respectively located on opposite sides of the opening C.

[0031] Please refer to FIG. 6, a schematic diagram of a shielding structure of a transformer according to another embodiment of the present disclosure is illustrated. The shielding structure 5 of the present disclosure further comprises an U-shaped shielding portion 53 connected between the two shielding portions 52, and the U-shaped shielding portion 53 is away from the bending portion 51, wherein the U-shaped shielding portion 53 can cover the shoulder A of the metal sheet 32, and a width of the U-shaped shielding portion 53 is more than half of a width of the shoulder A of the metal sheet 32. The two shielding portions 52 are capable of covering the two extension

portions B of the metal sheet 32, and a width of the shielding portion 52 is more than half of a width of the extension portion B of the metal sheet 32, so that a projection area of the shielding portions 52 and the U-shaped shielding portion 53 of the shielding structure 5, when projected onto the corresponding metal sheet 32, at least covers the two extension portions B and the shoulder A of the metal sheet 32. Preferably, the widths of the shielding portion 52 and the U-shaped shielding portion 53 of the shielding structure 5 are greater than or equal to the widths of the extension portion B and the shoulder A of the metal sheet 32, thereby increasing the shielded area of the metal sheet 32 to improve the shielding effect of the shielding structure 5.

[0032] Moreover, the two bending portions 51 of the shielding structure 5 are respectively located at a first side and a second side of the opening C of the corresponding metal sheet 32, and the bending portion 51 located at the first side corresponds to the bending portion 51 located at the second side.

[0033] Please refer to FIG. 7 and FIG. 8, wherein FIG. 7 illustrates a schematic diagram of a transformer according to an embodiment of the present disclosure and FIG. 8 illustrates a schematic diagram of an exploded view of FIG. 7. The secondary conductive unit 3 of the present disclosure comprises a plurality of metal sheets 31, 32, 33, 34. The plurality of main windings 21, 22, 23 of the primary conductive unit 2 of the present disclosure are disposed between the plurality of metal sheets 31, 32, 33, 34.

[0034] Please refer to FIG. 8, FIG. 9, and FIG. 10, wherein FIG. 9 illustrates a partial schematic diagram of the transformer of FIG. 7 and FIG. 10 illustrates a cross-sectional view of FIG. 7. The plurality of shielding portions 52 of the shielding structure 5 of the present disclosure are respectively arranged between the corresponding main windings 21, 22, 23 and the corresponding metal sheets 31, 32, 33, 34. The plurality of bending portions 51 of the shielding structure 5 extends across the corresponding main windings 21, 22, 23 and across the shoulders A of the corresponding metal sheets 32, 34. The plurality of metal sheets 31, 32, 33, 34 are disposed alternately so that the openings C of two adjacent metal sheets 31, 32, 33, 34 are in opposite directions. The plurality of metal sheets 32, 34 with the openings C facing upward are connected in parallel, and the plurality of metal sheets 31, 33 with the openings C facing downward are connected in parallel.

[0035] In the embodiment, as shown in FIG. 8, the starting end 54 and the ending end 55 of the shielding structure 5 respectively correspond to a first section D1 and a second section D2 of the U-shaped metal sheet 31. The first section D1 and the second section D2 of the U-shaped metal sheet 31 are fitted to the shielding portions 52. The shielding structure 5 extends from the starting end 54 in a first direction (upward) and passes through a gap between the first section D1 of the metal sheet 31 and the main winding 21. The shielding structure 5 is bent at

one end of the main winding 21 and then extends in the second direction (downward) to pass through a gap between the main winding 21 and the first section D1 of the metal sheet 32. The shielding structure 5 is bent at one end of the first section D1 of the metal sheet 32 and extends along the first direction, wherein the shielding structure 5 is wound around the main windings 22, 23 in the same manner as the main winding 21 and will not be described in detail herein. The shielding structure 5 then extends by the U-shaped shielding portion 53 and wraps around the second section D2 of the metal sheet 34 and extends along the second direction. The shielding structure 5 is bent at one end of the second section D2 of the metal sheet 34 and extends along the first direction to pass through a gap between the second section D2 of the metal sheet 34 and the main winding 23. The shielding structure 5 is bent at one end of the main winding 23 and then extends in the second direction to pass through the gap between the main winding 23 and the second section D2 of the metal sheet 33. The subsequent winding steps are performed in the same manner, and finally, the shielding structure 5 extends to the terminal end 55.

[0036] According to the above structure, the shielding structure 5 located between the primary conductive unit 2 and the secondary conductive unit 3 can form a shield between the main windings 21, 22, 23 and the metal sheets 31, 32, 33, 34 in the transformer to reduce electromagnetic interference. For example, in a transformer without the shielding structure 5, the EMI is -0.46dB, and in a transformer with the shielding structure 5, the EMI is reduced to -3.18dB. Therefore, the shielding structure 5 of the present disclosure can effectively reduce the impact of EMI.

[0037] As described above, the present disclosure arranges the shielding structure 5 in a bent configuration between the primary conductive unit 2 and the secondary conductive unit 3, thereby forming shielding between the two conductive units to reduce electromagnetic interference and prevent excessive induced voltage. It can enhance the stability and safety of the power supply system. Furthermore, the shielding structure 5 can be preassembled with the metal sheets 31, 32, thereby shortening the manufacturing process.

[0038] While the present disclosure has been disclosed with reference to specific embodiments, it is not intended to be limited thereto. Various modifications and alterations may be made by those skilled in the art without departing from the spirit and scope of the invention. Therefore, the scope of protection of the present disclosure shall be defined by the appended claims.

Claims

1. A transformer, **characterized in that** the transformer comprising:

a primary conductive unit (2) comprising at least

- one main winding (21);
 a secondary conductive unit (3) disposed alternately with the primary conductive unit (2);
 a core assembly (4) comprising a protrusion (41) and an accommodating space (42), wherein the main winding (21) and the secondary conductive unit (3) are disposed in the accommodating space (42) and wound around the protrusion (41); and
 a shielding structure (5) comprising a plurality of bending portions (51) and a plurality of shielding portions (52), wherein two adjacent shielding portions (52) respectively extend from two ends of a corresponding bending portion (51); at least one shielding portion (52) of the shielding structure (5) is disposed between at least one main winding (21) of the primary conductive unit (2) and the secondary conductive unit (3).
2. The transformer according to claim 1, **characterized in that** the secondary conductive unit (3) comprises two metal sheets (31, 32); at least one main winding (21) of the primary conductive unit (2) is disposed between the two metal sheets (31, 32); at least one shielding portion (52) of the shielding structure (5) is disposed between the corresponding main winding (21) and the corresponding metal sheet (31, 32).
 3. The transformer according to claim 1, **characterized in that** the secondary conductive unit (3) comprises a plurality of metal sheets (31, 32); the plurality of main windings (21, 22) of the primary conductive unit (2) are disposed between the metal sheets (31, 32); the plurality of shielding portions (52) of the shielding structure (5) are respectively disposed between the corresponding main windings (21, 22) and the corresponding metal sheets (31, 32).
 4. The transformer according to claim 3, **characterized in that** each metal sheet (31, 32) comprises a shoulder (A), two extension portions (B) and an opening (C); the two extension portions (B) are respectively connected to opposite sides of the shoulder (A); the opening (C) is formed between the two extension portions (B); the two shielding portions (52) are respectively located on opposite sides of the opening (C).
 5. The transformer according to claim 4, **characterized in that** the metal sheets (31, 32) are arranged alternately so that the openings (C) of two adjacent metal sheets (31, 32) are oriented in opposite directions; the metal sheets (31, 32) with openings (C) oriented in a first direction are connected in parallel; the metal sheets (31, 32) with openings (C) oriented in a second direction are connected in parallel; the first direction is opposite to the second direction.
 6. The transformer according to claim 4, **characterized in that** at least one bending portion (51) of the shielding structure (5) extends across the shoulder (A) of the corresponding metal sheet (31, 32).
 7. The transformer according to claim 4, **characterized in that** at least one bending portion (51) of the shielding structure (5) extends across the corresponding main winding (21).
 8. The transformer according to claim 4, **characterized in that** a projection area of the shielding portions (52) of the shielding structure (5), when projected onto the corresponding metal sheet (31, 32), covers the two extension portions (B) of the metal sheet (31, 32).
 9. The transformer according to claim 4, **characterized in that** the plurality of bending portions (51) of the shielding structure (5) are respectively located on a first side and a second side of the openings (C) of the metal sheets (31, 32); the bending portions (51) located on the first side correspond to the bending portions (51) located on the second side.
 10. The transformer according to claim 9, **characterized in that** the plurality of shielding portions (52) located on the first side correspond to the plurality of shielding portions (52) located on the second side.
 11. A shielding structure disposed in a transformer, the transformer comprising a primary conductive unit (2) and a secondary conductive unit (3) disposed alternately with the primary conductive unit (2), **characterized in that** the shielding structure (5) comprising:
 - a plurality of bending portions (51); and
 - a plurality of shielding portions (52), wherein two adjacent shielding portions (52) respectively extend from two ends of a corresponding bending portion (51);
 - wherein at least one shielding portion (52) of the shielding structure (5) is disposed between at least one main winding (21) of the primary conductive unit (2) and the secondary conductive unit (3).
 12. The shielding structure according to claim 11, **characterized in that** the shielding structure (5) comprises a starting end (54) and an ending end (55); the starting end (54) and the ending end (55) are respectively electrically connected to an external component.
 13. The shielding structure according to claim 11, **characterized in that** the shielding structure (5) is an elongated strip formed by an insulating layer covering a conductive sheet.

14. The shielding structure according to claim 11, **characterized in that** the shielding structure (5) is an elongated strip formed by a plurality of conductive wires arranged in parallel.

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15. The shielding structure according to claim 11, **characterized in that** the secondary conductive unit (3) comprises at least one metal sheet (31, 32); the metal sheet (31, 32) comprises a shoulder (A), two extension portions (B) and an opening (C); the two extension portions (B) are respectively connected to opposite sides of the shoulder (A); the opening (C) is formed between the two extension portions (B); a width of the shielding structure (5) is greater than or equal to a width of the corresponding extension portion (B).

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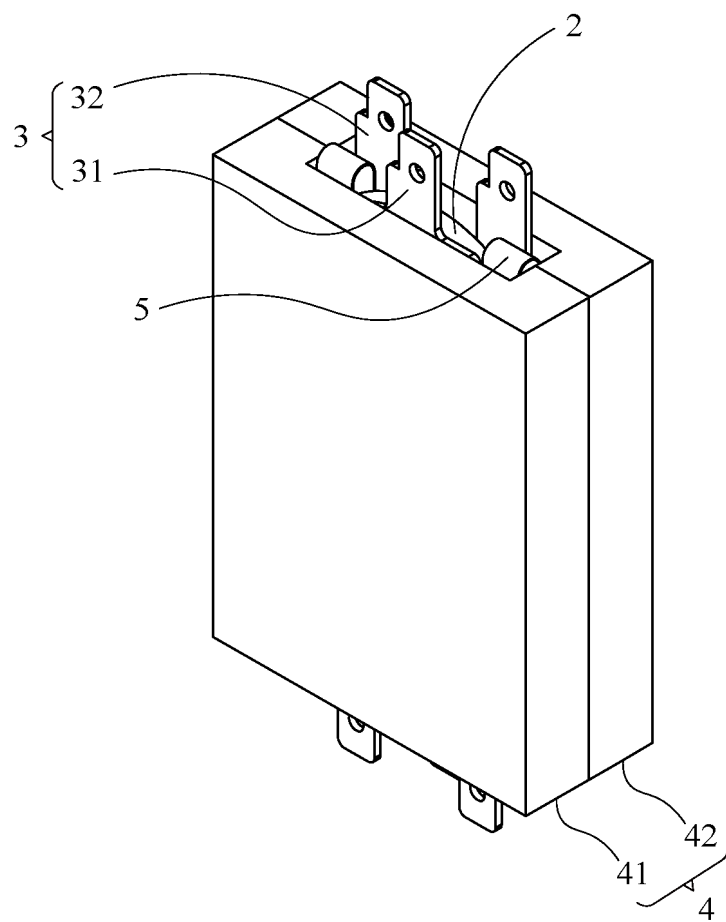


FIG. 1

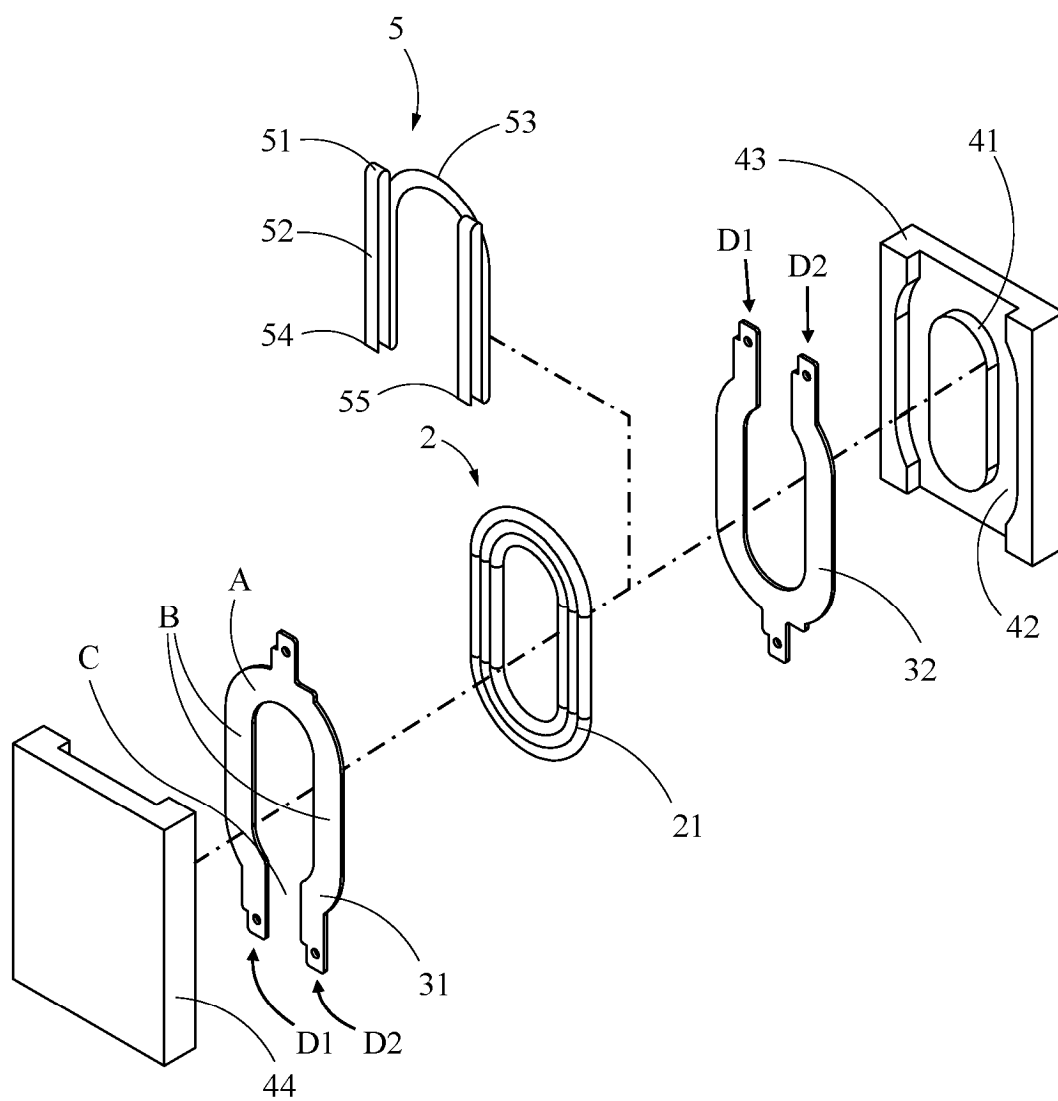


FIG. 2

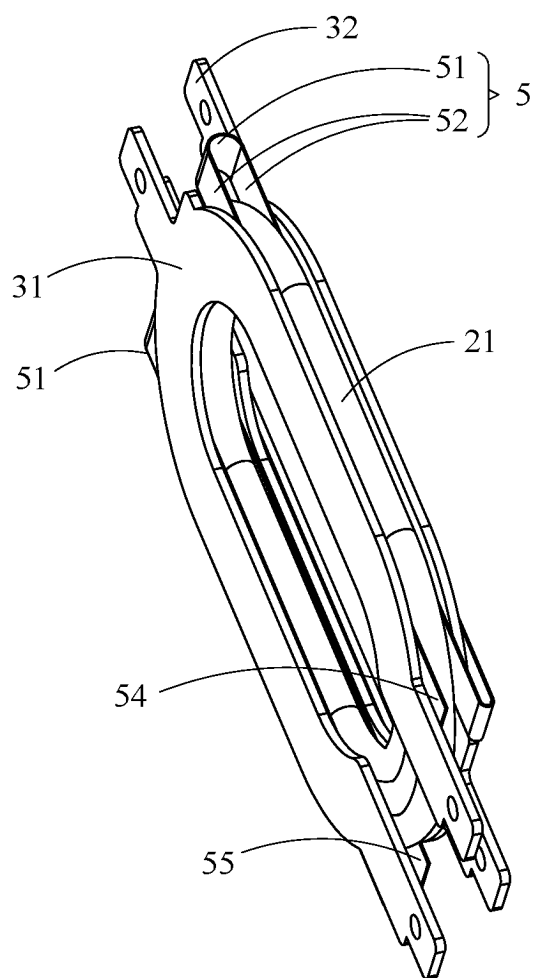


FIG. 3

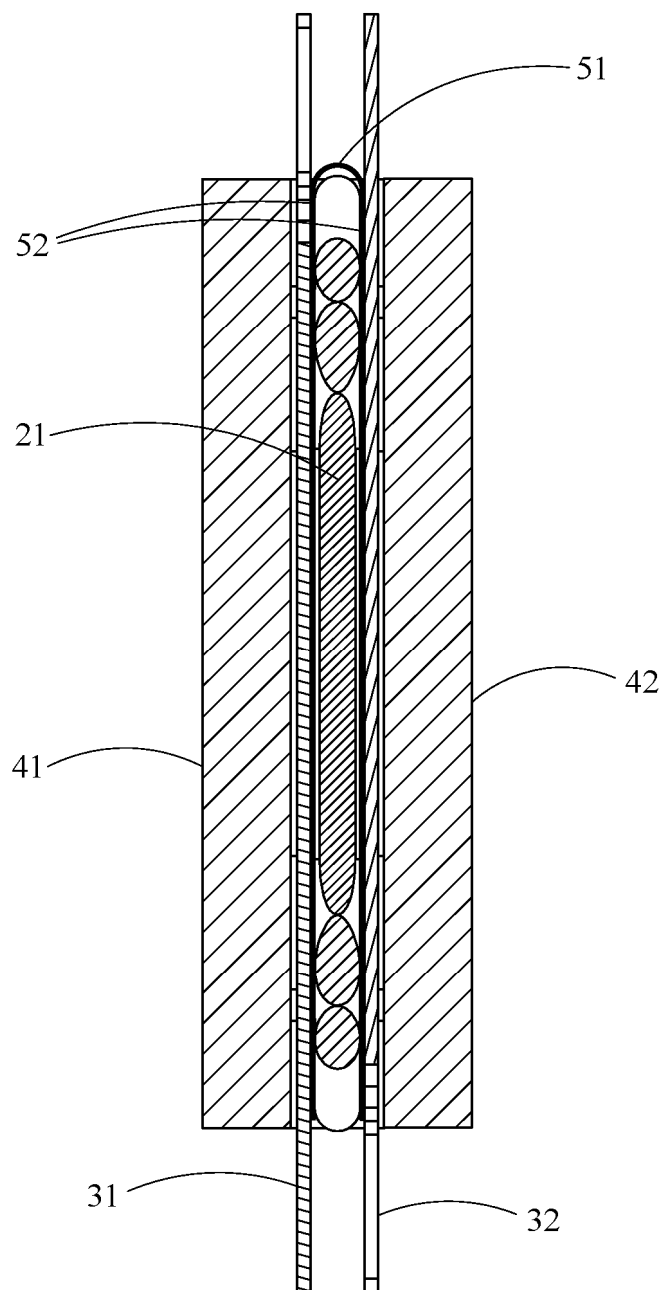


FIG. 4

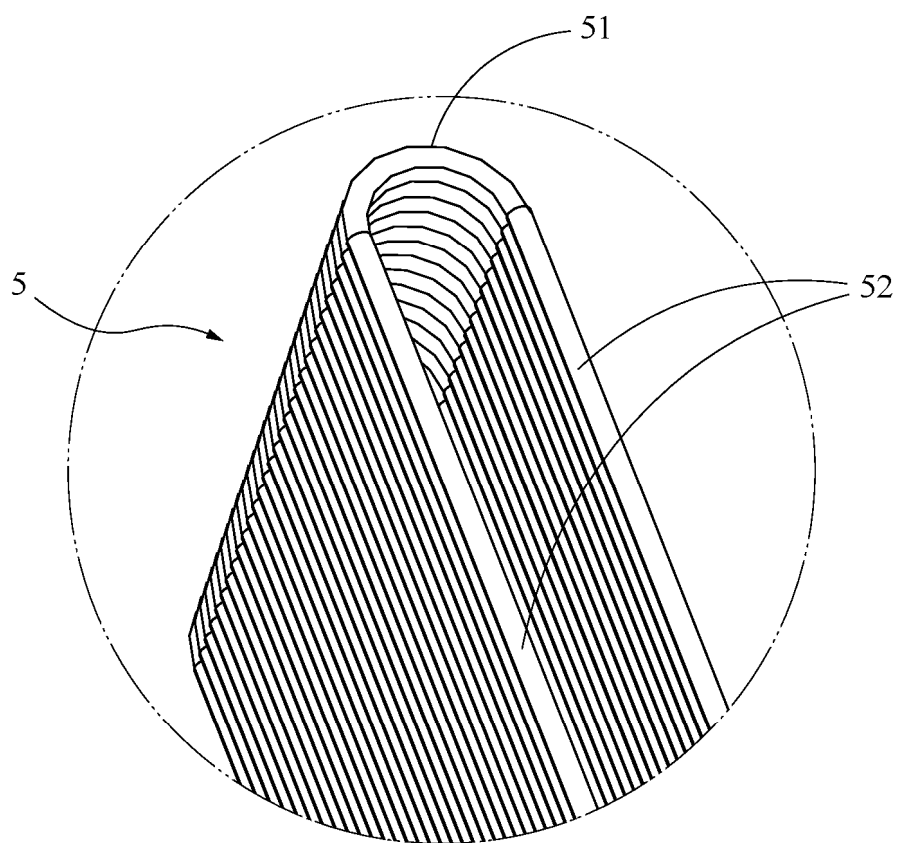


FIG. 5

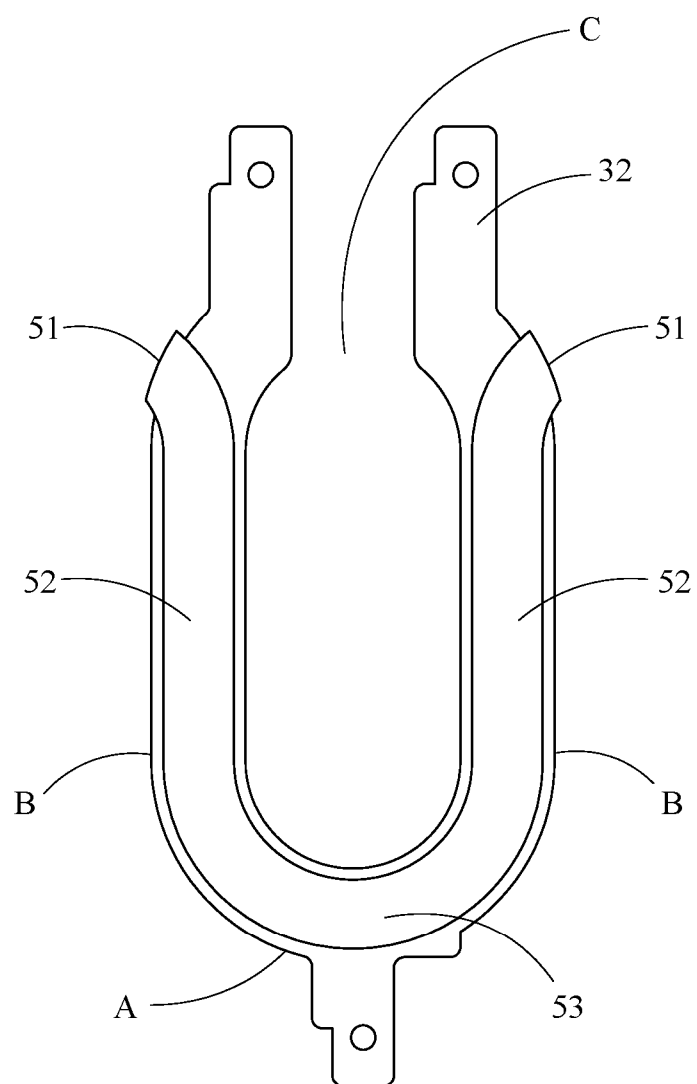


FIG. 6

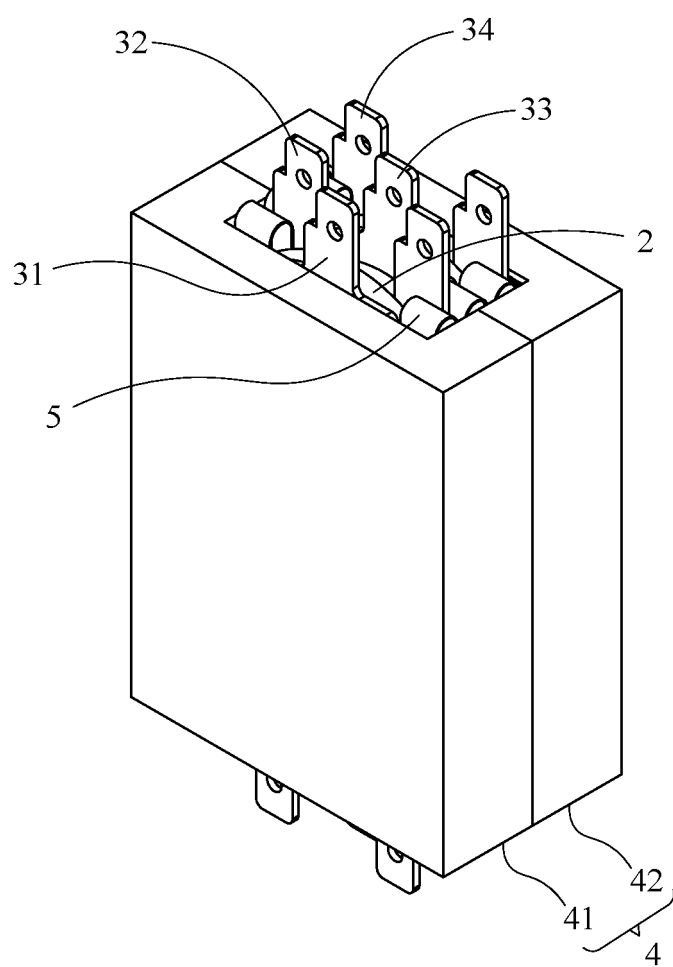


FIG. 7

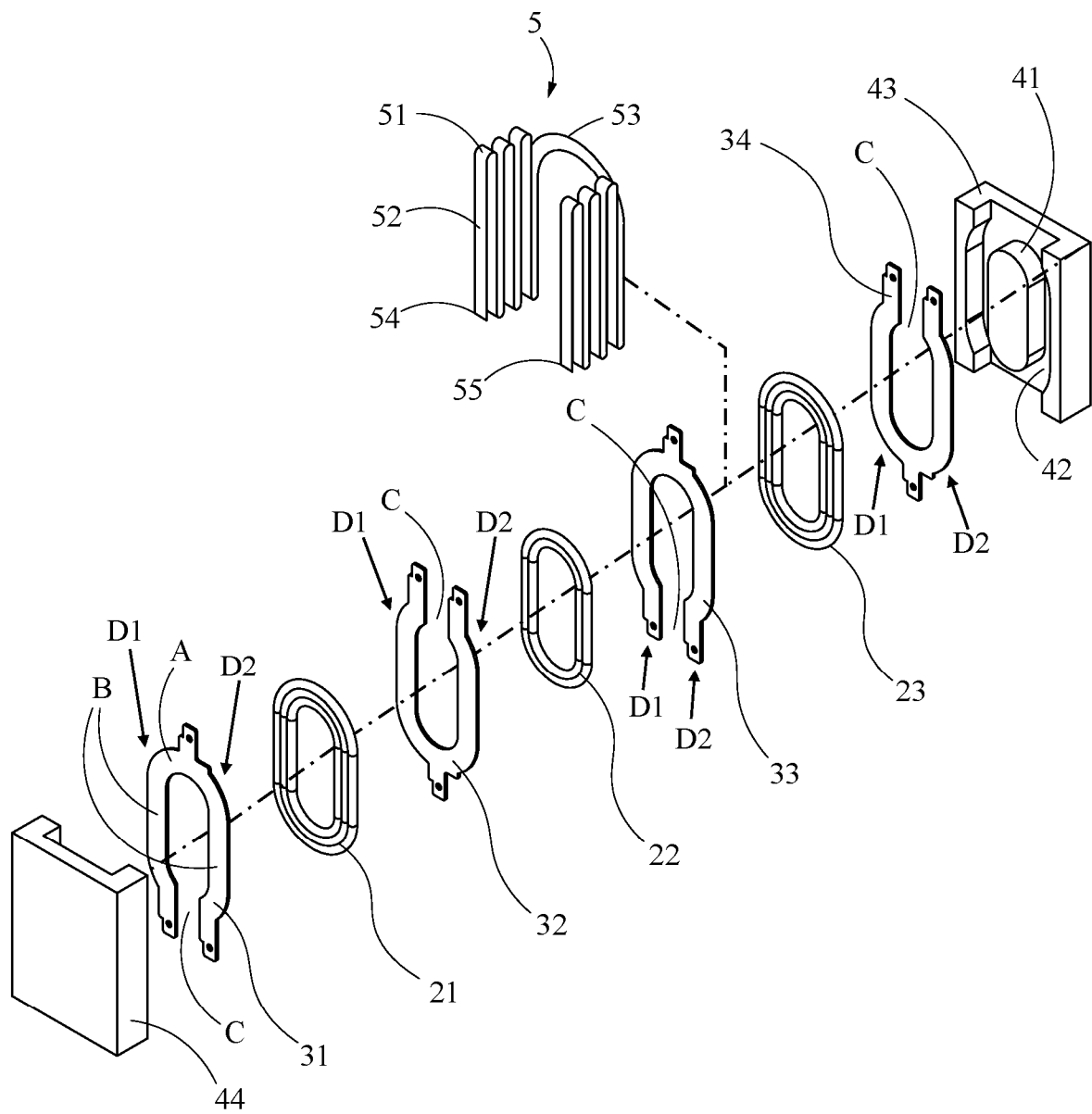


FIG. 8

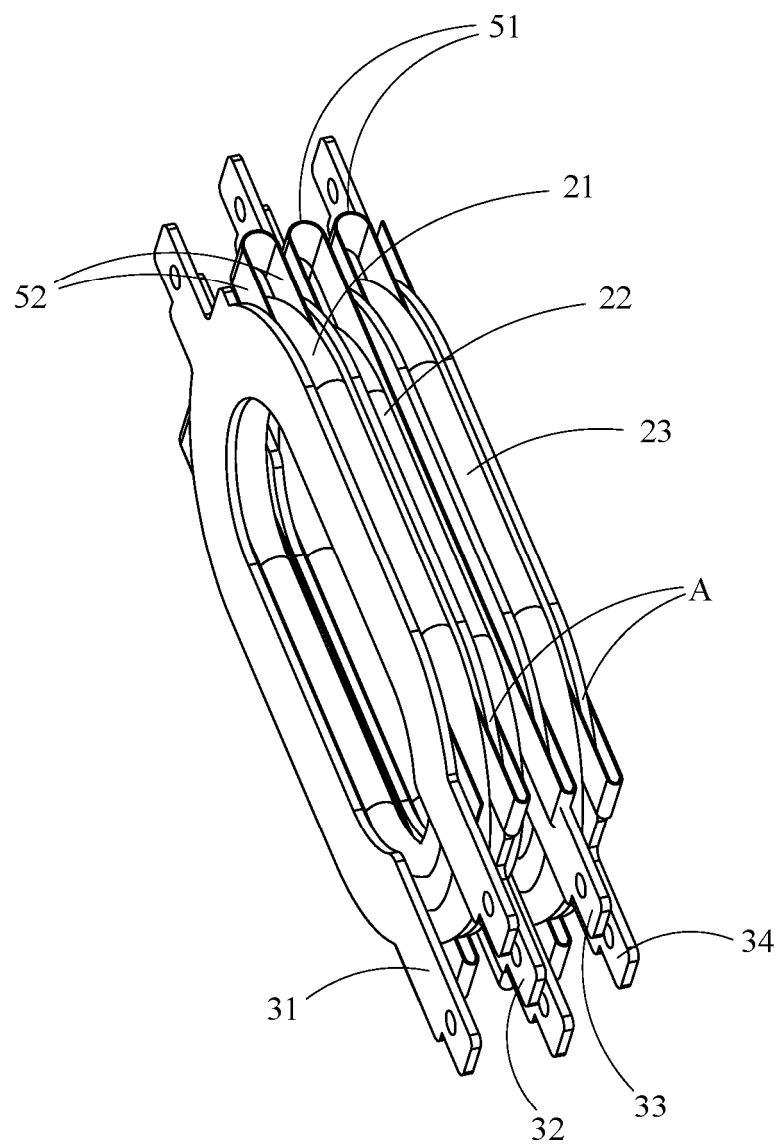


FIG. 9

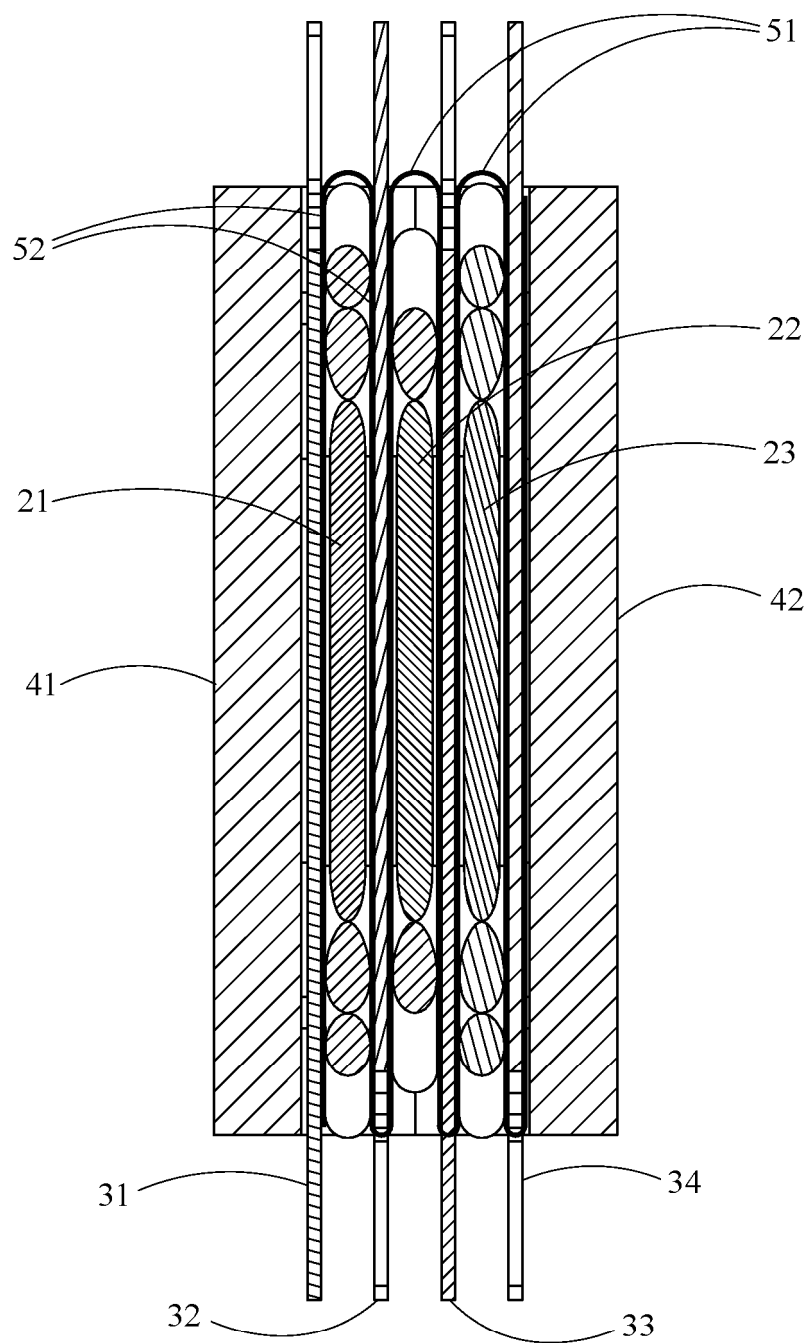


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2025/074279

A. CLASSIFICATION OF SUBJECT MATTER

H01F27/36(2006.01)i; H01F27/28(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:H01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, CNTXT, ENTXTC, DWPI, CNKI: 变压器, 并联, 箔, 不同侧, 初级, 出线, 次级, 导电片, 电极, 端, 对侧, 二次, 方向, 副边, 夹, 交错, 交替, 金属片, 开口, 相反, 跨, 片, 平板, 平面, 屏蔽, 绕组, 蛇, 梳, 输出, 台达电子, 弯, 折, 线圈, 一次, 引线, 原边, primary, secondary, shield, plate, sheet, Bend, coil, winding, Planar, foil

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 113632185 A (SHENZHEN HUNTKEY ELECTRIC CO., LTD.) 09 November 2021 (2021-11-09) description, paragraphs 51-113, and figures 1-14	1-15
Y	CN 102254898 A (INSTITUTE OF MICROELECTRONICS OF CHINESE ACADEMY OF SCIENCES) 23 November 2011 (2011-11-23) description, paragraphs 23-34, and figures 5-6	1-15
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Y	CN 103094256 A (INSTITUTE OF MICROELECTRONICS OF CHINESE ACADEMY OF SCIENCES) 08 May 2013 (2013-05-08) description, paragraphs 44-86, and figures 1-10	1-15
A	JP 2006100453 A (TDK CORP.) 13 April 2006 (2006-04-13) entire document	1-15
A	JP 2010171161 A (TDK CORP.) 05 August 2010 (2010-08-05) entire document	1-15

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2025/074279

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