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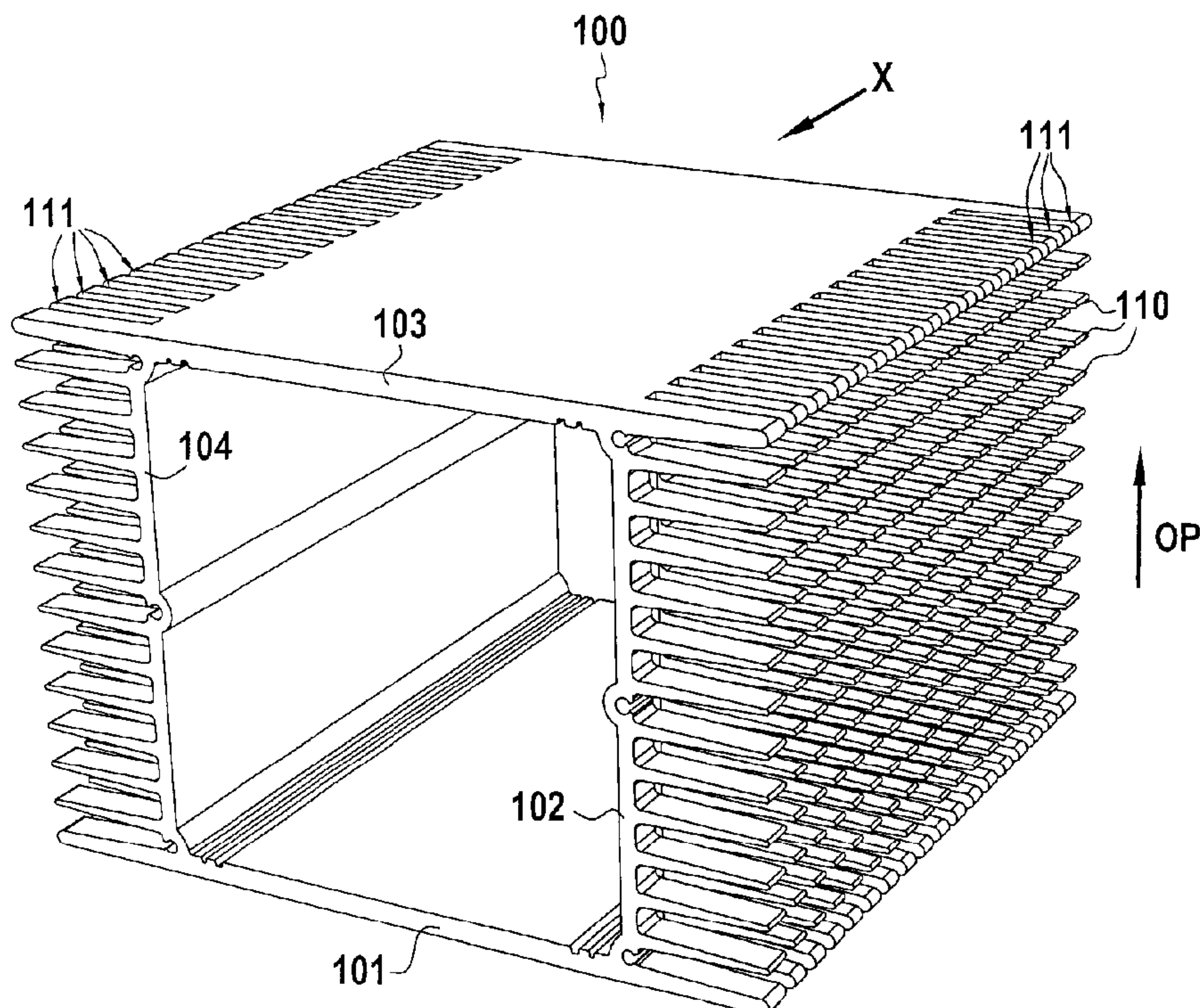
(72) Inventeurs/Inventors:
BIAGINI, ERIC, FR;
CAUSSIN, YVES, FR

(73) Propriétaire/Owner:
INTELLIGENT ELECTRONIC SYSTEMS, FR

(74) Agent: MCCARTHY TETRAULT LLP

(54) Titre : BOITIER MULTIPOSITION CONSTITUE D'ELEMENT SECTION EN METAL EXTRUDE POUR LA
FABRICATION D'UN DISPOSITIF ELECTRONIQUE DE PUISSANCE IMPERMEABLE

(54) Title: A MULTI-POSITION HOUSING MADE OF METAL EXTRUDED SECTION MEMBER FOR MANUFACTURING
A WATERPROOF POWER ELECTRONIC DEVICE



(57) Abrégé/Abstract:

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(57) Abrégé(suite)/Abstract(continued):

that is provided with fins (110) on at least one side of the rectangle (102, 104), said fins (110) allowing air to flow outside the housing (100) by natural convection in the extrusion direction (X), a side (101) that is not provided with fins being designed to serve as a base for fastening the housing (100) and as a support for power electronic components of the power electronic device (200). According to the invention, the fins (110) are machined transversely to the extrusion direction (X) so as to form notches (111) in the fins (110), said notches (111) being aligned in succession in an "optimum" direction (OP) that forms an angle with the extrusion direction (X) that is optimized as a function of a predetermined preferred installation direction, and said notches (111) being of geometrical shape such that they allow air to flow outside the housing (100) by natural convection in the optimum direction (OP).

A B S T R A C T

The invention relates to a housing (100) made of metal extruded section member for manufacturing a multi-
5 position waterproof power electronic device (200), the extruded section member forming a tunnel that is of substantially rectangular closed section and that is provided with fins (110) on at least one side of the rectangle (102, 104), said fins (110) allowing air to
10 flow outside the housing (100) by natural convection in the extrusion direction (X), a side (101) that is not provided with fins being designed to serve as a base for fastening the housing (100) and as a support for power electronic components of the power electronic device
15 (200). According to the invention, the fins (110) are machined transversely to the extrusion direction (X) so as to form notches (111) in the fins (110), said notches (111) being aligned in succession in an "optimum" direction (OP) that forms an angle with the extrusion
20 direction (X) that is optimized as a function of a predetermined preferred installation direction, and said notches (111) being of geometrical shape such that they allow air to flow outside the housing (100) by natural convection in the optimum direction (OP).

A MULTI-POSITION HOUSING MADE OF METAL EXTRUDED SECTION MEMBER
FOR MANUFACTURING A WATERPROOF POWER ELECTRONIC DEVICE

BACKGROUND OF THE INVENTION

5 The present invention relates to the general field
of housings made of metal extruded section members and
designed for manufacturing waterproof power electronic
devices.

 Such waterproof power devices are, for example,
10 battery chargers designed to be installed on board
vehicles such as, for example, fork-lift trucks, golf
carts, etc. that can be cleaned using methods that are
relatively intrusive, such as, for example, methods using
high-pressure fluid. In such applications, it is
15 necessary for the battery charger to be fully waterproof
in order to protect the electronic components that it
contains.

 In the particular context described above, it is
naturally out of the question to use conventional
20 ventilation with a fan blowing air into the housing. The
action of the fan requires an opening to be provided, and
fluid or solid particles can enter the housing through
the opening, which is unacceptable for this type of power
electronic device.

25 More particularly, the embodiments of the invention
relate to such a housing whose extruded section member
forms a tunnel that is of substantially rectangular
closed section and that is provided with fins on at least
one side of the rectangle. By increasing the heat
30 exchange area via which the housing can exchange heat
with the outside air, the fins make it possible to
dissipate heat. The heat dissipation is increased when a
flow of air is blown in contact with the fins. However,
in the particular context described above, it is also out
35 of the question to position a fan for blowing air over
the fins of the housing. That is because fan technology
does not make it

possible to implement such a fan with satisfactory and
relatable waterproofness at a reasonable cost.

Generally, a side that is not provided with fins
serves as a base for fastening the housing and as a
5 support for supporting the power electronic components of
the power electronic device.

The housing can then exchange heat to a marginal
extent with the support to which it is fastened.
However, the nature of said support is totally unknown a
10 priori. Its material, its thickness, or its surface can
have very varied thermal characteristics allowing heat to
be removed or preventing heat from being removed.

Thus, since the housing is closed and cannot be
ventilated externally, it must therefore exchange the
15 heat it generates with the surrounding air solely via
radiation and natural convection, i.e. without artificial
ventilation.

Even more precisely, the fins of the extruded
section member forming the housing are thus adapted to
20 the situation in which air flows by natural convection in
the extrusion direction outside the housing.

Therefore, it is necessary to make provision for
natural convection and for radiation to be maximized in
order to guarantee that sufficient heat is removed to
25 enable the power electronic device placed inside the
housing to operate properly.

In addition, it is known that power electronic
devices are generally mass-produced and are subject to
very tight cost constraints.

30 As regards satisfying cost constraints and procuring
waterproofness, it is known that the use of a one-piece
element extruded to form a tunnel is particularly
advantageous because it guarantees waterproofness on all
four sides of the housing. This also facilitates
35 mounting the battery charger or, more generally, mounting
a power device, and thus contributes to reducing the
final cost of the power electronic device.

For a heat dissipater or "heatsink", extruding an aluminum tunnel requires the fins to be in the extrusion direction. Therefore, currently existing housings made of extruded section members are provided with fins in the
5 extrusion direction, and they thus enable the heat generated inside the housing by the power electronic device to be removed via the fins, provided that said fins are positioned in such a manner as to be vertical.

It is also known that thermal performance improves
10 not only with increasing surface area in contact with the air, hence the advantageousness of fins, but also with increasing speed of air over said surface area. The air heating on coming into contact with the fins generates a natural upward movement of air, which movement is
15 facilitated if the air can rise freely, and thus if the fins extend vertically.

Mounting the housing on a vertical wall with the fins also extending vertically thus procures optimum dissipation for an extruded housing. This requires the
20 power device to be installed in the same way in all vehicles in which the power electronic device is to be installed.

Currently, this is a constraint that is holding back the development of the use of power devices implemented
25 using extruded housings. A very wide variety of contexts are thus currently deprived of this solution.

Unfortunately, if the device is mounted on a horizontal plane, the plane of the fins is then also horizontal, and the convection of air is much weaker. In
30 spite of the existence of radiation, a very significant reduction in effectiveness (a reduction by more than 30%) is observed.

Therefore, assembled solutions exist in which radiators carrying fins are assembled on a pre-extruded
35 tunnel that is not provided with fins. That makes it possible for the direction of the fins to be perpendicular to the extrusion direction or for the

direction of the fins to form an angle with said extrusion direction. The radiators used have standard comb-shaped section members that generally have long fins mounted on thick bases and that are designed for forced
5 convection. Forced convection requires a higher density for the heat flow and thus greater thickness for the base of the fins. Such solutions generally lead to housings having a very large mass of aluminum or of metal, which is penalizing. In addition, such solutions are complex
10 to manufacture in terms of machining and of assembly, because the waterproofness constraint is still present.

SUMMARY OF THE PRESENT INVENTION

According to a first broad aspect of the invention, there
15 is provided a housing made of aluminum alloy extruded section member for manufacturing a multi-position waterproof power electronic device, the extruded section member forming a tunnel that is of substantially rectangular closed section and that is provided with fins
20 on at least one side of the rectangle, said fins allowing air to flow outside the housing by natural convection in the extrusion direction, a side that is not provided with fins being designed to serve as a base for fastening the housing and as a support for power electronic components
25 of the power electronic device, wherein the fins are machined transversely to the extrusion direction so as to form notches in the fins, said notches being aligned in succession in an "optimum" direction that forms an angle with the extrusion direction that is optimized as a
30 function of a predetermined preferred installation direction for installing the housing, and said notches being of geometrical shape such that they allow air to flow outside the housing by natural convection in the optimum direction.

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According to a second broad aspect of the invention, there is provided a multi-position power electronic

device comprising at least one electronic module for performing the functions of a power electronic module mounted on at least one electronic card placed inside a housing according to the first broad aspect of the invention above, said housing being closed in waterproof manner by two side cheek plates fastened hermetically to the housing made of the extruded section member.

It is intended for the present invention is to mitigate the drawbacks encountered with housings that are known from the prior art, and also to satisfy the requirements of the production constraints that are known for this type of housing by providing a housing as defined above and on which the fins are machined transversely to the extrusion direction so as to form notches in the fins, said notches being aligned in succession in an "optimum" direction that forms an angle with the extrusion direction that is optimized as a function of a predetermined preferred installation direction for installing the housing, and said notches being of geometrical shape such that they allow air to flow outside the housing by natural convection in the optimum direction.

With such a housing, it is possible to make a power electronic device that can be installed in a plurality of positions while also intending to guarantee that natural air convection dissipates the heat in satisfactory manner.

Manufacturing the housing by extruding the tunnel makes it is possible to provide the tunnel with fins in the extrusion direction. When they are installed vertically, said fins make it possible for the heating of the air coming into contact with them to generate a

natural upward movement of the air facilitated by the vertical position of the fins.

When the power electronic device is placed along an installation direction other than the vertical direction, the fins also find themselves in said other direction. By means of embodiments of the invention, the openings constituted by the notches that are illustratively aligned in the vertical direction when the housing is placed in the preferred installation direction makes it possible to maintain natural convection for the air.

In accordance with embodiments of the invention, the direction in which the notches are aligned on the housing, which direction is referred to as the "optimum direction", is thus chosen as a function of the preferred installation direction of the housing, which preferred installation direction is determined while the electronic device is being designed. The optimum direction is then ideally vertical when the housing is placed along the determined installation direction. With embodiments of the invention, it is thus possible to allow the housing to be installed in at least two preferred installation directions. In practice, the housing can be installed in installation directions on either side of the preferred installation direction, with heat removal by means of the notches being quite satisfactory. The notches are then slightly inclined relative to the vertical but they nevertheless procure satisfactory convection. In practice, embodiments of the invention thus allow the housing to be installed in more than two directions.

The housing of embodiments of the invention is formed from a limited quantity of material, thereby making it possible to attempt to reduce costs, handling, transport, and associated energy consumption. The extruded tunnel structure makes a housing of embodiments of the invention very simple to manufacture in combination with the use of simple machining operations followed by simple assembly operations on the various component parts.

Illustratively, at least two opposite sides of the rectangle are provided with fins that are machined transversely so as to form notches that are aligned in succession in optimum directions that are identical on
5 both of the sides provided with fins.

This characteristic attempts to guarantee that heat is removed in satisfactory manner on two opposite sides of the structure of rectangular section that forms the housing.

10 According to an original characteristic of embodiments of the invention, at least two opposite sides of the rectangle are provided with fins that are machined transversely so as to form notches aligned in succession in optimum directions that are different on each of the
15 two sides provided with fins.

Providing two opposite sides with fins in which notches are machined in two different directions does not make it possible to maximize heat removal for a given installation direction but it does, however, offer
20 greater freedom for the directional placement of the housing of the invention, it being possible for the majority of the heat removal to take place on one side for certain installation directions, and on the other side for other installation directions.

25 According to an illustrative characteristic, the optimum direction(s) form(s) an angle lying in the range 45° to 90° in absolute terms with the extrusion direction.

This corresponds to the installation directions that
30 are generally observed. At less than 45° , heat removal takes place by natural air convection along the fins.

In an illustrative embodiment, the notches are aligned in a direction that is perpendicular to the extrusion direction.

35 This makes numerous installation angles possible for the housing. If the housing having perpendicular notches is installed at an angle in the range 0° to 45° , the fins are active and they remove heat effectively. Above that

range, embodiments of the invention allow natural convection to take place through the notches, with this convection being maximized when the housing is installed in a horizontal installation direction, in which the fins
5 are also horizontal but the notches are aligned in the vertical direction.

Therefore this characteristic provides best heat removal when the housing is installed vertically or horizontally, but it also provides satisfactory heat
10 removal in the intermediate installation directions.

In illustrative embodiments of the invention, notches are formed at regular intervals lying in the range 4 millimeters (mm) to 10 mm.

Such a characteristic attempts to guarantee that air
15 can flow by natural convection through said notches.

In illustrative embodiments of the invention, the notches present identical widths lying in the range 4 mm to 10 mm.

This characteristic attempts to guarantee that the
20 notches do not offer too much resistance to the air flowing by natural convection and also guarantees that the contact surface area over which the fins are in contact with the air is large enough to attempt to guarantee that heat is removed satisfactorily when the
25 housing is in the vertical position.

According to a particular characteristic of embodiments of the invention, the distances between the notches are substantially equal to the widths of the notches.

30 In practice, this characteristic makes it possible to optimize both the air flow by natural convection and also the exchange surface area available for heat transfer.

Illustratively, the fins are spaced apart by a
35 distance lying in the range 6 mm to 16 mm.

Such a distance between the fins corresponds to air flow by natural convection.

In practice, the widths of and the distances between the notches and the fins are involved in defining a maximum angle for the installation direction. The width of a vertical free passage for air between the notches varies as a function of the extent to which the preferred installation direction coincides with the real installation direction. The housing of the invention is illustratively implemented while seeking to achieve an optimum between the amount of aluminum removed and the amount of aluminum kept for heat exchange, and to achieve an optimum between the machining angle and the range of possible installation directions.

Therefore, the machining angle and the machining characteristics, such as the width of the notches and the spacing between notches, are illustratively determined so as to obtain an optimum as a function of the envisaged installation direction, of the range of possible installation directions, and of the quantity of heat to be removed.

According to a particular characteristic of embodiments of the invention, the extruded section member is such that the side(s) provided with fins is/are of thickness that tapers going from the base for fastening the housing and for supporting the electronic components towards the side of the rectangle that is opposite from said base.

Such a characteristic makes it possible to procure optimum removal of the heat that passes from the electronic components directly to the fastening base of the housing. The initially large and then tapering thickness that is present under the fins makes it possible to procure improved heat conduction as close as possible to the heat source. These conduction properties then decrease going away from the fastening base that constitutes the heat source.

The large width of the sides provided with fins at the fastening and support base makes it possible to procure increased thermal conduction at said base, where

it is most useful. This characteristic thus makes it possible to optimize the profile of the housing with a view to obtaining optimum removal of the heat generated at the fastening and support base.

5 Illustratively, the side serving as a base for fastening the housing and as a support for the electronic components has a thickness that is greater than the thickness of the side opposite from the base.

10 Here too, the idea is to facilitate conduction of heat where said heat is most present, namely where the electronic components are placed. Thus, the conduction phenomenon is optimized while also not adversely affecting the total weight of the housing.

15 According to an illustrative characteristic of the invention, the extruded section member is such that, on at least one of the sides of the rectangle, the inside wall is provided with micro-striations or with micro-fins.

20 This characteristic makes it possible to procure a further increase in the area of heat exchange with the outside air. This characteristic, which brings a significant increase in heat dissipation, can be implemented as a function of the extrusion constraints.

25 According to an illustrative characteristic, the housing is treated by anodization.

 This characteristic, which makes it possible to blacken the housing, increases the radiation therefrom, enabling the housing to offer increased heat removal.

30 Finally, embodiments of the invention provide a multi-position power electronic device comprising at least one electronic module for performing the functions of a power electronic module mounted on at least one electronic card placed inside a housing of the invention, said housing being closed in waterproof manner by two
35 side cheek plates fastened hermetically to the housing made of extruded section member. These cheek plates also make it

possible to implement the inputs and outputs necessary for the device to operate.

In an illustrative application, the device is a battery charger, and at least one electronic module is
5 suitable for implementing battery charging functions.

Illustratively, the power electronic device further includes an internal air flow system.

By combining an extruded-section-member housing of the invention with an internal air flow system, it is
10 possible to optimize the use of the heat dissipation offered by the fins formed on the housing. The internal air flow system is then used to put the internal air into contact with the walls of the housing. Convective phenomena take place, thereby facilitating absorption of
15 the heat by the walls of the housing.

Illustratively, the electronic card is carried by a metal support designed to be put into contact with at least one wall of the housing.

20 BRIEF DESCRIPTION OF THE DRAWINGS

Other characteristics and intended advantages of the present invention appear from the following description, given with reference to the accompanying drawings which show an embodiment of the invention that is in no way
25 limiting. In the drawings:

- Figure 1 is a perspective view of an illustrative embodiment of a housing of the invention;

- Figures 2A, 2B, and 2C are respectively a front view, a detail view, and a view from below of the housing
30 shown in Figure 1;

- Figures 3A to 3D show an on-board charger of an embodiment of the invention;

- Figures 4A and 4B show an illustrative embodiment of a power electronic device of the invention;

- Figures 5A and 5B are respectively a front view
35 and a detail view of a particular embodiment of the invention;

- Figures 6A and 6B show various particular characteristics of an embodiment of the invention; and
- Figure 7 shows the principles of an embodiment of the invention diagrammatically.

5

DETAILED DESCRIPTION OF AN EMBODIMENT

Figure 1 shows an illustrative embodiment of a housing 100 of the invention. The housing 100 is a section member extruded into a tunnel in the direction X.

10 Thus, as shown in Figure 2A, the extrusion profile is substantially rectangular (it is square in this example), and it is such that the housing 100 carries fins 110 laterally on two sides 102 and 104 of the extruded rectangle. It can be seen clearly that the
15 profile enables fins to be formed in the extrusion direction X only.

 The extruded fins 110 extend in parallel manner between a base 101 that serves to fasten the housing and a fourth side 103 of the rectangle forming the tunnel by
20 extrusion. This is the particular context within which the invention lies. As explained below, the base 101 illustratively also serves as a support for supporting electronic elements of the power electronic device that is to be carried by the housing 100.

25 In accordance with an embodiment of the invention, the fins 110 are machined in such a manner as to present notches 111 aligned in succession with one another in an "optimum" direction OP. In this illustrative embodiment of the invention, the optimum direction OP is
30 perpendicular to the extrusion direction X which is also the direction of the fins 110. The preferred installation direction is then the horizontal direction.

 When the optimum direction forms an angle different from 90° with the extrusion direction, the preferred
35 installation direction is the direction for which, when the housing 100 is placed in said installation direction, the optimum direction is vertical.

Figure 2 shows, more precisely, the details of how the housing 100 shown in Figure 1 is formed. In this embodiment, the density of fins 110 and of metal corresponds to the needs of natural convection.

5 Figure 2B shows a detail of the profile of the extruded section member of the housing 100 as shown in Figure 2A. This detail shows that the fins 110 are separated from one another by a distance of 11 mm and that they have a length of 35 mm outside the tunnel structure constituted
10 by the sides 101, 102, 103, and 104. In addition, it can be seen in Figure 2B that the fins 110 have a thickness of 3.5 mm and are flanked by two thicker fins 112 extending respective ones of the sides 101 and 103 of the extruded tunnel.

15 The spacing of the fins and their shape and dimensions are adapted to air flow by natural convection. As shown in Figure 2, the fins 110 are considered to be quite widely spaced apart from one another, corresponding to characteristics making it possible to procure good air
20 flow by natural convection. The fins are much closer together when they are on radiators operating with forced convection and therefore in combination with blown air.

Illustratively, on its face on the outside of the housing 100, the side 103 has a micro-striated surface
25 with striations 113 whose characteristic radius is about a few tenths of a millimeter, and 0.25 mm in Figure 2B.

Figure 2C is a view from below of the housing 100. It can be observed that, in accordance with an embodiment of the invention, the fins 110 are machined in such a
30 manner as to present notches 111.

In the illustrative embodiment shown, the notches 111 are machined perpendicularly to the direction X. They are thus aligned with one another in the direction perpendicular to the direction X, i.e. in the viewing
35 direction of Figure 2C. The alignment of the notches 111 can also be seen in Figure 1.

Figure 3 shows an on-board charger 200 obtained by means of a housing 100 as shown in Figure 1. Inside said housing, the quantity of heat that is generated by operation of the electronic components of the charger is
5 such that it is absolutely necessary to remove heat in order to avoid damaging the electronic components.

Before the housing 100 is closed by two cheek plates 201 and 202, all of the electronic components that are necessary for operation of the on-board charger 200 are
10 mounted inside said housing 100. At least one of the cheek plates (the cheek plate 202) carries a connection element 205 making it possible to connect the on-board battery charger 200 to power supply means (not shown). It should be noted that the use of a housing 100 that is
15 extruded into a tunnel and then closed by two cheek plates 201 and 202 makes it easy to guarantee that the on-board charger 200 is waterproof, while also making said charger very easy to assemble.

Connection means 206 and 207 for connecting to a
20 battery (not shown) are illustratively provided on each of the cheek plates 201 and 202 of the battery charger 200.

Illustratively, each of the cheek plates 201 and 202 has a portion designed to fasten the charger 200 to an
25 element integral with the vehicle on board which the charger 200 is installed.

Fastening elements 203 and 204 are thus
illustratively integral with the cheek plates 201 and 202. They are provided with orifices suitable for
30 receiving fastener screws.

The fastener elements 203 and 204 illustratively have a slight offset relative to the plane level of the side 101 of the housing 100. This offset makes it possible to attempt to guarantee that the bottom of the housing 100
35 is properly in contact with the support to which the charger 200 is fastened. This enables the heat also to dissipate as much as possible by means of conduction

between the side 101 of the housing 100 and the support to which the charger 200 is fastened.

In this example, the optimum direction in which the fins are machined and in which the notches are aligned is the direction Z on the reference frame of Figure 3, in which the direction X is the extrusion direction. By means of the presence of the fins in which the notches are machined, the on-board charger 200 shown in Figure 3 can be installed by fastening the fastener portions 203 and 204 to any plane support of the vehicle on board which said charger is installed. Illustratively, the plane support is horizontal or vertical, but it can also lie at any angle in the range 0° to 90° .

Removing heat by means of the natural convection of air between the fins and through the notches makes it possible to dissipate heat satisfactorily for numerous angular positions in which the on-board charger 200 is installed. However, heat removal is optimum for an installation direction such that either the fins are vertical or the optimum direction is vertical.

It is observed that, by adding transversely machined fins on the third side of the housing, i.e. on the side opposite from the base 101, it becomes also possible to install the housing on a vertical support, the extrusion direction being horizontal or forming a non-zero angle with the vertical. With a third side provided with perpendicularly machined fins, the housing can, in practice, be installed in any angular position.

When the housing is in the vertical position, it might be assumed that the housing of an embodiment of the invention presents energy dissipation that is lower than with a housing in which no notch is machined in the fins 110.

Whereas actually, with the invention, which aims to use natural convection only, energy dissipation is still better with notches 111 than without notches 111, including in the position in which the fins 110 are vertical. In natural convection, the presence of

turbulence makes it possible to obtain energy dissipation efficiency that is better in the vertical position, even though metal has been removed.

As shown in Figure 3A, the housing is illustratively
5 anodized in such a manner as to present a black surface that therefore radiates to a greater extent than does a non-anodized surface.

Illustratively, the charger 200 further presents an internal structure making it possible to achieve a
10 further improvement in heat dissipation by means of the fins.

Figures 4A and 4B are diagrammatic section views, seen looking respectively from the front and from above, showing a particular embodiment of the charger 200 shown
15 in Figure 3.

In this embodiment, the electronic elements necessary for charger to operate are carried by two electronic cards 211 and 212. Between the two cards 211 and 212, a fan 210 is placed that is suitable for causing
20 the air inside the housing 100 to flow in the manner represented by arrows in Figure 4B.

In order to enable the air that is blown in this way to flow properly between the cards 211 and 212 and the sides 102 and 104, partitions 213 and 214, shown in
25 Figure 4A, close the spaces between the housing 100, the fan 210 and the two cards 211 and 212, at the top of and at the bottom of the fan 210. The flow of the air is thus forced.

This embodiment is presented for a charger having
30 two electronic cards placed laterally in the housing 100. However, other embodiments of a charger or of a power electronic device are quite possible with the housing 100 of embodiments of the invention. In particular, such other embodiments include an embodiment in which a card
35 carrying the power electronic components is placed in contact with or in the vicinity of the base 101 of the housing 100, which base

serves to collect heat and to conduct heat towards the sides 102 and 104 carrying the fins 110.

Figure 5 shows certain additional characteristics for the housing 100' of embodiments of the invention. In
5 Figures 5A and 5B, the extrusion profile presents a profile of undulating fins 110'. This undulation makes it possible to increase the surface area for exchange between the fins 110' and the air flowing between the fins 110'.

In Figure 5B, it can also be seen that the thickness
10 of the fins 110' is smaller than the thickness of the fins 110 shown in the Figure 1 embodiment. These fins 110' have a width of 2.2 mm and are separated by 10 mm. Since the housings of embodiments of the invention operate with natural convection, each fin does not have a
15 very large thermal load to convey. Thus, the fins 110' are illustratively high and narrow.

In this example too, these characteristics make it possible to adapt the housing 110' to the specific conditions of natural convection, in which the easier it
20 is for air to flow between the fins 110' and the more the exchange area is increased, the better heat is removed. The fact that the fins 110' are less thick makes it possible to increase the air flow space, which is a major parameter in natural convection.

25 The extrusion profile shown in Figure 5A also has small fins internal to the housing 100', which fins are separated from one another by a distance of 5 mm and have a thickness of 2.2 mm.

These fins makes it possible to increase the
30 exchange area inside the housing 100' and thus to facilitate conduction of heat towards the outside of the housing 100'.

It can also be seen that this housing 100' is provided with micro-striations 115' on the inside of the
35 side 103' in addition to micro-striations 113' on the outside of the housing 100'. This characteristic aims to procure a further increase in the area of exchange

between the housing 100' and the internal or the external air.

Finally, the side 101' is thicker than the side 101 of the housing 100 of Figure 2 so as to conduct heat
5 towards the sides 102' and 104' carrying the fins 110'. This characteristic is particularly illustrative when an electronic card carrying power electronic components is placed in the vicinity of or in contact with the side
10 101' and removes heat by conduction through the housing 100' via this placement in contact with or in the vicinity of said side 101'.

In addition, the use of the side 101 for placing the electronic components and optionally for placing a card supporting them is vary illustrative in practice, because it
15 is intended to avoid problems of fastening to the lateral sides on which the fins are placed. It is difficult to place screws or fastener elements in amongst the fins because the fins take up a non-negligible amount of space and hinder putting screws in place and tightening them.

Furthermore, when the electronic elements or an
20 electronic card are/is fastened to the side 101 and when screws therefore pass through the side 101, subsequently fastening the charger 200 to the plane support makes it possible to guarantee good waterproofing at the base 101
25 even if said base is provided with holes for allowing the screws to pass through it.

Figures 6A and 6B show two embodiments that are based on the embodiments of Figures 1 and 5. The characteristics of these embodiments are intended to
30 procure an overall improvement in the energy dissipation efficiency of the housing 100 or 100'.

In Figures 6A and 6B, the sides 102 or 102' and 104 or 104' present a thickness that tapers going from the base 101 or 101' to the top of the housing 103 or 103'.
35 This characteristic is thus particularly illustrative when the base 101 serves as a support for an electronic card containing power electronic components.

Tapering the thickness of the sides 102 or 102' and 104 or 104' serves to optimize energy dissipation while not compromising the ease of handling of the charger, i.e. while not increasing the total weight of the housing 100 or 100' to a dissuasive extent.

With the sides 102 or 102' and 104 or 104' having such profiles, the fins 110 or 110' that are lowest, and thus that are closest to the side 101 or 101' are allowed to remove more heat than the fins 110 or 110' that are highest, i.e. than the fins close to the top side 103 or 103'.

More precisely, it is observed that the temperature difference between the top and the bottom of a housing 100 or 100' is smaller in the embodiments of Figures 6A or 6B than in a housing 100 or 100' in the embodiments of Figures 2 or 5 that has constant thickness for the sides 102 or 102' and 104 and 104'. Since dissipation is proportional to the difference between the temperature of the outside air and the temperature of the housing, the energy dissipation is thus better distributed when the extruded profile has the characteristics of Figure 6.

The closer a point is to the side 103, the less it is necessary for thermal resistance at that point to be low.

Therefore, the further a point is away from the base 101, the less it is necessary for heat to be transferred at that point, and thus the less it is necessary for major conduction to be possible and the less thick the side 102 or 104 needs to be at said point.

In the embodiments proposed in Figures 6A and 6B, heat removal is further improved by means of the presence of small fins 114 or 114'.

In addition, in Figure 6A, the top side 103 is illustratively provided with small fins 116 of different heights. This characteristic is an additional improvement procured by embodiments of the invention, making it possible to increase the removal of heat also via the top face 103

of the housing 100. Such an extruded profile carrying fins on the side 103 is illustrative in certain applications. The small fins 116 can optionally also be machined in a manner similar to the fins 110 and thus be provided with
5 notches.

Thus, it is possible to imagine providing the side 103 of the extrusion profile of the housing 100 with fins 116 that are longer, e.g. that are of the same length as the fins 110, so as to provide the housing with a third
10 face having fins, be they machined or not machined.

All of the embodiments shown are such that the notches are formed perpendicularly to the extrusion direction. This characteristic makes it possible to offer very good compatibility with all of the possible
15 installation positions of the power electronic device manufactured with this embodiment of the housing of embodiments of the invention.

However, as defined in accordance with the principles of embodiments of the invention, for
20 applications in which the housing is to be installed on supports that form angles with the horizontal that lie in a certain range that is known in advance, the optimum direction for machining the notches illustratively forms an angle of 90° minus the mean angle of said range
25 relative to the extrusion direction, this characteristic being shown in Figure 7.

In Figure 7, which summarizes the principles of embodiments of the invention, the installation direction I of the housing 100, which coincides with the extrusion direction
30 X, forms an angle α with the horizontal H. In accordance with embodiments of the invention, the optimum direction OP then forms an angle $90^\circ - \alpha$ with the extrusion direction X. The notches (not shown but whose alignments are represented diagrammatically by dashed lines in Figure 7) are then
35 machined so as to be aligned along the optimum direction OP. They are then aligned in the vertical direction when

the housing 100 is installed along the installation direction I.

This makes it possible to intend to guarantee that, in accordance with embodiments of the invention, the
5 notches are aligned with another along a median direction which is substantially placed vertically when the power electronic device is placed on its plane support.

Finally, it should be noted that various
10 implementations can be achieved using the principles of embodiments of the invention. In particular, in addition to the characteristics and embodiments presented above, the housing of embodiments of the invention can be provided with asymmetrical fins. Such an implementation is illustrative when an electronic card is placed in the
15 vicinity of a single one of the two sides 102 or 104 of the housing of embodiments of the invention, the longer fins being on the same side as the side on which said card is placed.

CLAIMS

1. A housing made of aluminum alloy extruded section member for manufacturing a multi-position waterproof power electronic device, the extruded section member forming a tunnel that is of substantially rectangular closed section and that is provided with fins on at least one side of the rectangle, said fins allowing air to flow outside the housing by natural convection in the extrusion direction, a side that is not provided with fins being designed to serve as a base for fastening the housing and as a support for power electronic components of the power electronic device, wherein the fins are machined transversely to the extrusion direction so as to form notches in the fins, said notches being aligned in succession in an "optimum" direction that forms an angle with the extrusion direction that is optimized as a function of a predetermined preferred installation direction for installing the housing, and said notches being of geometrical shape such that they allow air to flow outside the housing by natural convection in the optimum direction.
2. The housing according to claim 1, wherein at least two opposite sides of the rectangle are provided with fins that are machined transversely so as to form notches that are aligned in succession in optimum directions that are identical on both of the sides provided with fins.
3. The housing according to claim 1, wherein at least two opposite sides of the rectangle are provided with fins that are machined transversely so as to form notches aligned in succession in optimum directions that are different on each of the two sides provided with fins.
4. The housing according to any one of claims 1 to 3, wherein the optimum direction(s) form(s) an angle lying in the range 45° to 90° in absolute terms with the extrusion direction.

5. The housing made of metal extruded section member according to claim 2, wherein the notches are aligned in a direction that is perpendicular to the extrusion direction.

6. The housing made of metal extruded section member according to any one of claims 1 to 5, wherein the notches are formed at regular intervals lying in the range 4 mm to 10 mm.

7. The housing made of metal extruded section member according to any one of claims 1 to 6, wherein the notches have identical widths lying in the range 4 mm to 10 mm.

8. The housing made of metal extruded section member according to any one of claims 1 to 7, wherein the distances between the notches are substantially equal to the widths of the notches.

9. The housing made of metal extruded section member according to any one of claims 1 to 8, wherein the fins are spaced apart by a distance lying in the range 6 mm to 16 mm.

10. The housing made of metal extruded section member according to any one of claims 1 to 9, wherein the extruded section member is such that the side(s) provided with fins is/are of thickness that tapers going from the base for fastening the housing and for supporting the electronic components towards the side of the rectangle that is opposite from said base.

11. The housing made of metal extruded section member according to any one of claims 1 to 10, wherein the side serving as the base for fastening the housing and as the support for the electronic components has a thickness

that is greater than the thickness of the side opposite from the base.

5 12. The housing made of metal extruded section member according to any one of claims 1 to 11, wherein the extruded section member is such that, on at least one of the sides of the rectangle, the inside wall is provided with micro-striations or with micro-fins.

10 13. The housing made of metal extruded section member according to any one of claims 1 to 12, wherein the housing is treated by anodization.

15 14. A multi-position power electronic device comprising at least one electronic module for performing the functions of a power electronic module mounted on at least one electronic card placed inside a housing according to any one of the preceding claims 1 to 13, said housing being closed in waterproof manner by two
20 side cheek plates fastened hermetically to the housing made of the extruded section member.

25 15. The multi-position power electronic device according to claim 14, wherein said device is a battery charger, and at least one electronic module is suitable for implementing battery charging functions.

30 16. The multi-position power electronic device according to any one of claims 14 and 15, wherein the multi-position power electronic device further includes an internal air flow system.

35 17. The multi-position power electronic device according to any one of claims 14 to 16, wherein the electronic card is carried by a metal support designed to be put into contact with at least one wall of the housing.

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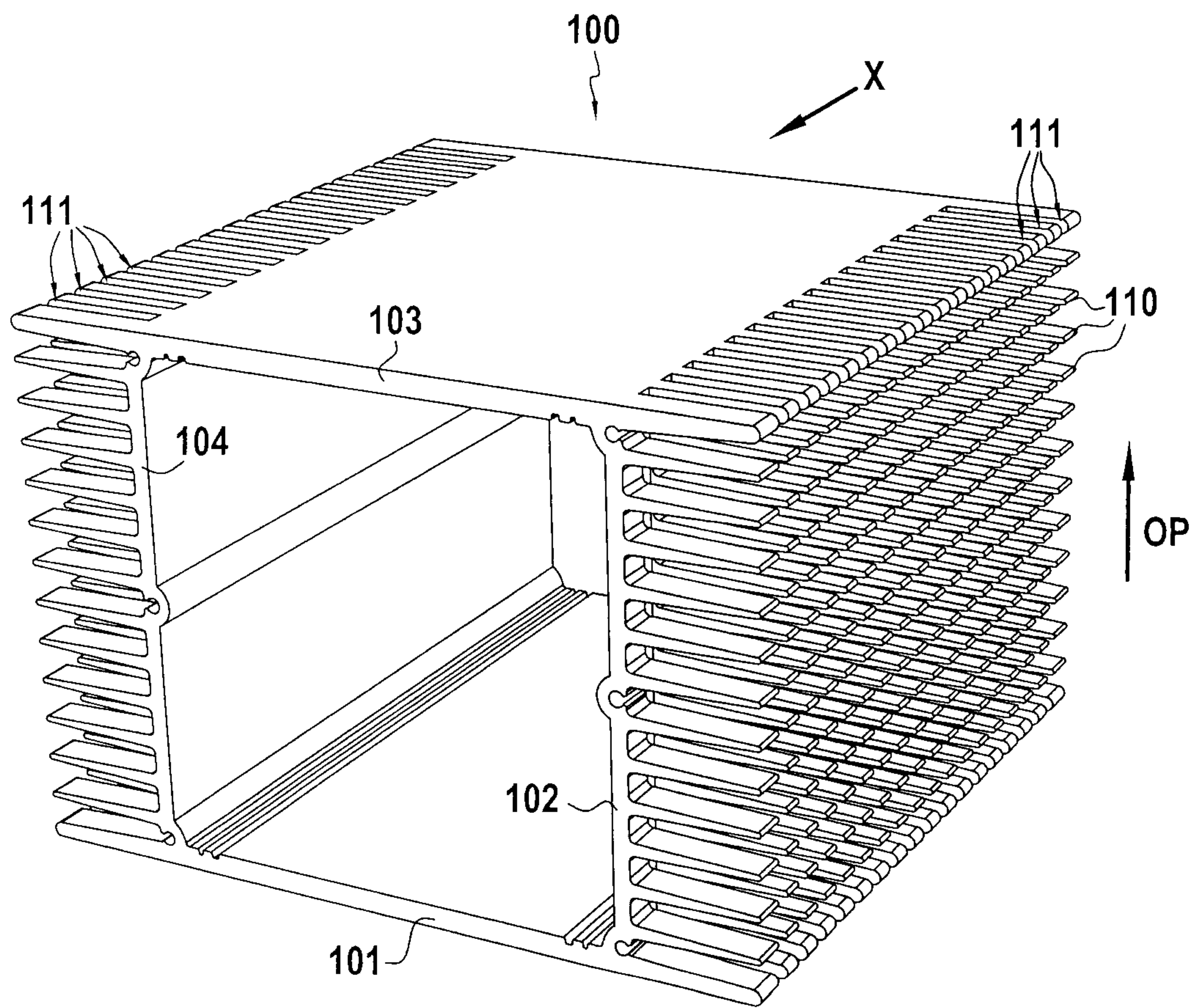


FIG.1

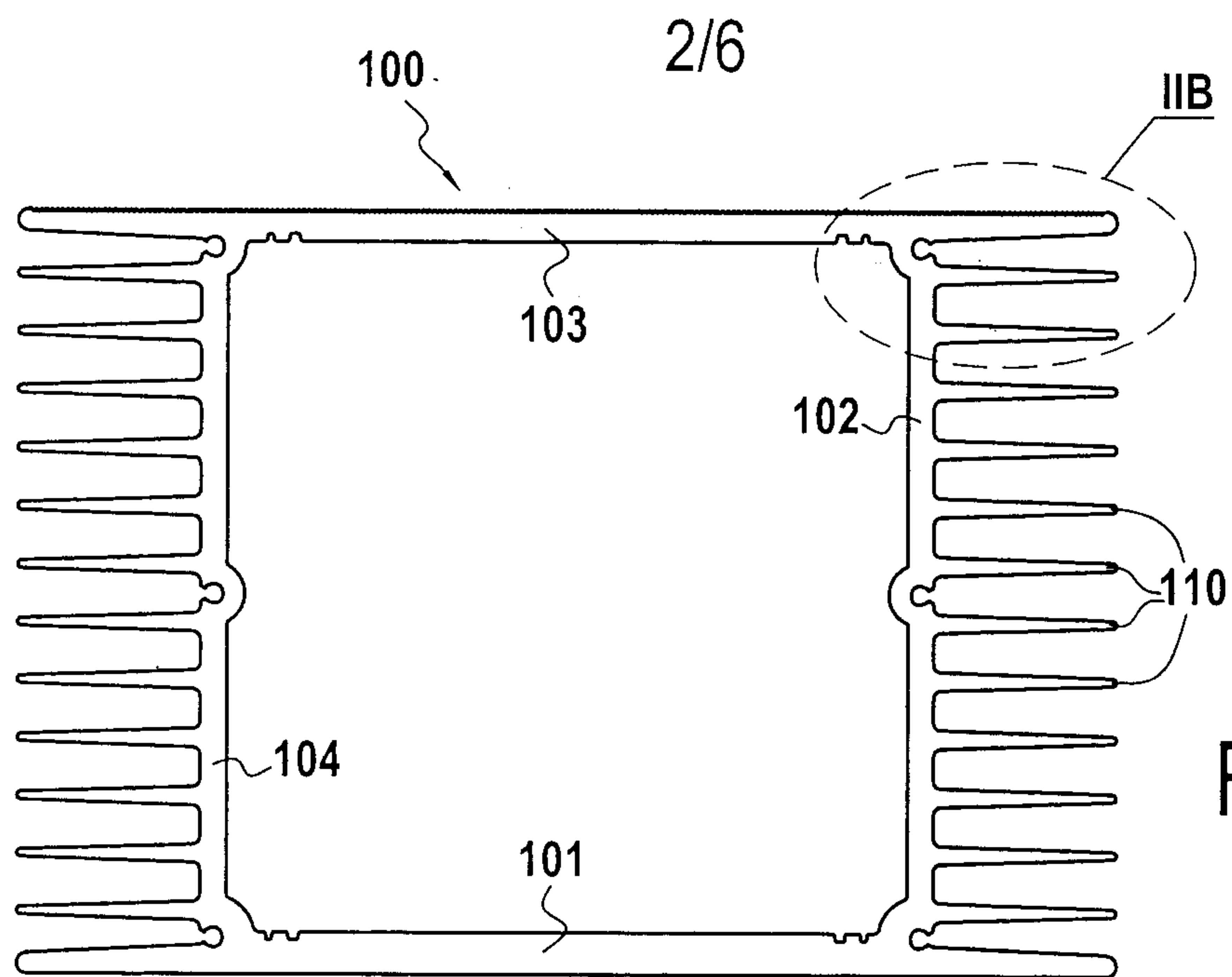


FIG. 2A

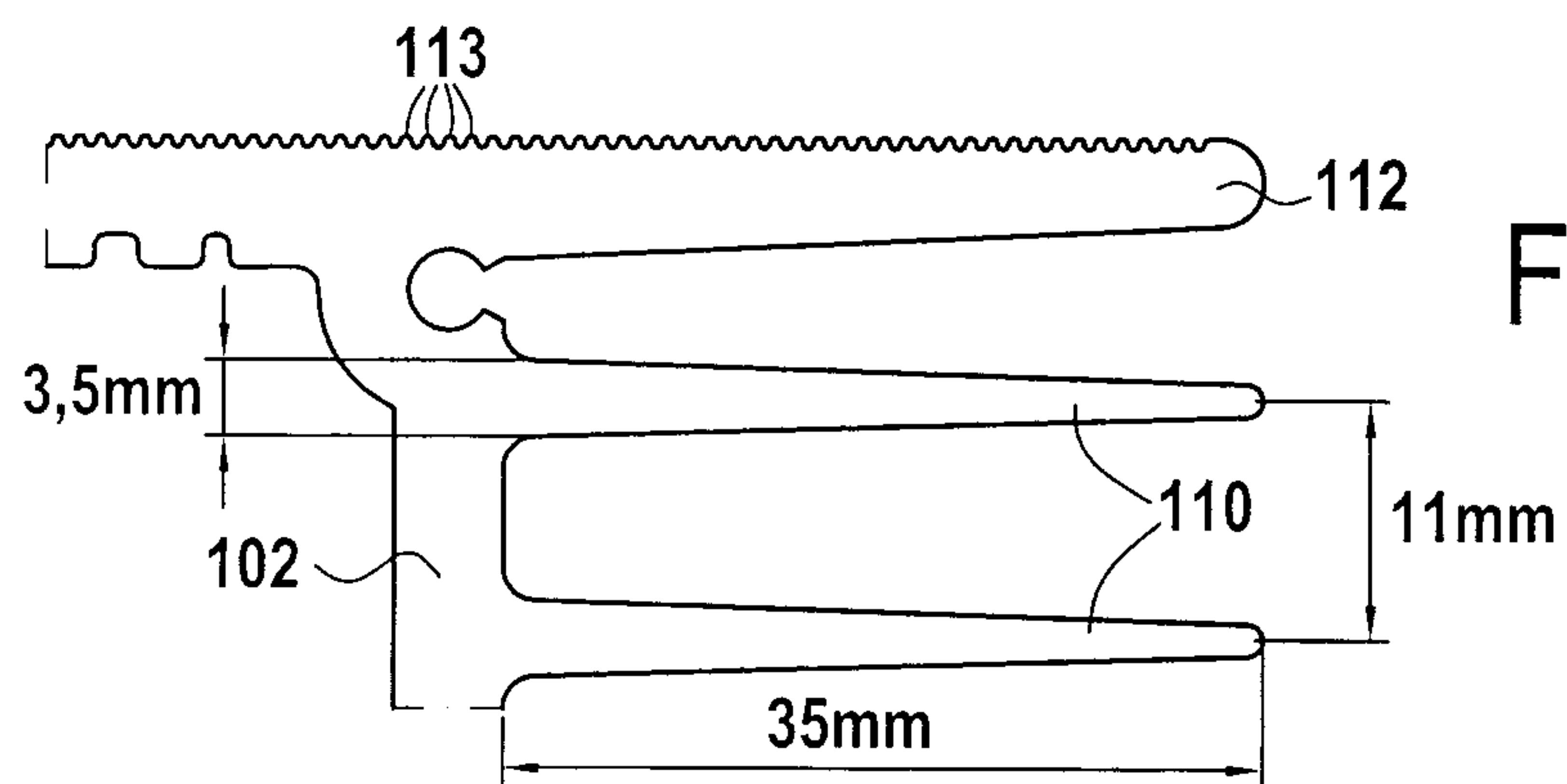


FIG. 2B

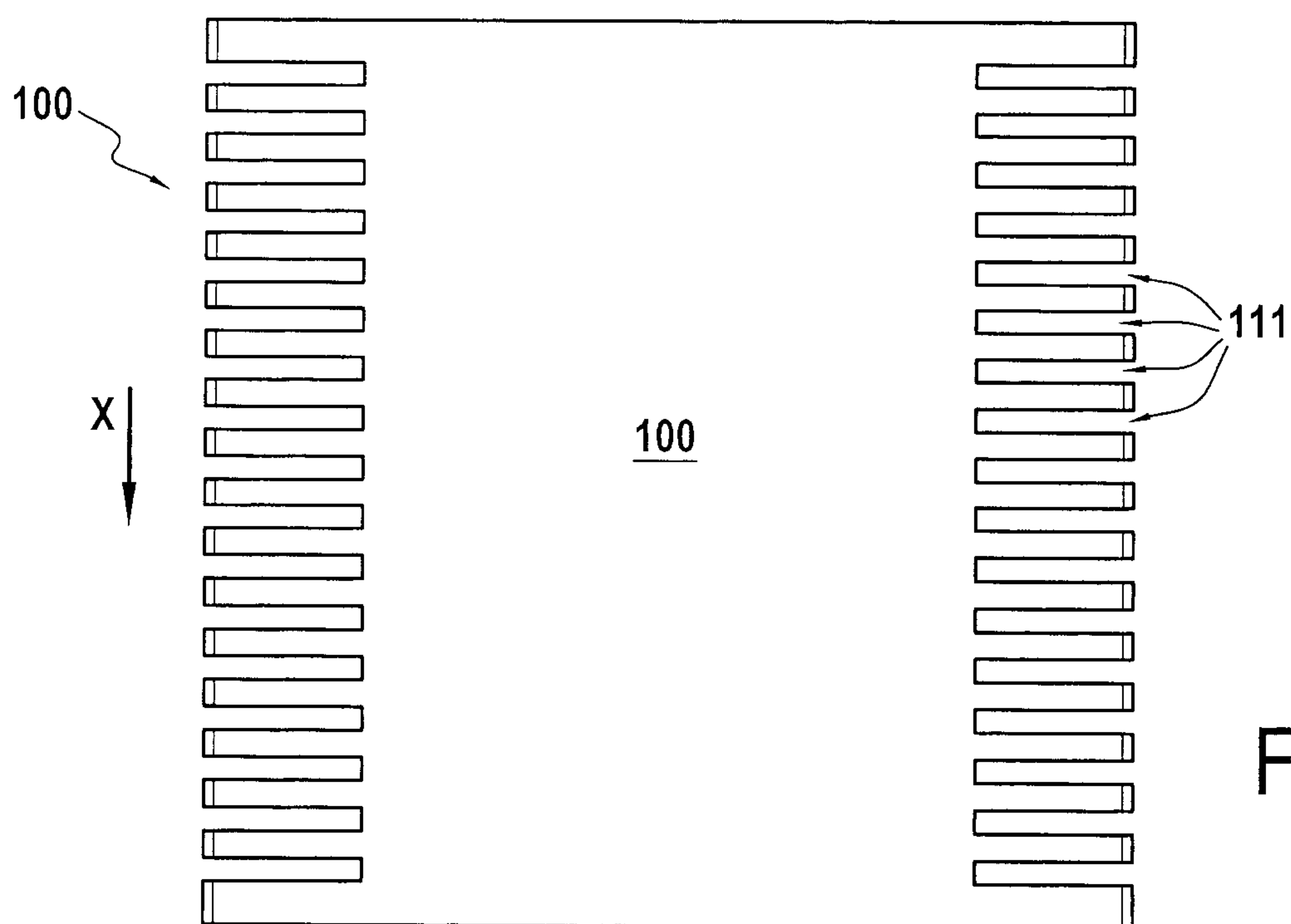


FIG. 2C

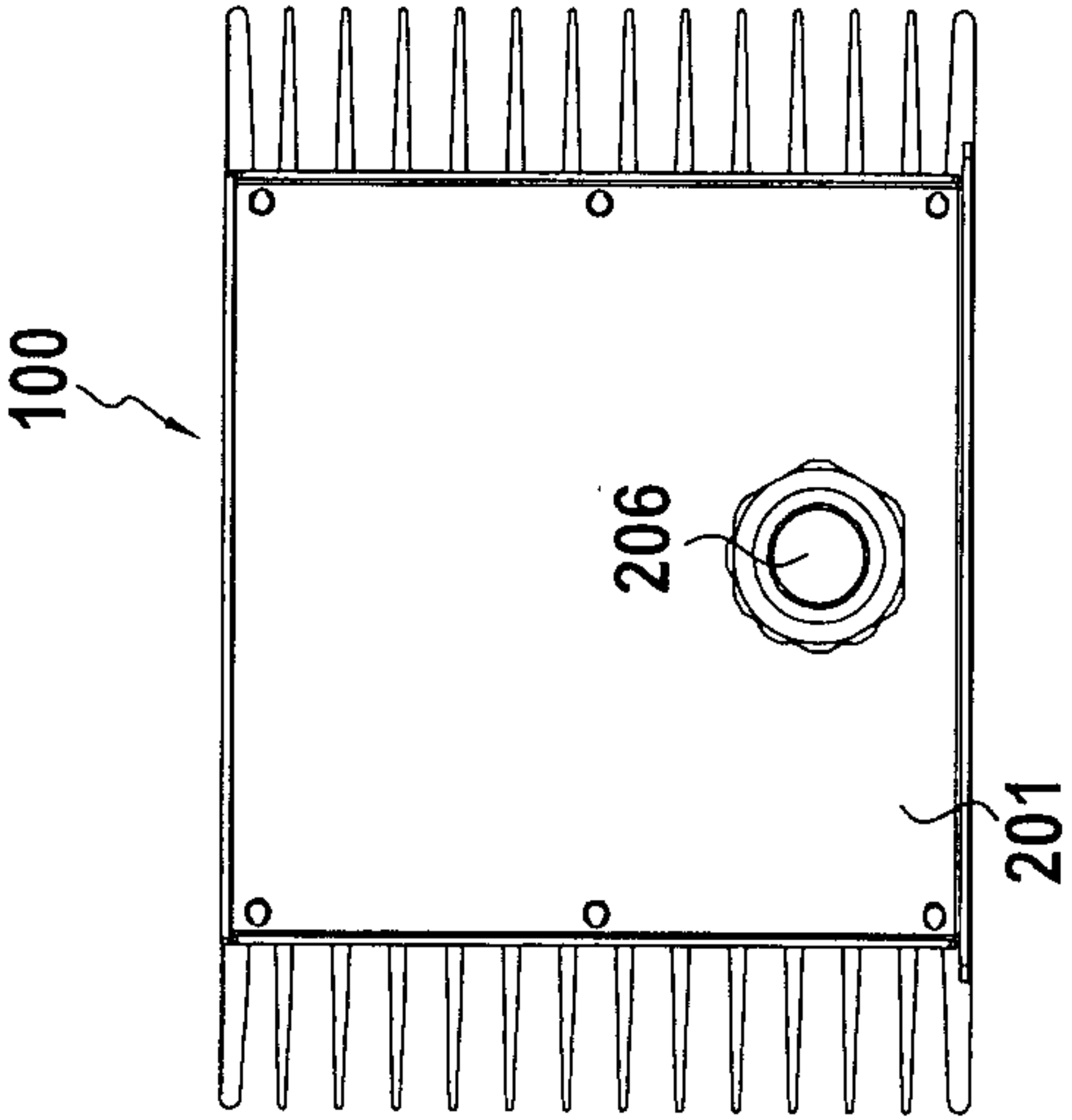


FIG. 3C

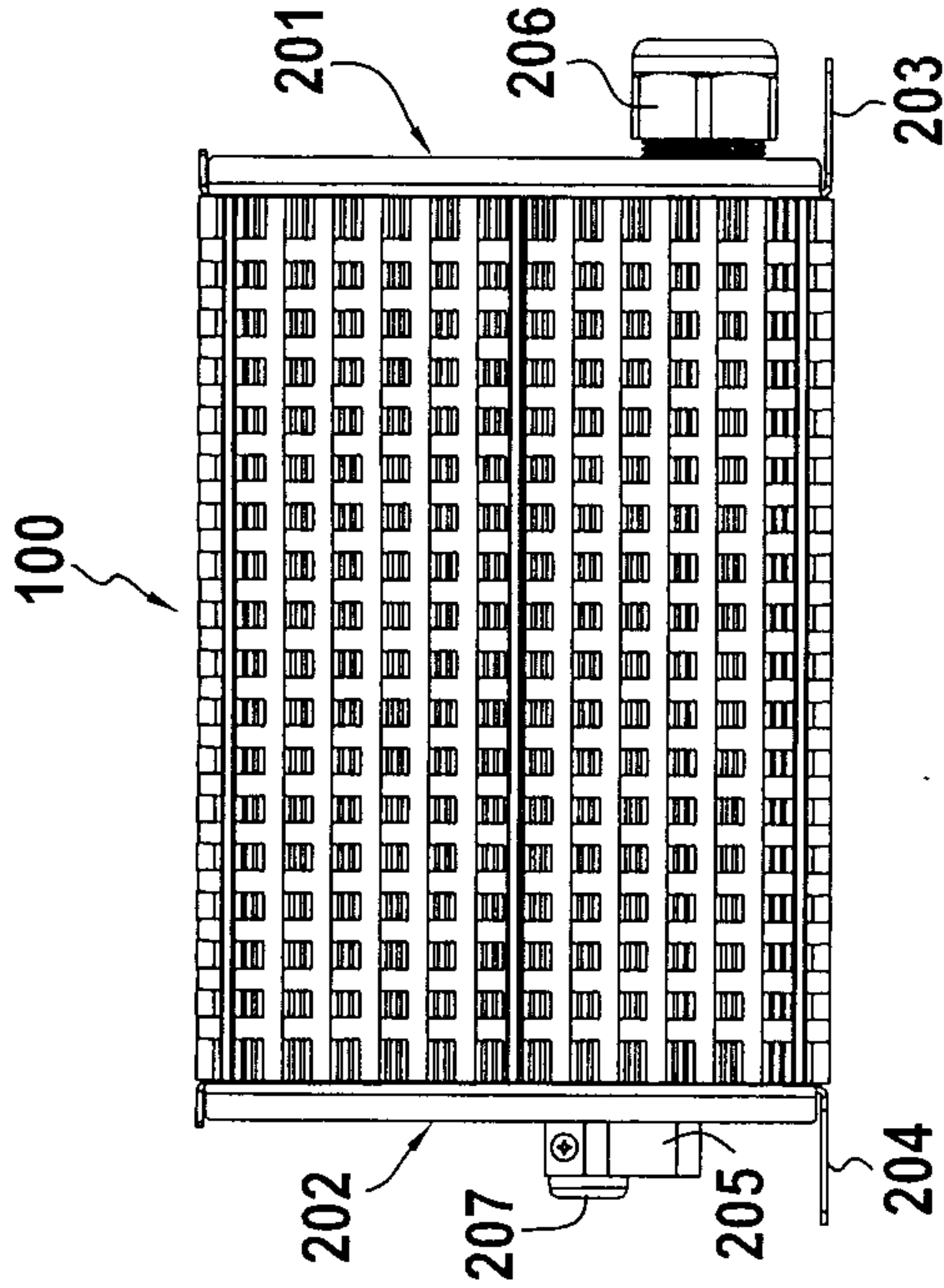


FIG. 3B

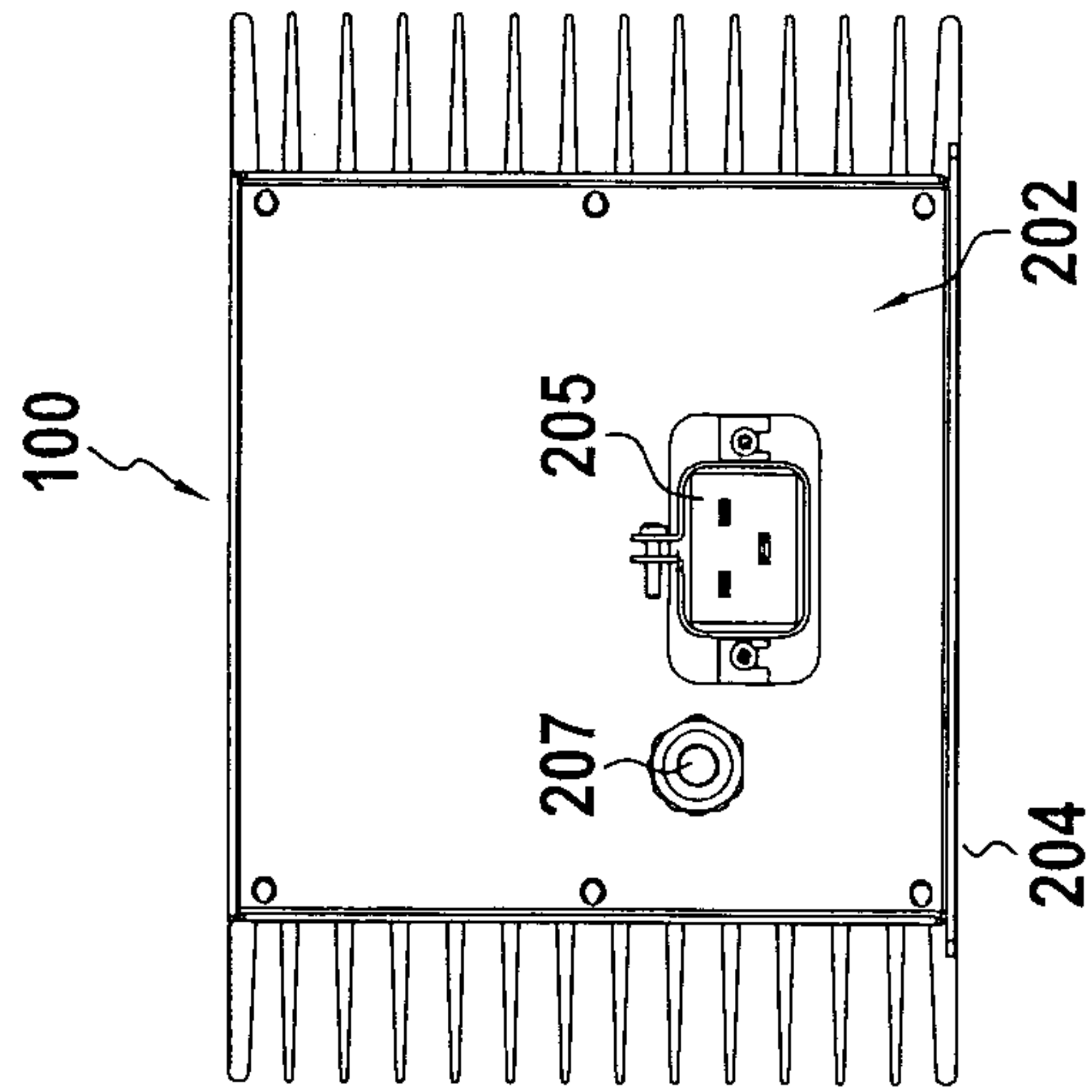


FIG. 3D

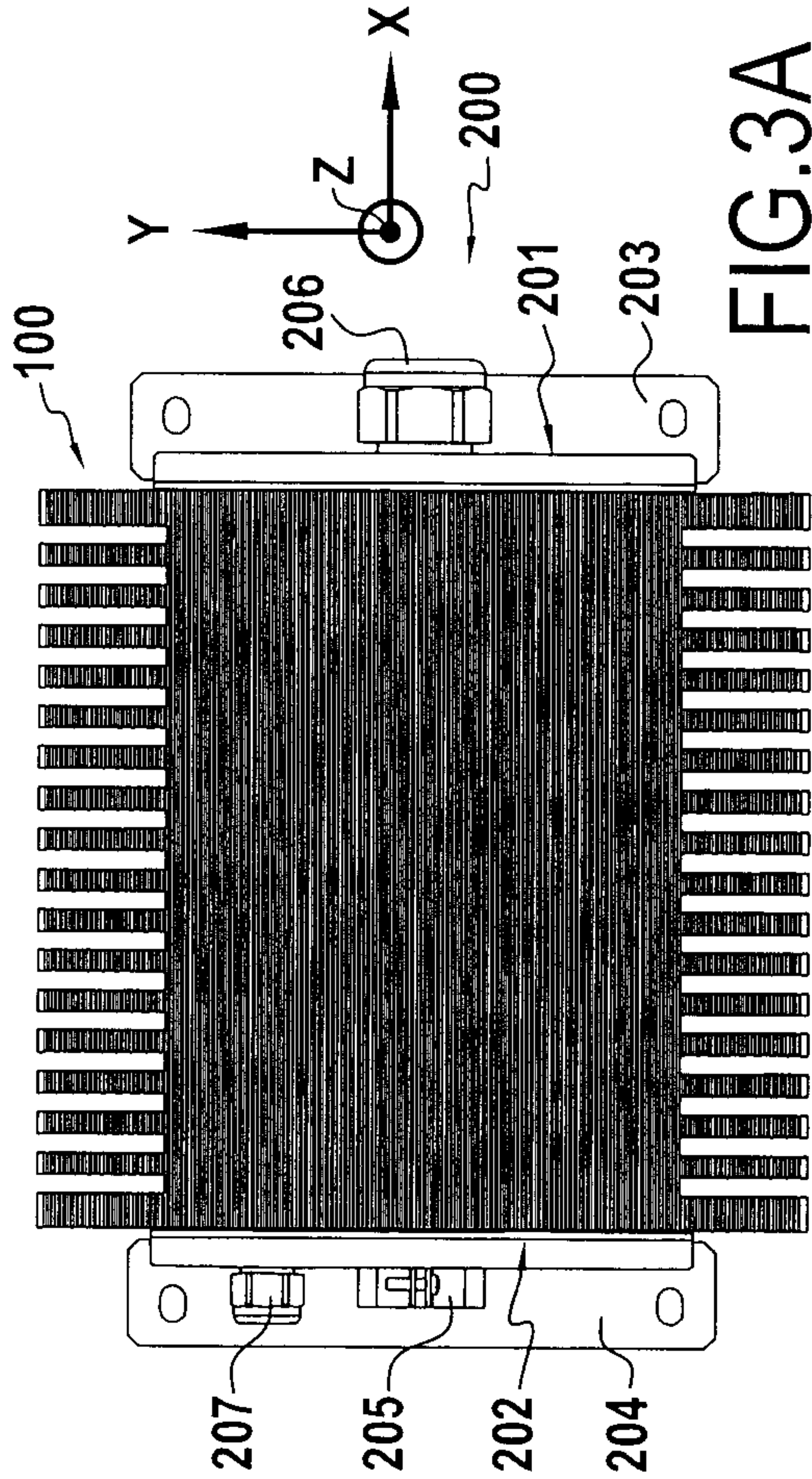


FIG. 3A

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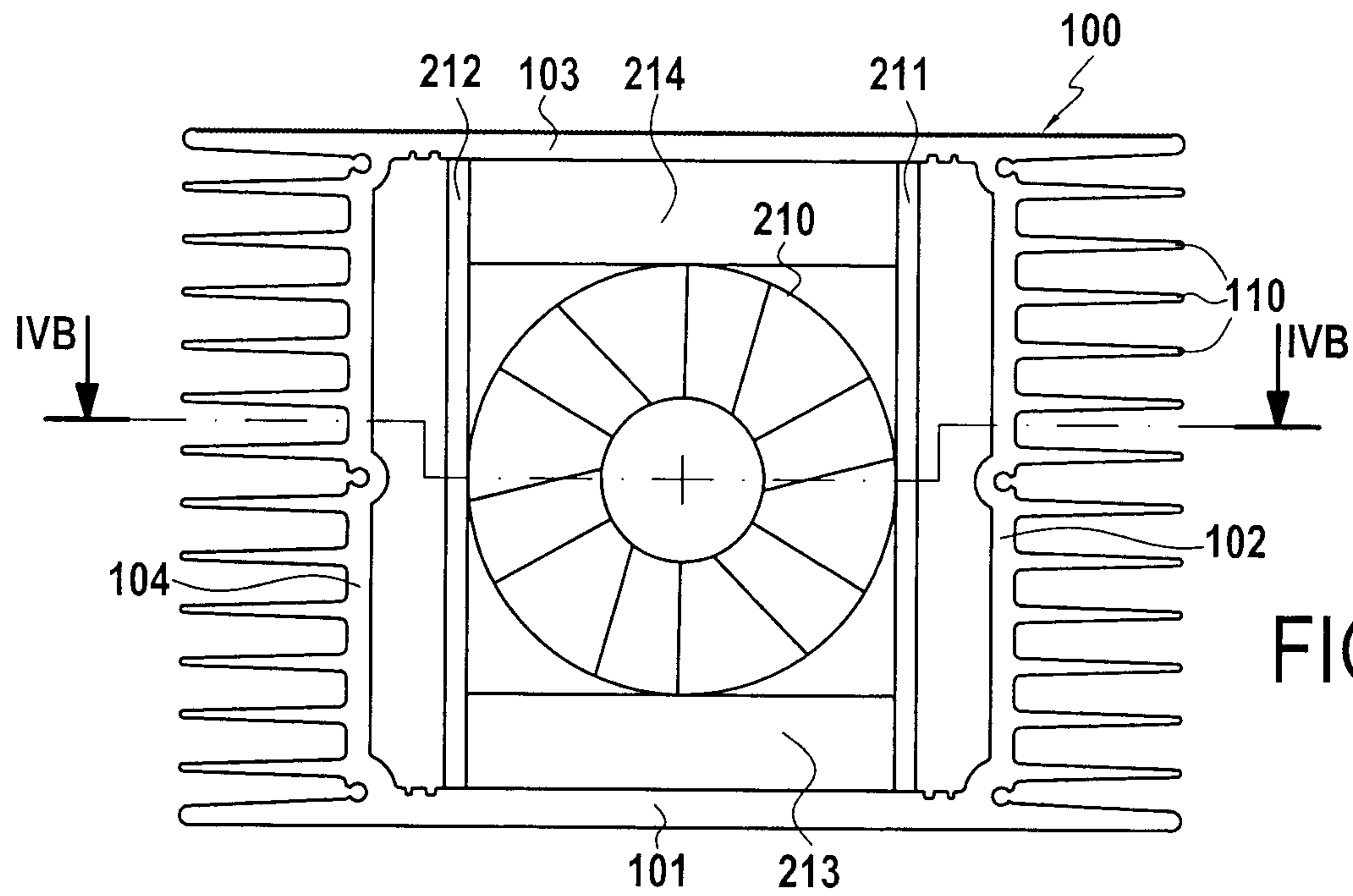


FIG. 4A

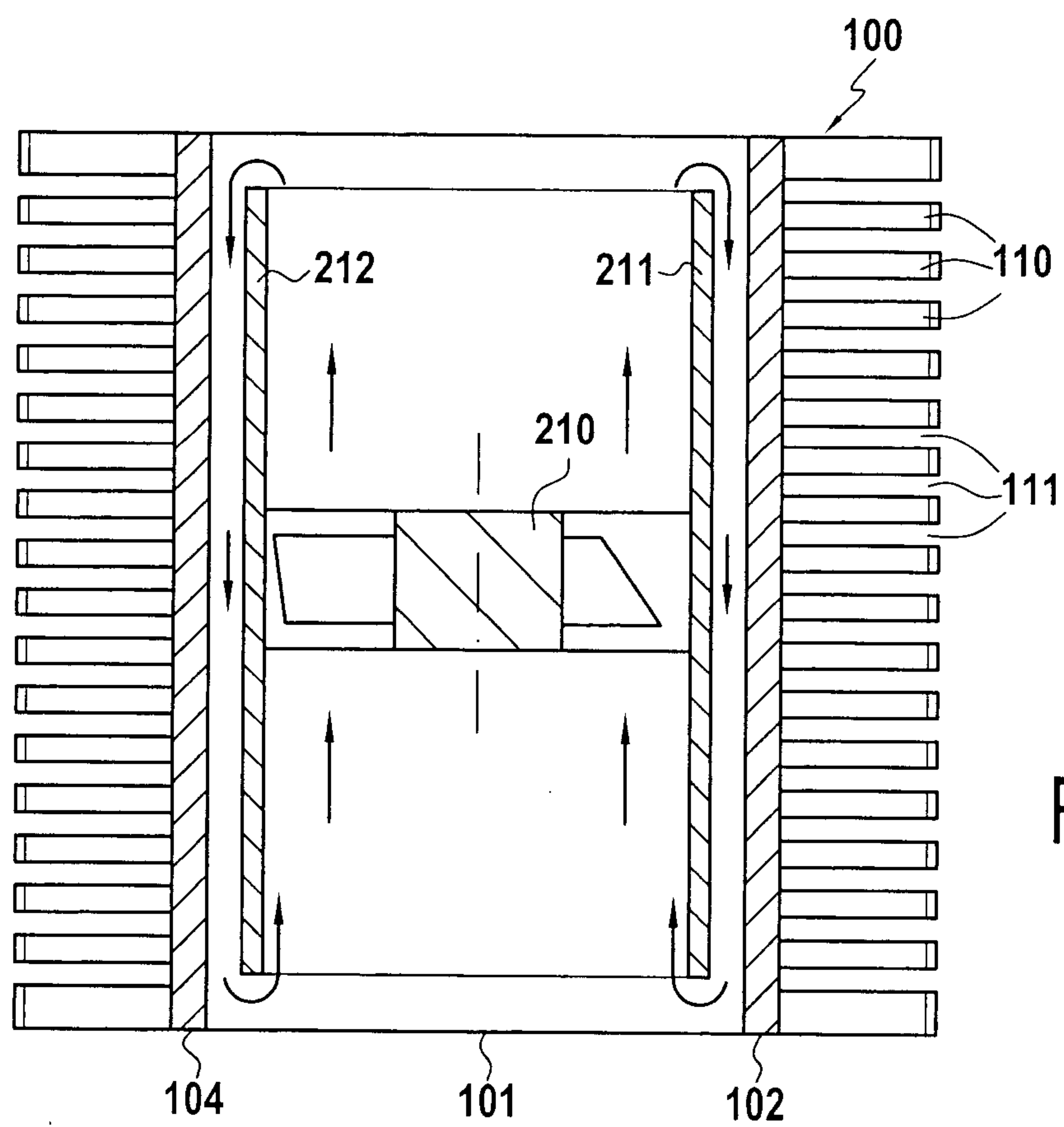


FIG. 4B

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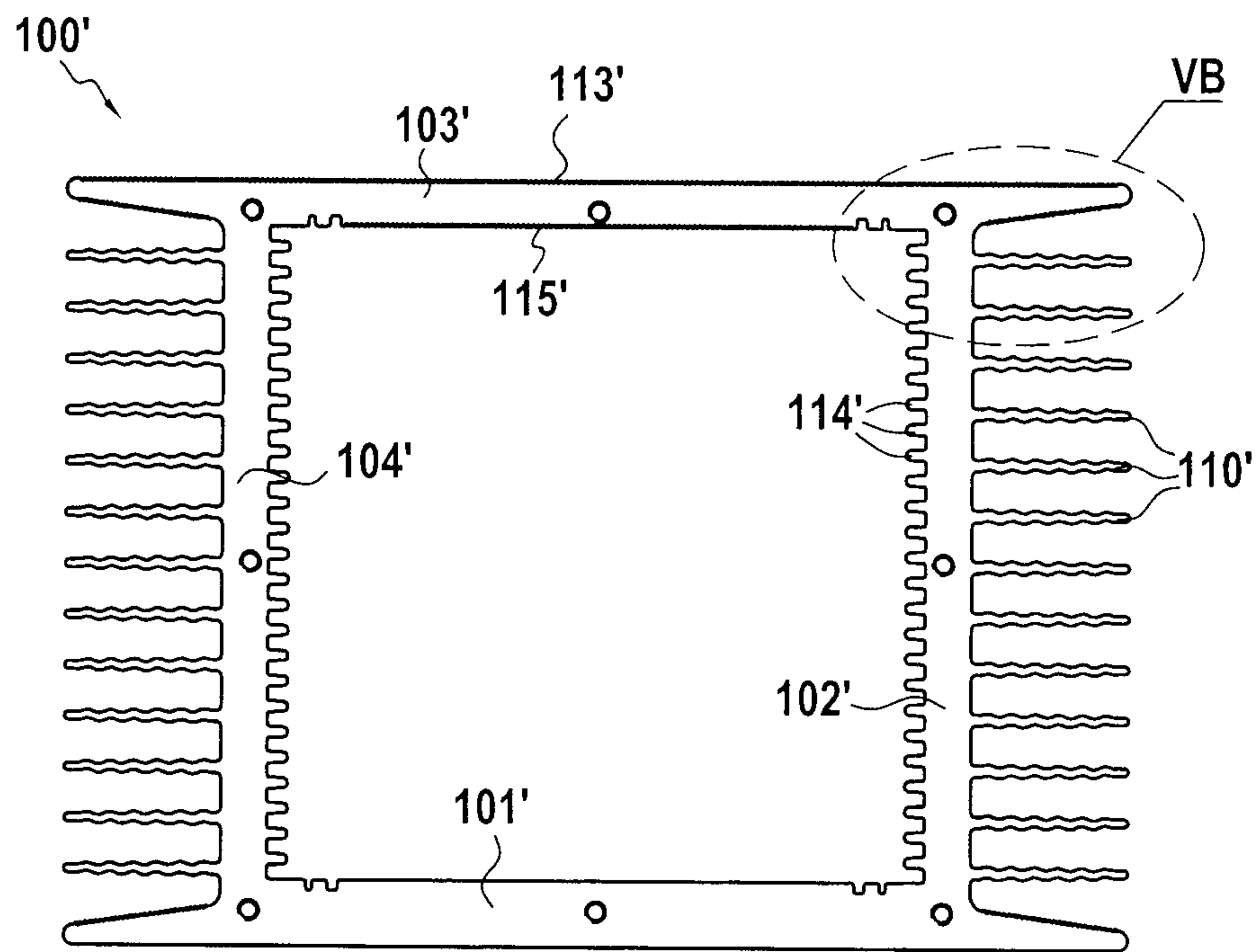


FIG. 5A

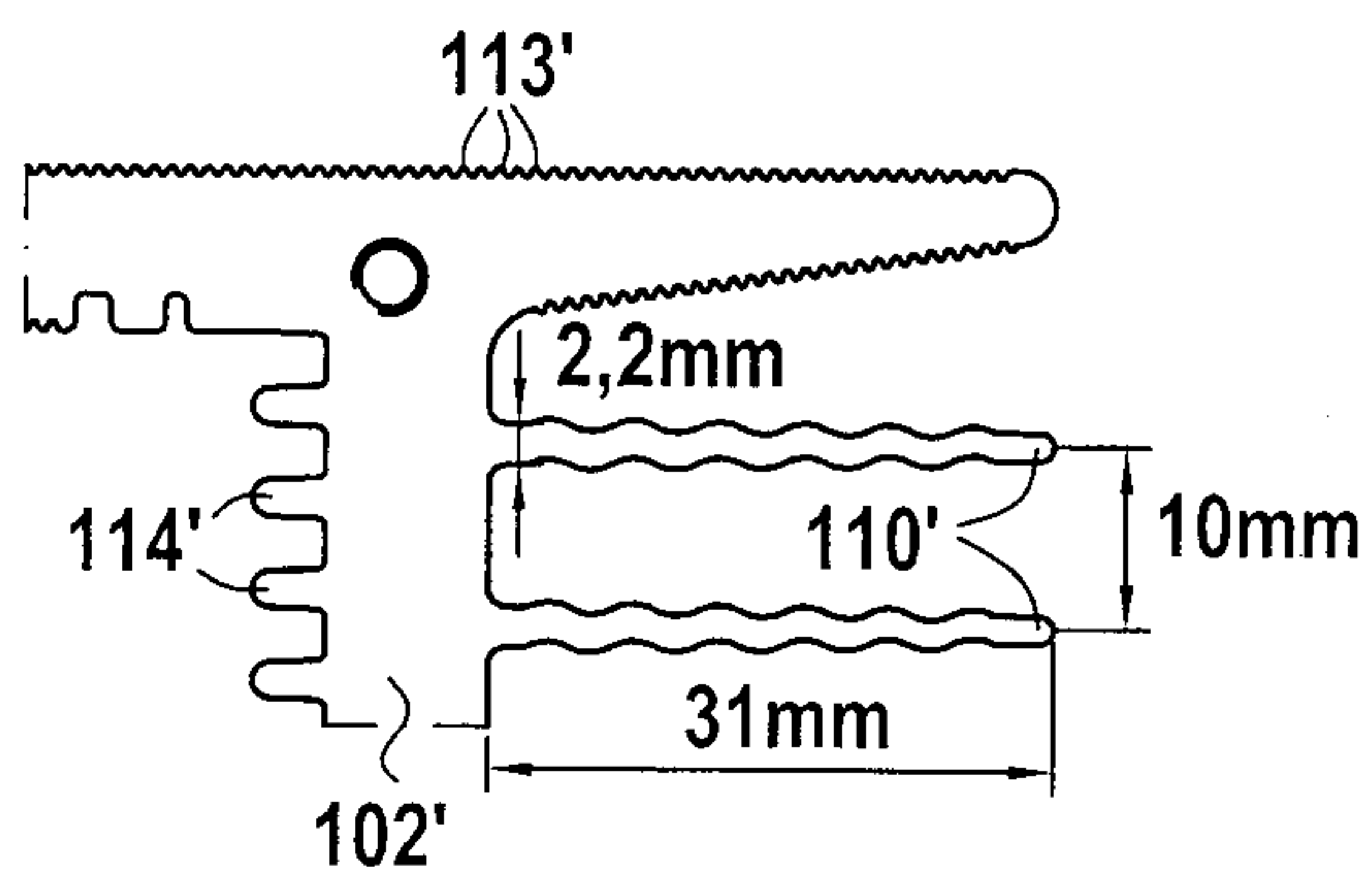


FIG. 5B

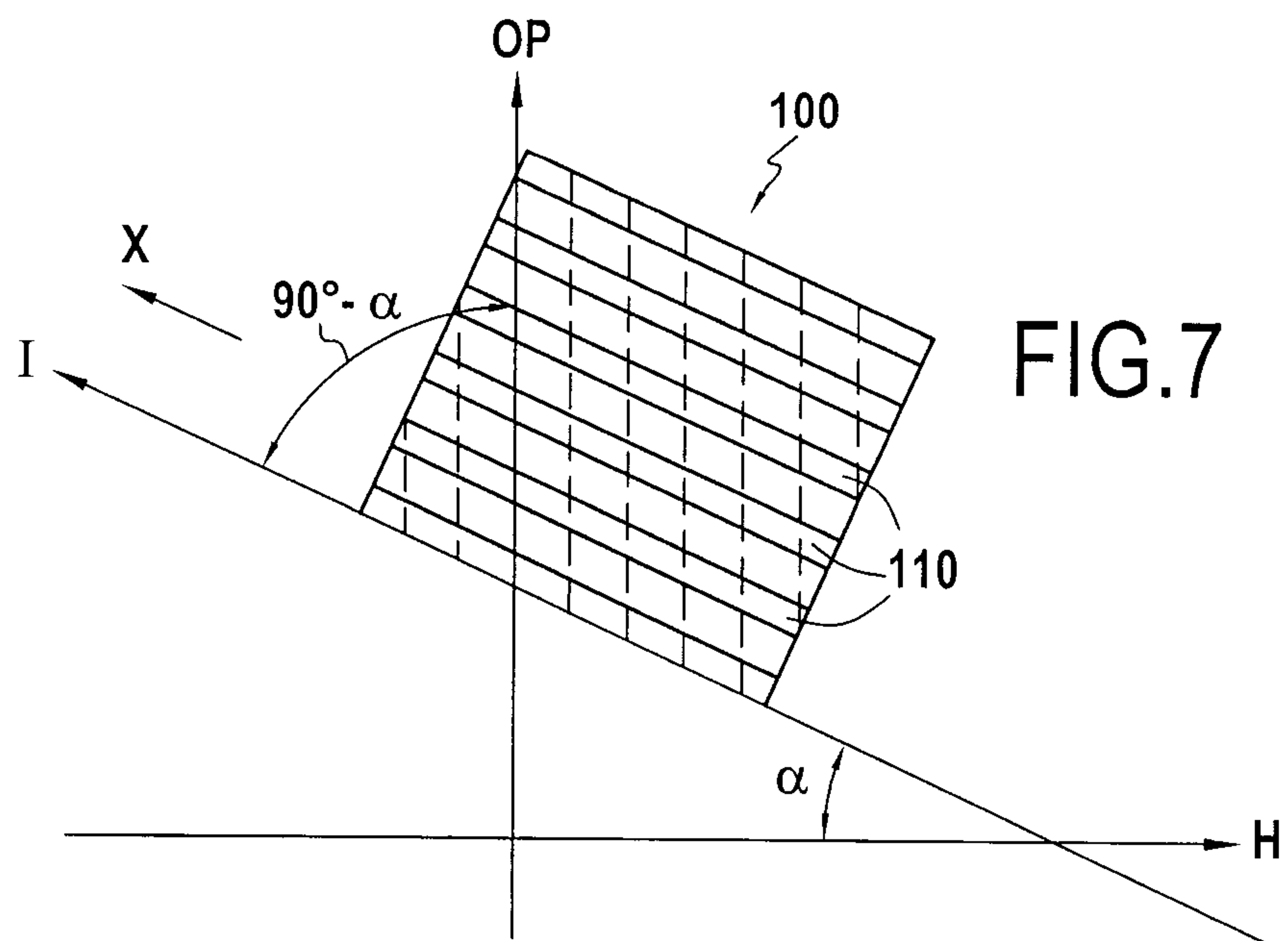


FIG. 7

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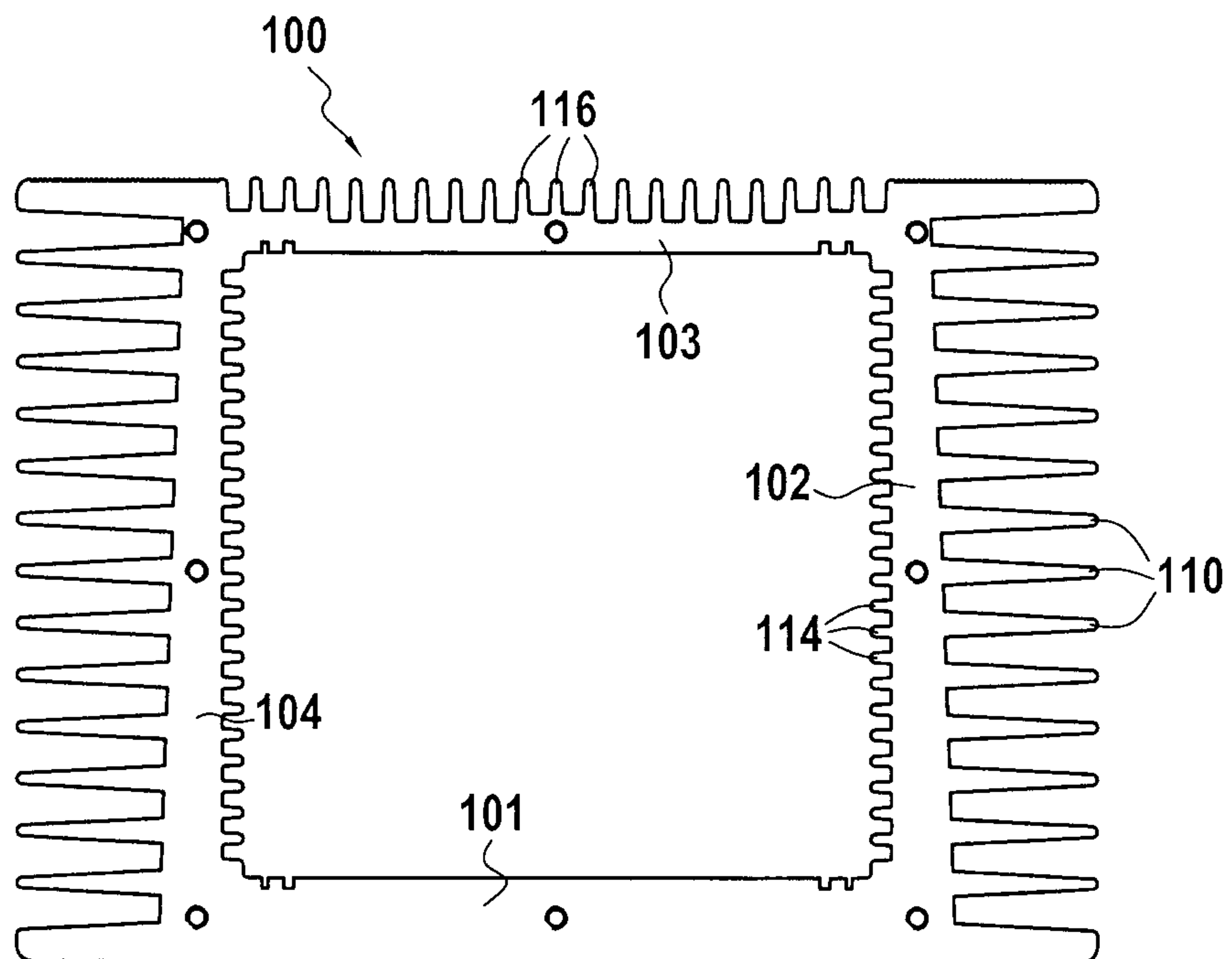


FIG. 6A

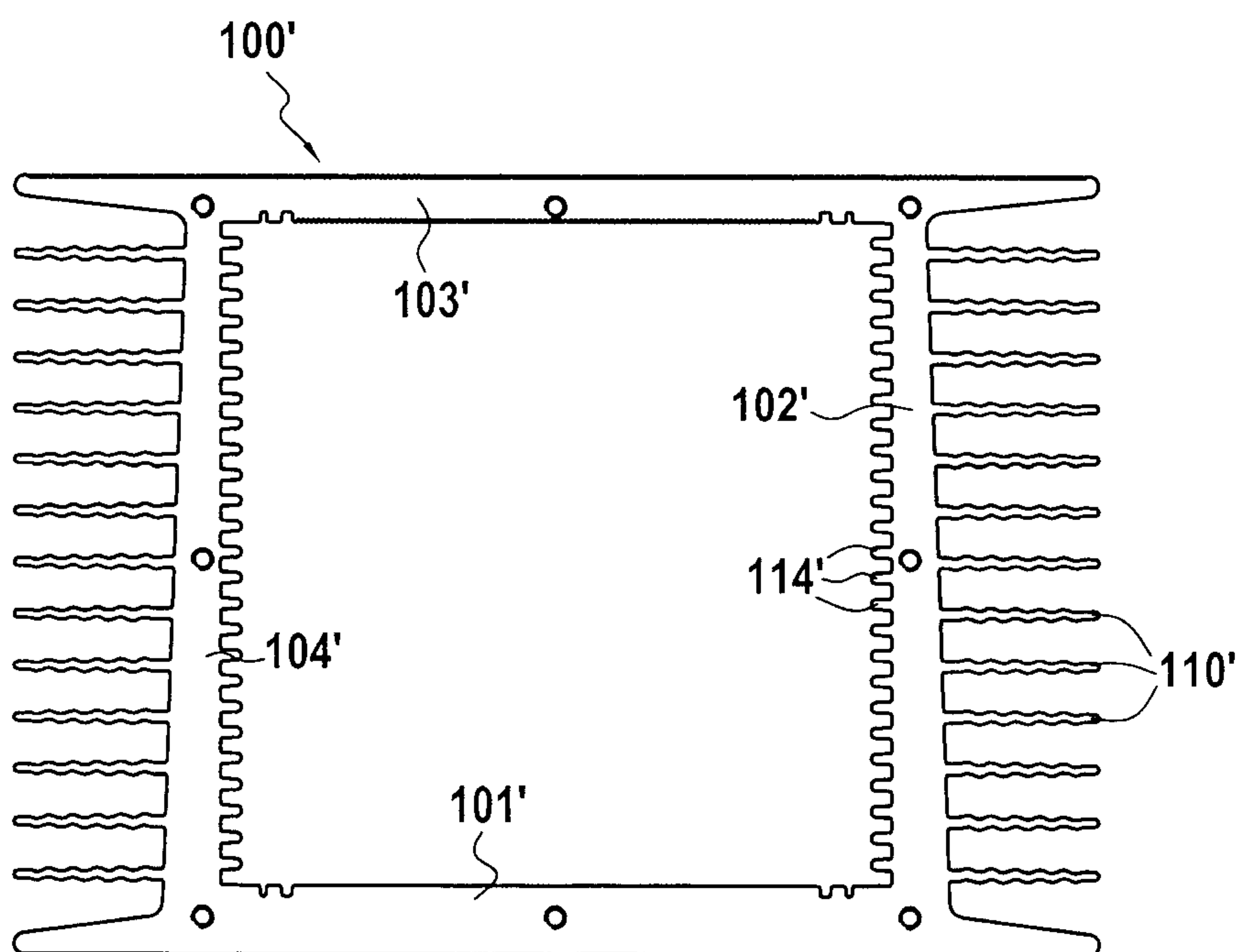


FIG. 6B

