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(54) HIGH FREQUENCY TRANSFORMER WITH IMPROVED HEAT DISSIPATION

HOCHFREQUENZTRANSFORMATOR MIT VERBESSERTER WÄRMEABFUHR

TRANSFORMATEUR HAUTE FRÉQUENCE À DISSIPATION DE CHALEUR AMÉLIORÉE

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Description

[0001] The present invention relates to electrical transformers, and particularly to high-frequency transformers; more specifically, the invention relates to a high-frequency transformer with improved heat dissipation.

[0002] High-frequency transformers have application fields mainly aimed at obtaining currents at high values from a power source, such as an inverter; one of the main characteristics of high-frequency transformers is that they are modest in size compared to low-frequency transformers, a feature that favors their use in modular structures.

[0003] The features of a high-frequency transformer must take into account needs related to its structure, which must be able as best as possible to absorb the vibrations generated, and which must adequately dissipate heat, as well as being able to minimize eddy currents.

[0004] Document US6087916 describes a high-frequency transformer comprising a pair of juxtaposed load-bearing tubular elements, rigidly connected to each other at one respective end, being at the opposite end connected to suitable supporting means, and being arranged on each said tubular element a plurality of annular ferromagnetic elements sized to cooperate with said tubular elements and suitable for forming the core of said transformer, the windings of said transformer being arranged coaxially to said tubular elements; this type of transformer is cooled by wrapping the ferromagnetic elements with a metal sheet, which then goes to discharge the heat onto the plate of a radiator. This solution is not optimal, however, because the contact surface between the transformer and the sheet is not completely effective.

[0005] Document EP3474300, which is owned by the same applicant, relates to a high-frequency transformer of a similar type to the one described above, in which the problem of heat dissipation is approached by introducing the transformer into a box container filled with thermoconductive resin; however, even in this case the solution does not always give the expected results, since any unevenness in the distribution of the resin within the container can lead to poor heat dissipation.

[0006] Document US2014224998 describes a high-frequency transformer provided with a casing made of a metallic material that is able to surround the side surface of the transformer, but does not interact with the windings; clearly, the efficiency of heat dissipation is far from optimal.

[0007] The aim of the present invention, therefore, is a high-frequency transformer in which heat dissipation is accomplished in a manner that is simple, effective, and such that a well-organized arrangement on the surface intended for cooling is possible.

[0008] Thus, an object of the present invention is a high-frequency transformer comprising:

- a pair of juxtaposed carrying tubular elements, being arranged on each said tubular elements a plurality of annular ferromagnetic elements sized to cooperate with said tubular elements and suitable for forming the core of said transformer, the windings of said transformer being arranged coaxially with said tubular elements;
- a parallelepiped container made of metallic material, consisting of two half-shells, each half-shell being provided with a pair of juxtaposed semi-cylindrical cavities, suitable for housing the annular ferromagnetic elements; in each of the two half-shells there are also provided two semi-ellipsoidal cavities, formed at the ends of the semi-cylindrical cavities, and perpendicular to them, and intended to house the windings of said transformer.

[0009] A plurality of through-holes, perpendicular to the longitudinal axes of said semi-cylindrical cavities, are advantageously provided for the placement of means of fastening through both half-shells; a half-shell is provided with through-openings on the back wall of said semi-ellipsoidal cavities.

[0010] Preferably, said openings have the same outer perimeter as said semi-ellipsoidal cavities.

[0011] In an embodiment, a wall of a minimum thickness shall be provided between said two semi-cylindrical cavities of each half-shell to allow the formation of at least one through-hole for the placement of suitable fasteners. Specifically, such a wall shall have a minimum thickness between 3.0 mm and 7.0 mm.

[0012] Further advantages and features of the transformer according to the present invention will be apparent from the following description of an embodiment of the same rendered, for illustrative and non-limiting purposes, with reference to the accompanying tables of drawings, wherein:

figure 1 is a perspective view of an embodiment of the transformer according to the present invention;
figure 2 is a cross-sectional view of the transformer of figure 1:

figures 3A and 3B are perspective views of a semi-shell of the transformer case of Figure 1; and
figures 4A and 4B are perspective views of the other half-shell of the transformer container of figure 1.

[0013] An embodiment of the transformer according to the present invention is illustrated in Figure 1; 1 designates the parallelepiped container body in which the toroidal rings 2, arranged on the juxtaposed tubular supports 102, in which the primary 202 and secondary 302 windings are arranged, as will be better shown below. Container 1 comprises the two half-shells 101 and 201; the upper half-shell 101, provided with the ellipsoidal openings 131 that allow the connection of the ends of

the windings, which are housed in the respective semi-ellipsoidal cavities 121, 221 of each half-shell. Near the four corners of the outer face of half-shell 101 are formed through holes 111b, perpendicular to the plane of said face; a similar hole 111a is formed centrally to the same face.

[0014] Figure 2 shows the transformer of Figure 1 in cross section; equal parts correspond to equal numerals. The structure of the transformer is well shown in the figure, with the toroidal rings 2 supported by the tubular elements 2, shaped to accommodate both the primary 202 and the secondary 302. The two juxtaposed sets of rings 2 are located in the semi-cylindrical cavities 141 of the semi-shell 101 and 241 of the semi-shell 201, which are separated from each other by the respective intermediate walls, 151 and 251. Through said walls, through holes 111a and 211a are formed for the insertion of fasteners.

[0015] Figures 3A and 3B show the lower half-shell 201 in perspective; equal parts correspond to equal numerals.

[0016] Highlighted in the figure is the shape and position of the semi-ellipsoidal 221, located at the ends of the semi-cylindrical cavities 241, and with the major axis perpendicular to the longitudinal axis of said cylindrical cavities. It can also be seen that the middle wall 251 and the two side walls 261 have essentially the same minimum thickness. The through-holes 211a and 211b are arranged in a quincunx pattern; the outer face of Figure 3B is the one that is to contact the means of heat dissipation, such as a cold plate, a radiator, or the like.

[0017] Figures 4A and 4B show the upper half-shell 101 in perspective; equal parts correspond to equal numerals. Highlighted in the figure is the fact that semi-ellipsoidal cavity 121 is completely open at its top, or bottom, and the perimeter of opening 131 corresponds to the maximum perimeter of said cavity 121. The outer side walls 161 and the middle wall 151 have the same features as the similar walls described for the lower half-shell 201, as do the through holes 111a and 111b.

[0018] The construction and operation of the transformer according to the present invention will appear evident from the following. The two half-shells are made of metallic material, and preferably of a highly conductive and preferably lightweight metallic material. The use of Al or its alloys is preferred for this purpose. The two half-shells of the container can be made by machining with material removal, as well as by die casting.

[0019] The openings 131 formed on the upper half-shell 101 allow the passage of the winding ends, and at the same time keep the said ends at the appropriate distance from the cooling surface on which the transformer is fixed. The choice of forming a partition between the two cylindrical cavities descends from two considerations; the first is of a structural order, since an intermediate stiffening line is thus provided in addition to the two side walls 161, 261. The second is related to the possibility of inserting in this way at least one means of attachment in the center of the housing, thus making more effective contact with the cooling surface and thus achieving better thermal dissipation. In addition, the compact design of this container body and the robust fastening system allow for effective vibration control.

[0020] The size of the container body is clearly related to the number and size of the toroidal elements that are provided in the specific high-frequency transformer design. The size of the intermediate wall is clearly related to the symmetries of the whole structure, but it is also determined by the minimum size of the fastening means that is chosen to connect the transformer to the cooling surface. In the most generally found cases, the minimum wall thickness can be between 3.0 mm and 7.0 mm, and in the present case a thickness of 4.5 mm is considered. The outer side walls have a thickness essentially similar to that of the intermediate wall.

[0021] The regular shape of the container body and the large openings on the top half-shell 101 facilitate an effective vacuum resination process of the assembly. This improves the quality of the resination itself by preventing the formation of air bubbles. The new solution, in addition to fitting naturally into the construction of a transformer of the type described above, provides at the end of the process a completely electrically insulated element that can be effectively attached to any radiator without the need for any additional insulation or the like.

[0022] The through holes for inserting the fastening means are preferably arranged in a quincunx pattern, as shown in the figures of the accompanying drawings, in order to distribute the fastening load over the entire contact surface of the container body.

[0023] The transformer according to the present invention thus solves the problems highlighted in the state of the art by means of a solution that is simple to implement and effective in heat dissipation.

Claims

1. High-frequency transformer, comprising:

- a pair of juxtaposed bearing tubular elements (102), being arranged on each said tubular elements (102) a plurality of annular ferromagnetic elements (2) sized to cooperate with said tubular elements (102) and forming the core of said transformer, the windings (202, 302) of said transformer being arranged coaxially with said tubular elements (102);
- a parallelepiped container (1) made of metallic material, consisting of two half-shells (101, 201), each half-shell being provided with a pair of juxtaposed semi-cylindrical cavities (141, 241), suitable for housing the annular ferromagnetic elements (2),

characterized by the fact that in each of the two

half-shells (101, 201) there are also provided two semi-ellipsoidal cavities (121, 221), located at the axial ends of the semi-cylindrical cavities (241) and with their major axis perpendicular to the longitudinal axis of said semi-cylindrical cavities (241), and housing the parts of the windings (202, 302) of said transformer located outside the tubular elements.

2. Transformer according to claim 1, in which there is a plurality of through holes (111a, 111b) through both half-shells (101, 201), perpendicular to the longitudinal axes of the aforementioned half-cylindrical cavities (141,241), for the placement of fastening means.

3. Transformer according to claim 1 or 2, in which a half-shell (101) is provided with through openings (131) on the bottom wall of each said semi-ellipsoidal cavities (121, 221).

4. Transformer according to claim 3, in which said through openings (131) have the same outer perimeter as said semi-ellipsoidal cavities (121).

5. Transformer according to any one of claims 1 to 4, wherein between said two semi-cylindrical cavities (141, 241) of each half-shell (101, 201) there is provided an intermediate wall (151, 251) having a minimum thickness such that at least one through-hole (111a) is formed for the positioning of suitable fastening means.

6. Transformer according to claim 5, in which such a wall (151, 251) has a minimum thickness between 3.0 mm and 7.0 mm.

7. Transformer according to any of the preceding claims 1 to 6, wherein said container is made of Al or an alloy thereof.

Patentansprüche

1. Hochfrequenztransformator, umfassend:

   - ein Paar nebeneinanderliegender röhrenförmiger Lagerelemente (102), wobei auf jedem der röhrenförmigen Elemente (102) eine Vielzahl ringförmiger ferromagnetischer Elemente (2) angeordnet ist, die so bemessen sind, dass sie mit den röhrenförmigen Elementen (102) zusammenwirken und den Kern des Transformators bilden, wobei die Wicklungen (202, 302) des Transformators koaxial zu den röhrenförmigen Elementen (102) angeordnet sind;
   - einen parallelepipedischen Behälter (1) aus metallischem Material, der aus zwei Halbschalen (101, 201) besteht, wobei jede Halbschale mit einem Paar nebeneinanderliegender halbzylindrischer Hohlräume (141, 241) versehen ist, die zur Aufnahme der ringförmigen ferromagnetischen Elemente (2) geeignet sind,

   dadurch gekennzeichnet, dass in jeder der beiden Halbschalen (101, 201) auch zwei halbellipsenförmige Hohlräume (121, 221) vorgesehen sind, die sich an den axiale Enden der halbzylindrischen Hohlräume (241) befinden und deren Hauptachse senkrecht zur Längsachse der halbzylindrischen Hohlräume (241) verläuft und die Teile der Wicklungen (202, 302) des Transformators aufnehmen, die sich außerhalb der rohrförmigen Elemente befinden.

2. Transformator nach Anspruch 1, bei dem eine Vielzahl von Durchgangslöchern (lila, 111b) durch die beiden Halbschalen (101, 201) senkrecht zu den Längsachsen der vorgenannten halbzylindrischen Hohlräume (141, 241) für die Anbringung von Befestigungsmitteln vorgesehen ist.

3. Transformator nach Anspruch 1 oder 2, bei dem eine Halbschale (101) mit Durchgangsöffnungen (131) an der Bodenwand jedes der halbellipsenförmige Hohlräume (121, 221) versehen ist.

4. Transformator nach Anspruch 3, bei dem die Durchgangsöffnungen (131) den gleichen Aussenrand haben wie die halbellipsenförmigen Hohlräume (121) .

5. Transformator nach einem der Ansprüche 1 bis 4, wobei zwischen den beiden halbzylindrischen Hohlräumen (141, 241) jeder Halbschale (101, 201) eine Zwischenwand (151, 251) mit einer solchen Mindestdicke vorgesehen ist, dass mindestens ein Durchgangsloch (lila) für die Positionierung geeigneter Befestigungsmittel ausgebildet ist.

6. Transformator nach Anspruch 5, bei dem eine solche Wand (151, 251) eine Mindestdicke zwischen 3,0 mm und 7,0 mm aufweist.

7. Transformator nach einem der vorhergehenden Ansprüche 1 bis 6, wobei der Behälter aus Al oder einer Legierung davon hergestellt ist.

Revendications

1. Transformateur à haute fréquence, comprenant

   - une paire d'éléments tubulaires porteurs juxtaposés (102), étant disposés sur chacun desdits éléments tubulaires (102) une pluralité d'éléments ferromagnétiques annulaires (2) dimensionnés pour coopérer avec lesdits éléments tubulaires (102) et formant le noyau dudit

transformateur, les spires (202, 302) dudit transformateur étant disposées coaxialement avec lesdits éléments tubulaires (102) ;
- un réceptacle parallélépipédique (1) en matériau métallique, constitué de deux coquilles (101, 201), chaque coquille étant pourvue d'une paire de cavités semi-cylindriques juxtaposées (141, 241), aptes à loger les éléments ferromagnétiques annulaires (2),

caractérisée par le fait que dans chacune des deux demi-coquilles (101, 201) sont également prévues deux cavités semi-ellipsoïdales (121, 221), situées aux extrémités axiales des cavités semi-cylindriques (241) et dont le grand axe est perpendiculaire à l'axe longitudinal desdites cavités semi-cylindriques (241), et abritant les parties des spires (202, 302) dudit transformateur situées à l'extérieur des éléments tubulaires.

2. Transformateur selon la revendication 1, dans lequel il y a une pluralité de trous de passage (111a, 111b) à travers les deux demi-coquilles (101, 201), perpendiculairement aux axes longitudinaux des cavités demi-cylindriques susmentionnées (141, 241), pour le placement de moyens de fixation.

3. Transformateur selon la revendication 1 ou 2, dans lequel une demi-coquille (101) est pourvue d'ouvertures traversantes (131) sur la paroi inférieure de chacune desdites cavités semi-ellipsoïdales (121, 221).

4. Transformateur selon la revendication 3, dans lequel lesdites ouvertures traversantes (131) ont le même périmètre extérieur que lesdites cavités semi-ellipsoïdales (121).

5. Transformateur selon l'une quelconque des revendications 1 à 4, dans lequel entre lesdites deux cavités semi-cylindriques (141, 241) de chaque demi-coquille (101, 201) est prévue une paroi intermédiaire (151, 251) ayant une épaisseur minimale telle qu'au moins un trou traversant (111a) est formé pour le positionnement de moyens de fixation appropriés.

6. Transformateur selon la revendication 5, dans lequel une telle paroi (151, 251) a une épaisseur minimale comprise entre 3,0 mm et 7,0 mm.

7. Transformateur selon l'une des revendications précédentes 1 à 6, dans lequel ledit réceptacle est en Al ou en un de ses alliages.

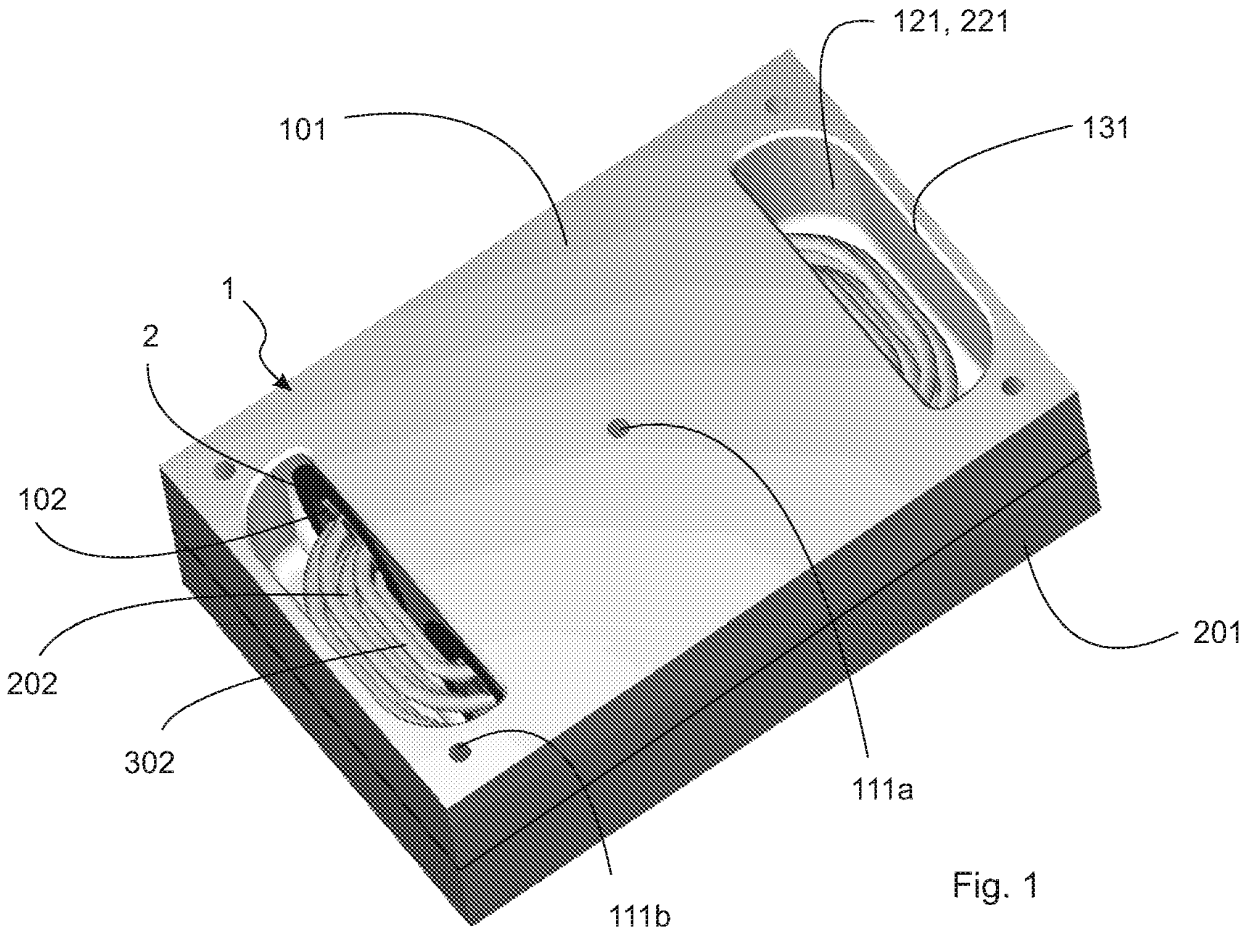
121, 221
101
131
1
2
102
202
302
111a
111b
201

Fig. 1

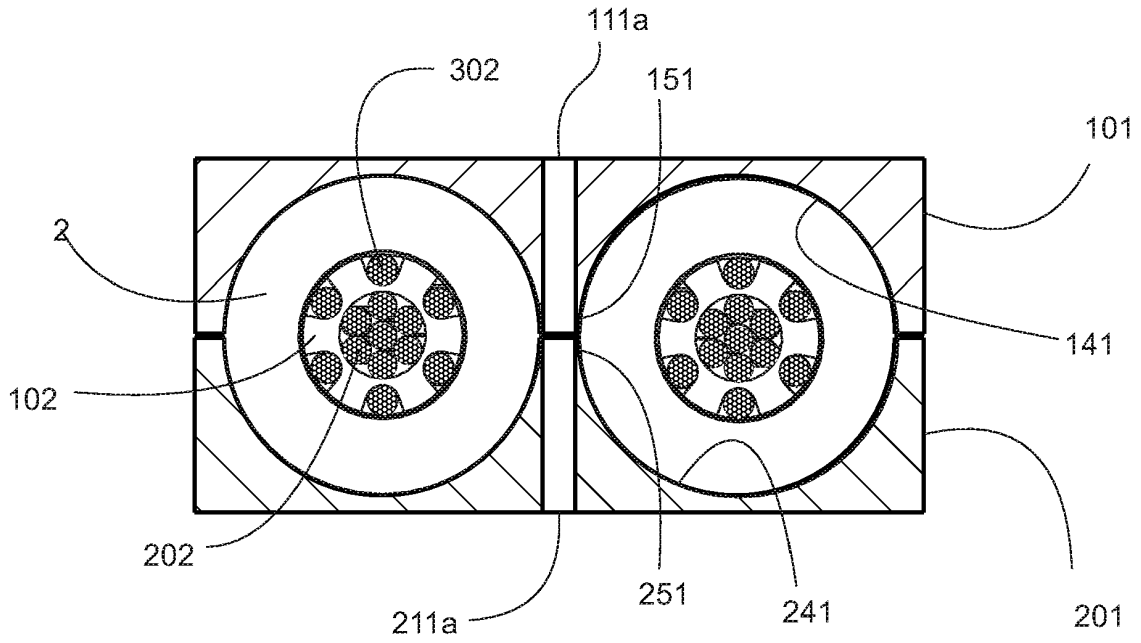
111a
302
151
101
2
141
102
202
211a
251
241
201

Fig. 2

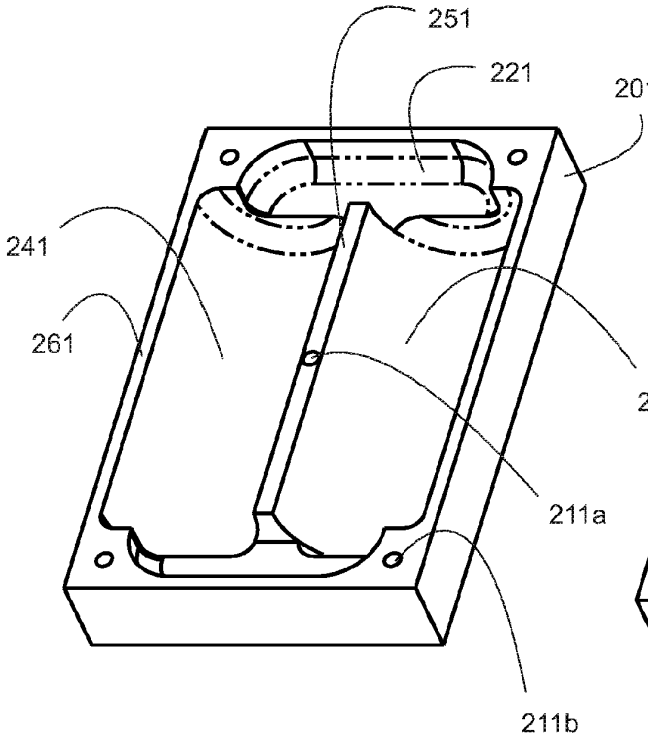

Fig. 3A

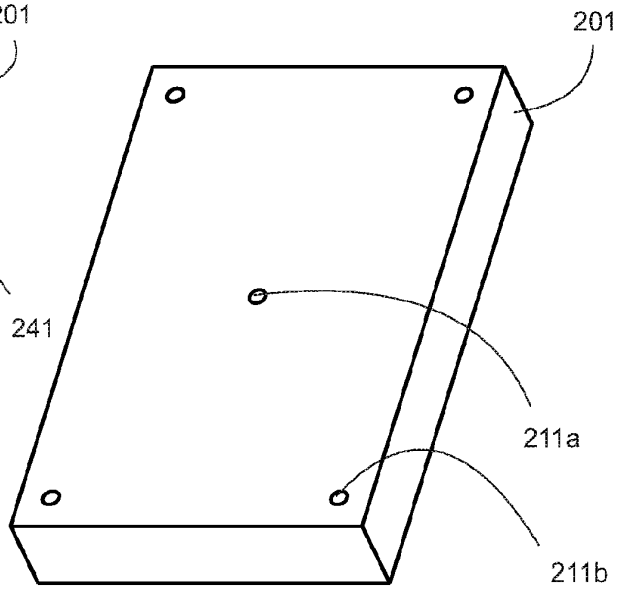

Fig. 3B

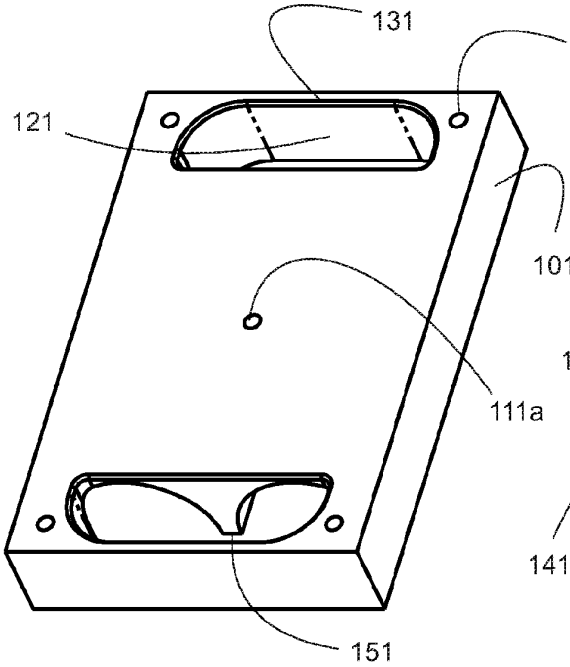

Fig. 4A

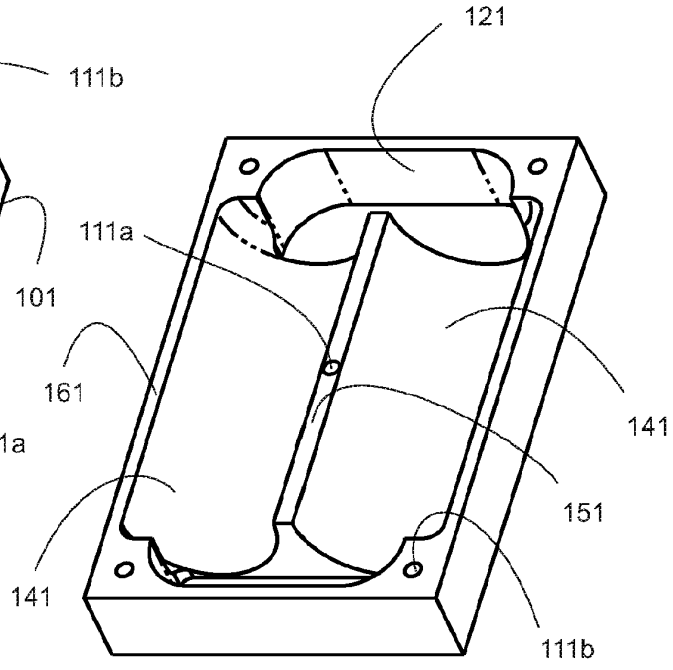

Fig. 4B

REFERENCES CITED IN THE DESCRIPTION

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