US 20130112388A1

(19) United States
(12) Patent Application Publication
Kwak et al.
(10) Pub. No.: US 2013/0112388 A1
(43) Pub. Date: May 9, 2013

(54) HEAT SINK

(75) Inventors: **Young Hoon Kwak**, Gyunggi-do (KR); **Kyu Hwan Oh**, Gyunggi-do (KR)

(73) Assignee: **SAMSUNG ELECTRO-MECHANICS CO., LTD.**, Gyunggi-do (KR)

(21) Appl. No.: **13/448,797**

(22) Filed: **Apr. 17, 2012**

(30) **Foreign Application Priority Data**

Nov. 4, 2011 (KR) 1020110114602

Publication Classification

(51) **Int. Cl.**
F28F 7/00 (2006.01)

(52) **U.S. Cl.**
USPC **165/185**

(57) **ABSTRACT**

Disclosed herein is a heat sink including: a first region connected to a cooling water introduction part and having a plurality of first pins arranged therein; and a second region connected to a cooling water discharge part and having a plurality of second pins arranged therein.

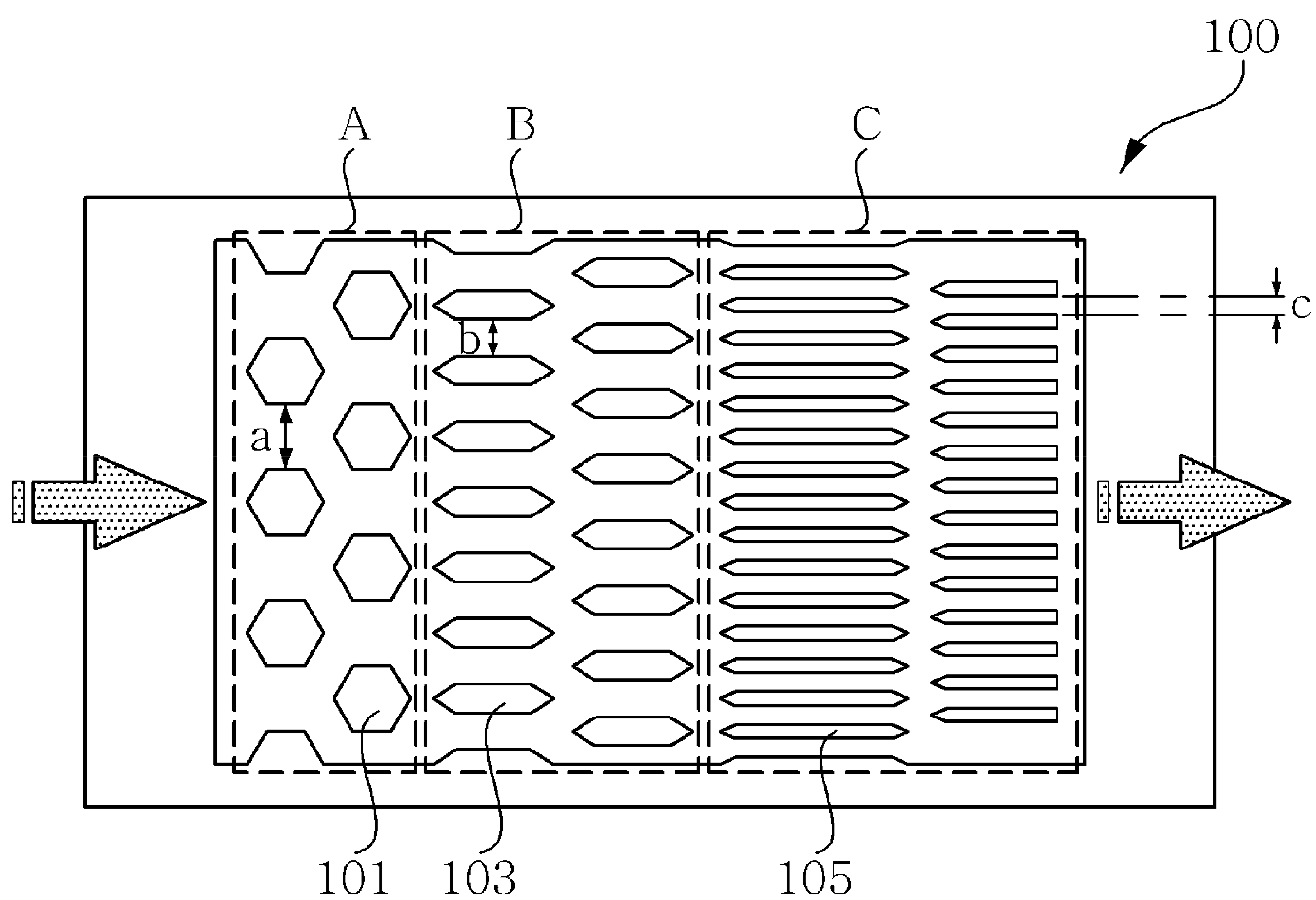


FIG.1

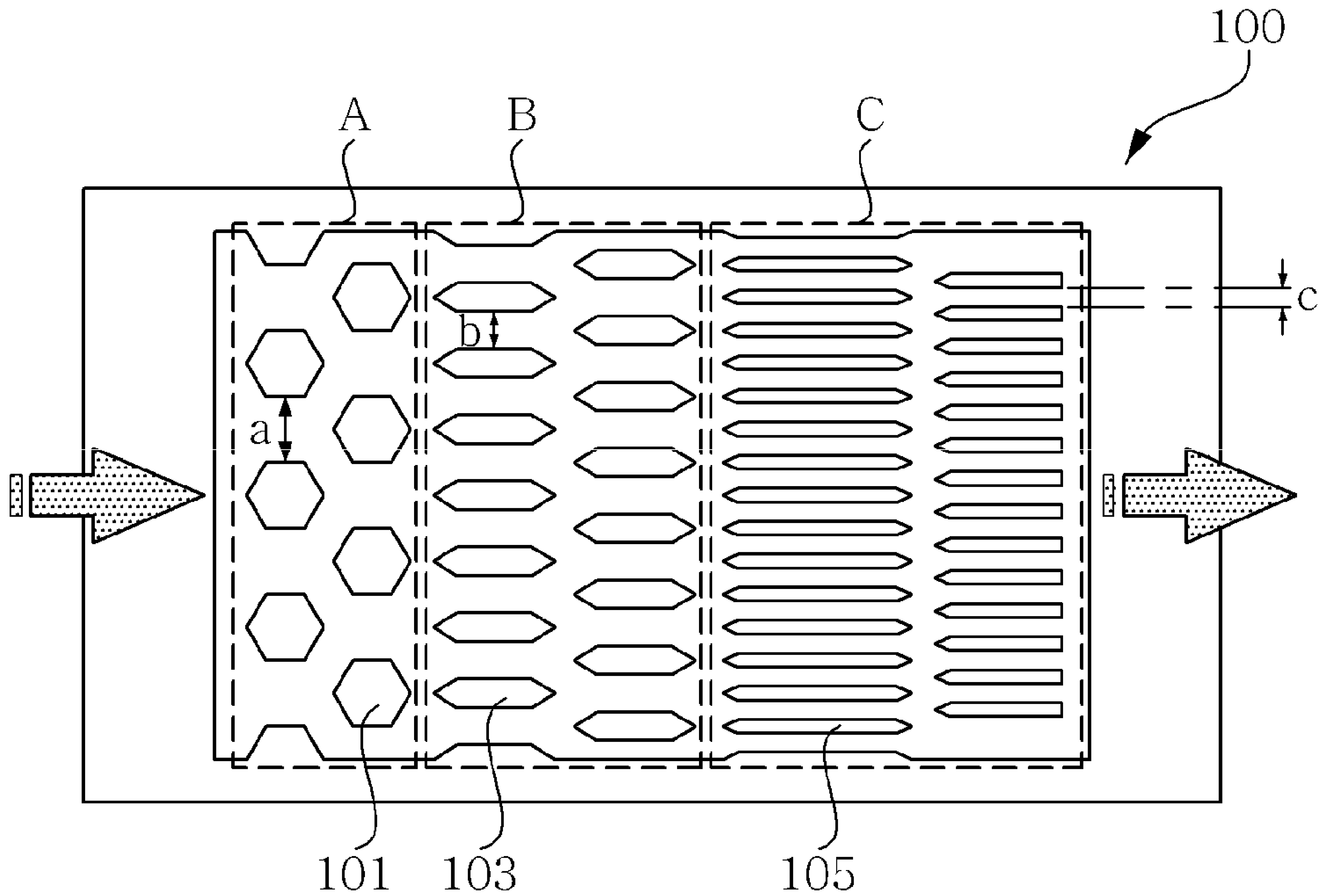


FIG.2

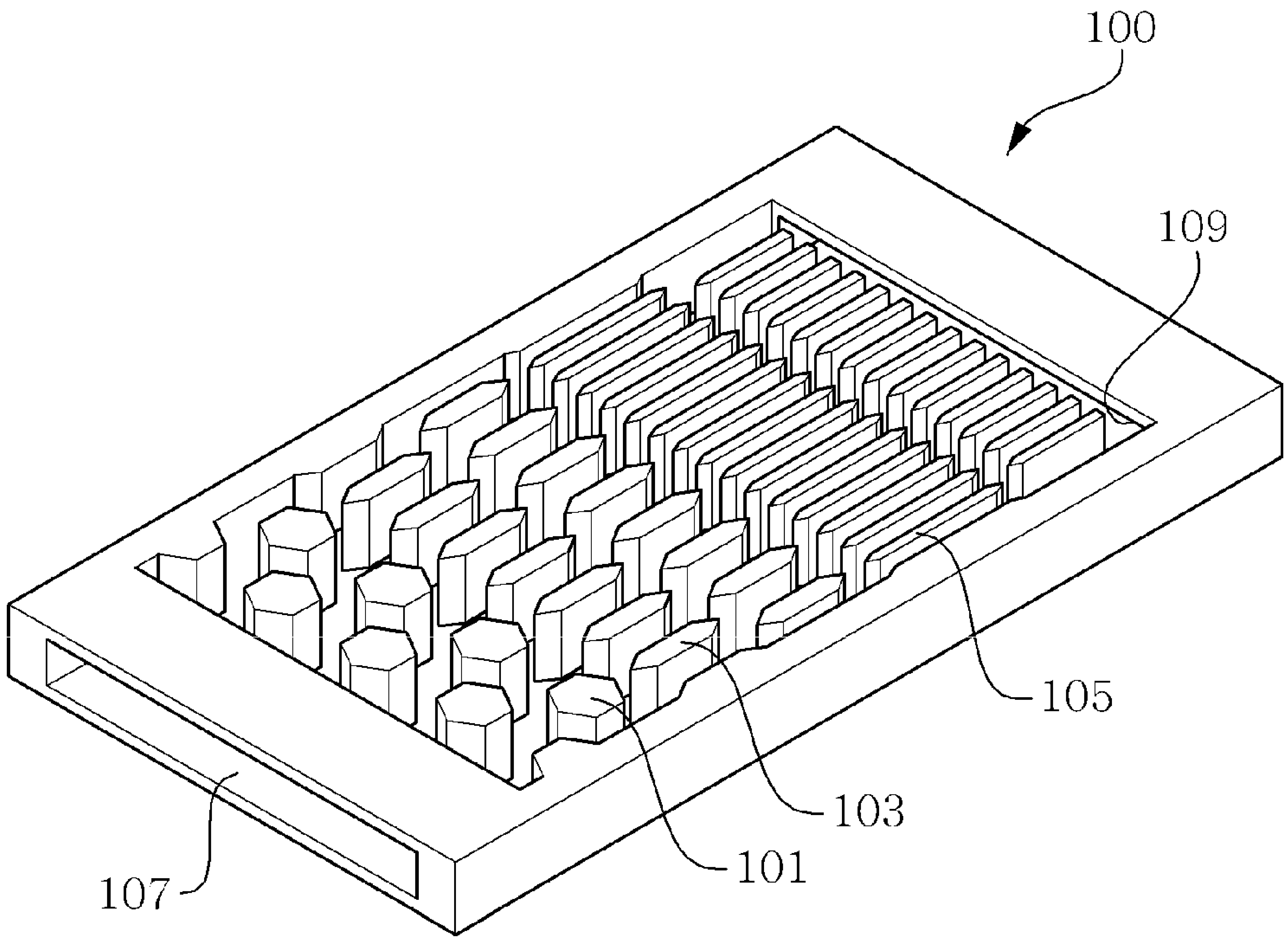


FIG. 3

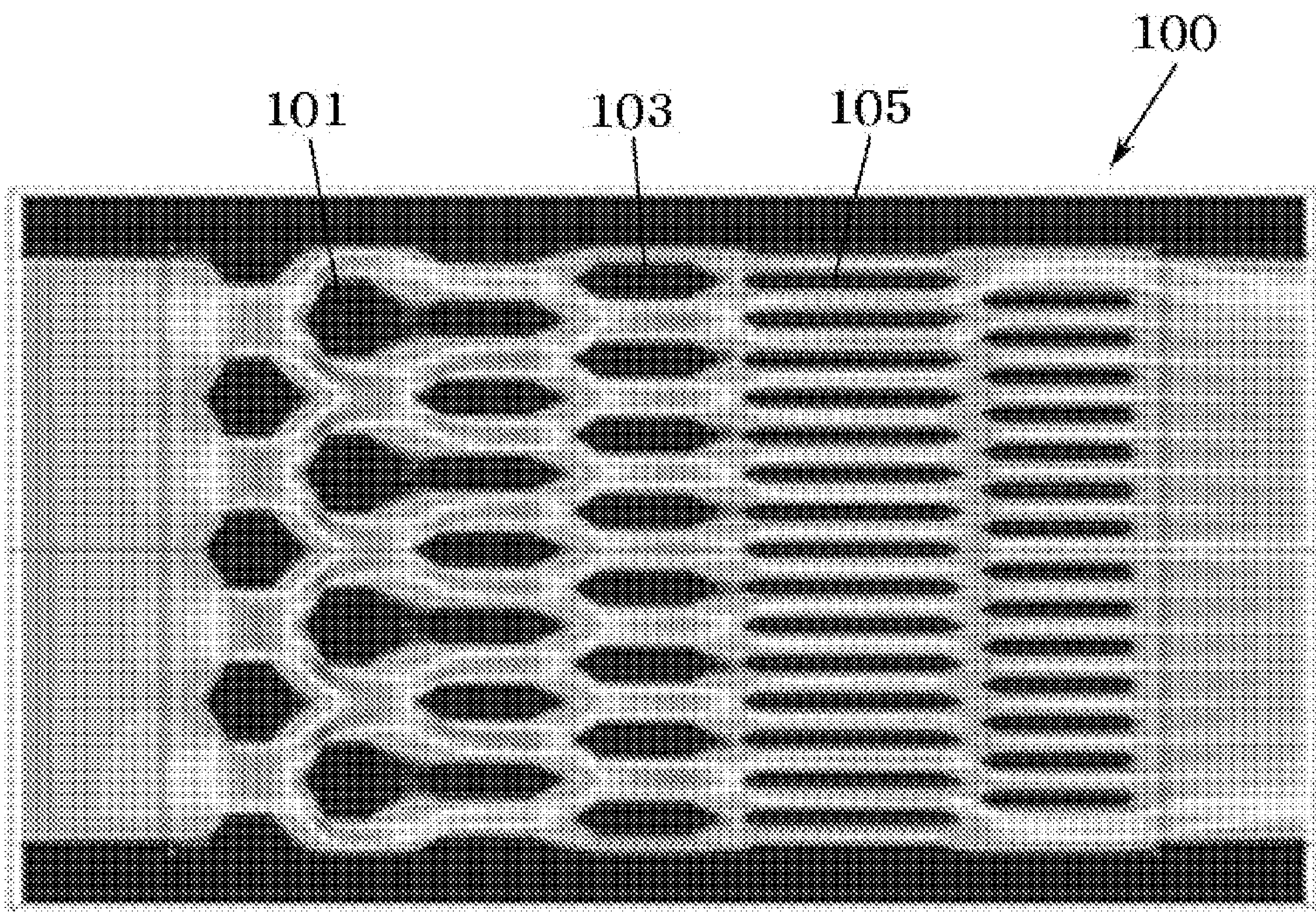


FIG. 4

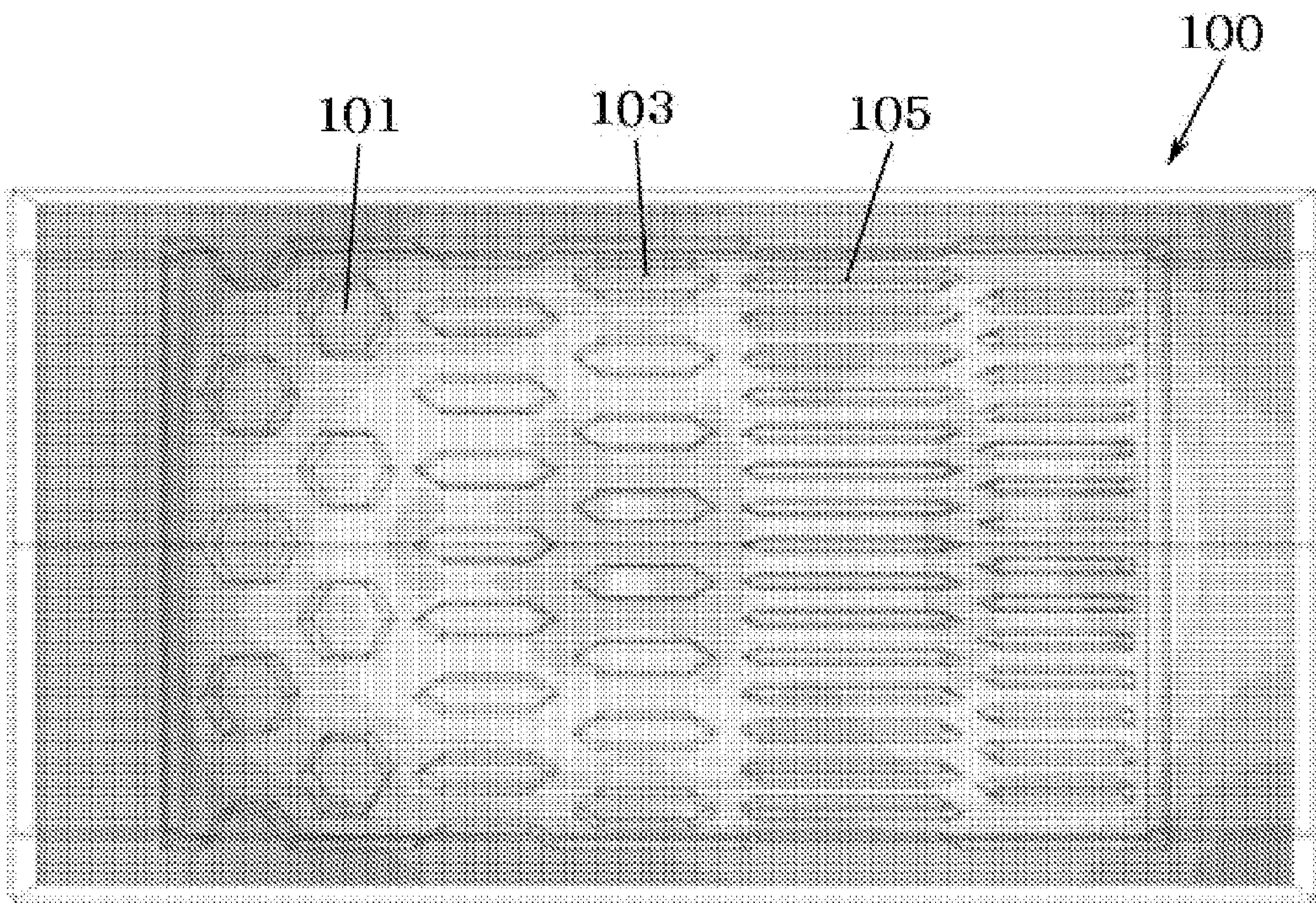


FIG.5

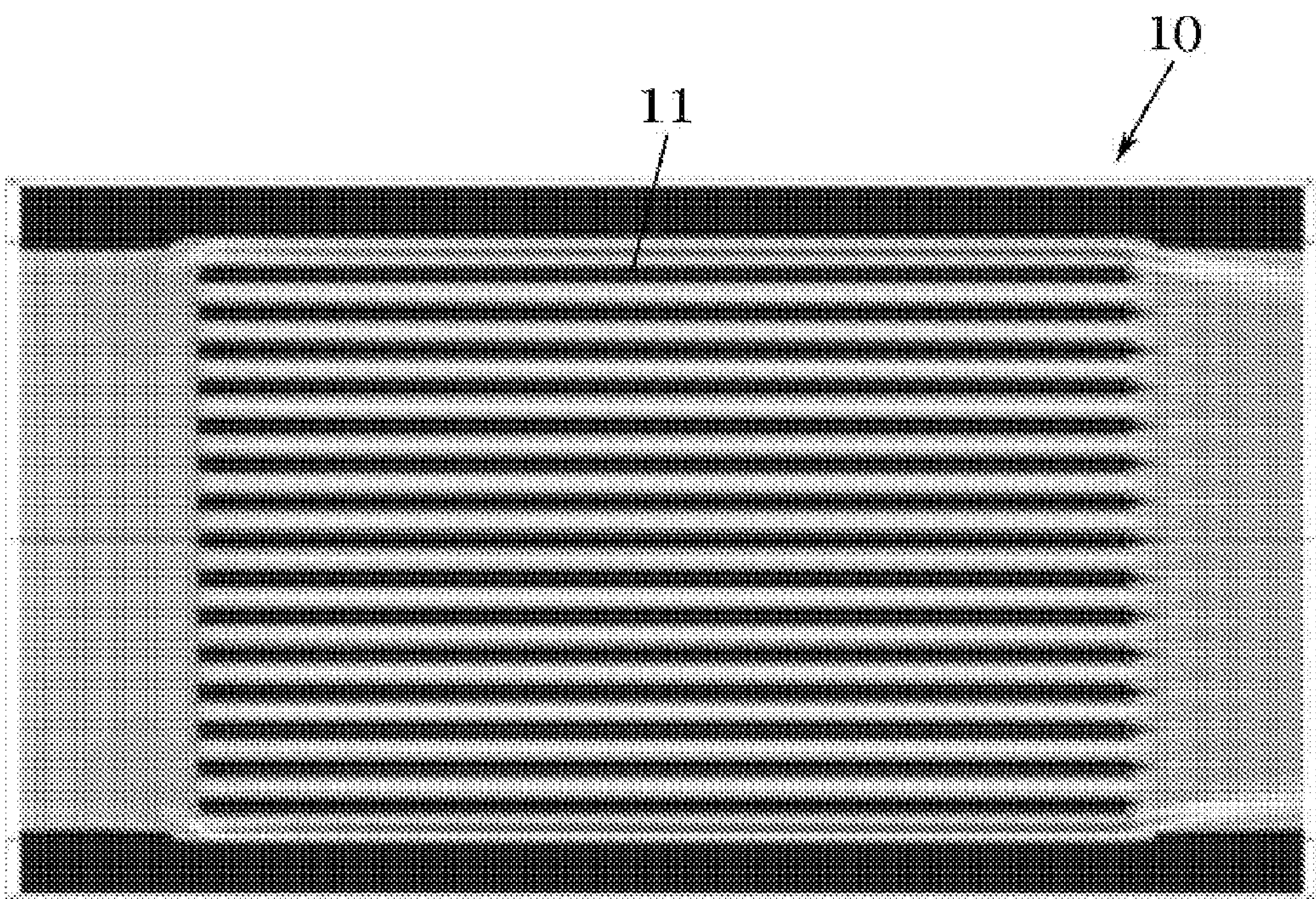
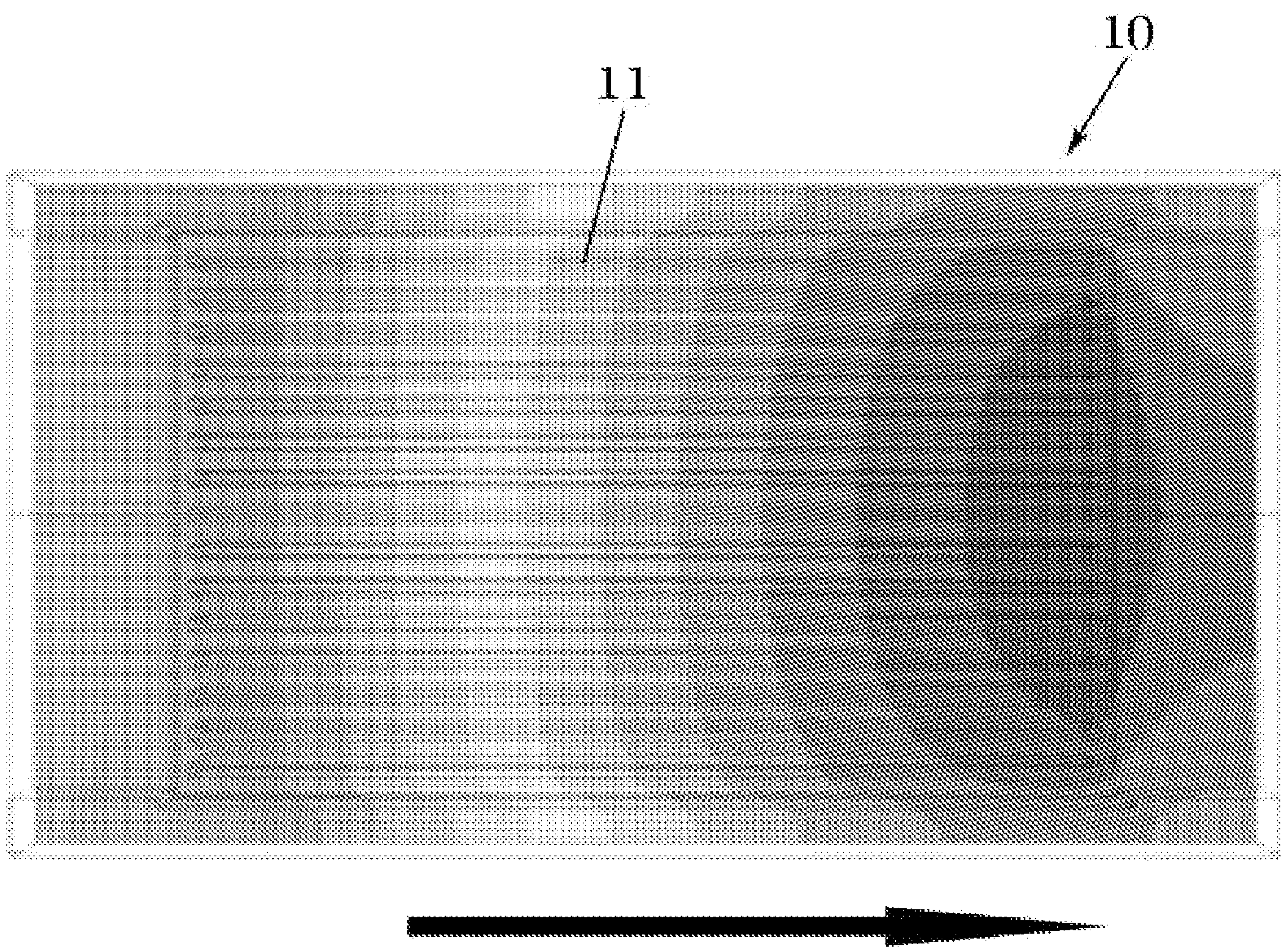


FIG. 6



HEAT SINK

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of Korean Patent Application No. 10-2011-0114602, filed on Nov. 4, 2011, entitled "Heat Sink", which is hereby incorporated by reference in its entirety into this application.

BACKGROUND OF THE INVENTION

[0002] 1. Technical Field

[0003] The present invention relates to a heat sink.

[0004] 2. Description of the Related Art

[0005] A power control unit (PCU), including an inverter for converting a DC current supplied from a battery into an AC current for driving a motor and a control device for effectively converting it, is essential in an electric vehicle.

[0006] Recently, in order to enhance efficiency of vehicles, PCUs tend to be lightweight, compact, and highly integrated, and thus, heat dissipation of highly integrated power devices is an important issue.

[0007] Meanwhile, Korean Patent No. 0598516 discloses a heat sink according to the prior art.

[0008] As disclosed in the Patent Document, the prior art heat sink is fabricated to have a structure in which thin fin type columns or pin type columns having a certain diameter are arranged at regular intervals.

[0009] However, the heat sink has a problem in that temperature of a heating part where cooling water is injected is reduced, while the temperature of the heating part is increased toward the direction where cooling water is discharged.

[0010] Also, since the heat sink with the fin type columns arranged therein causes a loss of a flow pressure of cooling water, a relatively high pumping power is required.

SUMMARY OF THE INVENTION

[0011] The present invention has been made in an effort to provide a heat sink capable of increasing a heat dissipation effect while minimizing a loss of a flow pressure of cooling water.

[0012] Another aspect of the present invention is to provide a heat sink capable of minimizing a temperature deviation of the entire area of a heating unit.

[0013] According to a first preferred embodiment of the present invention, there is provided a heat sink including: a first region connected to a cooling water introduction part and having a plurality of first pins arranged therein; and a second region connected to a cooling water discharge part and having a plurality of second pins arranged therein.

[0014] The heat sink may further include: one or more regions provided between the first and second regions and having pins arranged therein, the pins having a surface area greater than that of the first pins and smaller than that of the second pins.

[0015] A space between the first pins arranged in the first region may be greater than that between the second pins arranged in the second region.

[0016] A total area of the sides that cooling water faces perpendicularly in the second region may be greater than a total area of the sides that the cooling water faces perpendicularly in the first region.

[0017] The heat sink may further include: a cover member covering the first and second regions.

[0018] The heat sink may be made of copper (Cu) or aluminum (Al).

[0019] According to a second preferred embodiment of the present invention, there is provided a heat sink including: a first region having a plurality of first pins arranged therein; a second region having a plurality of second pins whose surface area is larger than that of the first pins, and formed to be adjacent to the first region; and a third region having a plurality of third pins whose surface area is larger than that of the second pins, and formed to be adjacent to the second region.

[0020] The first region may be connected to a cooling water introduction part, the third region may be connected to a cooling water discharge part, and a total area of the sides that cooling water faces perpendicularly in the second region may be greater than a total area of the sides that the cooling water faces perpendicularly in the first region.

[0021] The first region may be connected to a cooling water introduction part, the third region may be connected to a cooling water discharge part, and a total area of the sides that cooling water faces perpendicularly in the third region may be greater than a total area of the sides that the cooling water faces perpendicularly in the second region.

[0022] The first pins, the second pins, and the third pins may be arranged at regular intervals in the first region, the second region, and the third region, respectively.

[0023] A space between the first pins arranged in the first region may be greater than that between the second pins arranged in the second region. The space between the second pins arranged in the second region may be greater than that between the third pins arranged in the third region.

[0024] The heat sink may be made of copper (Cu) or aluminum (Al).

[0025] The heat sink may further include: a cover member covering the first, the second, and the third regions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. **1** is a plan view showing an internal structure of a heat sink according to an embodiment of the present invention;

[0027] FIG. **2** is a perspective view showing an internal structure of the heat sink according to an embodiment of the present invention;

[0028] FIG. **3** is a view showing distribution of a velocity of the flow (or flux distribution) of cooling water introduced into the heat sink according to an embodiment of the present invention;

[0029] FIG. **4** is a view showing a temperature distribution of the entire area of the heat sink according to an embodiment of the present invention;

[0030] FIG. **5** is a view showing distribution of a velocity of the flow of cooling water introduced into a heat sink according to a prior art; and

[0031] FIG. **6** is a view showing a temperature distribution of the entire area of the heat sink according to the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0032] Various features and advantages of the present invention will be more obvious from the following description with reference to the accompanying drawings.

[0033] The terms and words used in the present specification and claims should not be interpreted as being limited to typical meanings or dictionary definitions, but should be interpreted as having meanings and concepts relevant to the technical scope of the present invention based on the rule according to which an inventor can appropriately define the concept of the term to describe most appropriately the best method he or she knows for carrying out the invention.

[0034] The above and other objects, features and advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings. In the specification, in adding reference numerals to components throughout the drawings, it is to be noted that like reference numerals designate like components even though components are shown in different drawings. In describing the present invention, a detailed description of related known functions or configurations will be omitted so as not to obscure the gist of the present invention. In the description, the terms "first", "second", "one surface", "the other surface" and so on are used to distinguish one element from another element, and the elements are not defined by the above terms.

[0035] Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

[0036] FIG. **1** is a plan view showing an internal structure of a heat sink according to an embodiment of the present invention. FIG. **2** is a perspective view showing an internal structure of the heat sink according to an embodiment of the present invention. FIG. **3** is a view showing distribution of a velocity of the flow (or flux distribution) of cooling water introduced into the heat sink according to an embodiment of the present invention. FIG. **4** is a view showing a temperature distribution of the entire area of the heat sink according to an embodiment of the present invention.

[0037] With reference to FIG. **1**, a heat sink **100** according to present embodiment includes a first region A in which a plurality of first pins **101** are arranged, a second region B in which a plurality of second pins **103** are arranged, and a third region C in which a plurality of third pins **105** are arranged.

[0038] In FIG. **1**, it is illustrated that the heat sink **100** according to a preferred embodiment of the present invention includes three regions of the first region A, the second region B, and the third region C, but two or more regions may also be formed between the first region A connected to a cooling water introduction part **107** and the third region C connected to a cooling water discharge part **109**.

[0039] Here, the second region B may be formed to be adjacent to the first region A, and the third region C may be formed to be adjacent to the second region B. Namely, the first region A, the second region B, and the third region C are sequentially formed as shown in FIG. **1**.

[0040] The second pins **103** arranged in the second region B may have a larger surface area than that of the first pins **101** arranged in the first region A, and the third pins **105** arranged in the third region C may have a larger surface area than that of the second pins **103** arranged in the second region B.

[0041] If a fourth region (not shown) in which fourth pins (not shown) are formed is formed between the second region B in which the second pins **103** are formed and the third region C in which the third pins **105** are formed, a surface area of the fourth pins (not shown) may be larger than that of the second pins **103** and smaller than that of the third pins **105**.

[0042] Namely, in order to enhance a heat dissipation performance toward the third region C connected to the cooling water discharge part **109** from the first region A connected to the cooling water introduction part **107**, the surface areas of the pins are increased.

[0043] In FIGS. **1** and **2**, the first pins **101** arranged in the first region A have a hexagonal columnar shape, but it is merely an example, and the shape of the pins is not particularly limited. For example, the cross-section of the pins may have a circular shape, a triangular shape, a quadrangular shape, or the like.

[0044] In the present embodiment, based on the plan view of FIG. **1**, the diameter of the first pins **101** in a vertical direction arranged in the first region A may be greater than the diameter of the second pins **103** in the vertical direction arranged in the second region B, and the diameter of the second pins **103** in the vertical direction arranged in the second region B may be greater than the diameter of the third pins **105** in the vertical direction arranged in the third region C.

[0045] Meanwhile, based on FIG. **1**, the diameter of the first pins **101** in a horizontal direction arranged in the first region A may be smaller than the diameter of the second pins **103** in the horizontal direction arranged in the second region B, and the diameter of the second pins **103** in the horizontal direction may be smaller than the diameter of the third pins **105** in the horizontal direction arranged in the third region C.

[0046] Namely, the diameter of the pins in the vertical direction is reduced and the diameter of the pins in the horizontal direction is increased in the direction from the first pins **101** to the third pins **105** based on FIG. **1**, whereby the shape of the pins is changed from a pin-like shape to a fin-like shape as shown in FIG. **1**.

[0047] This is to enlarge the surface area, namely, a heat transmission area, of the pins from the first region A and the second region B toward the third region C to thus increase heat conductivity, resulting in enhancement of heat dissipation efficiency.

[0048] In addition, in the present embodiment, as shown in FIGS. **1** and **2**, a total area obtained by adding the areas of the sides that cooling water faces perpendicularly in the second region B is greater than a total area obtained by adding the areas of sides that the cooling water faces perpendicularly (which refers to vertical cross-sections between the first pins **101**, i.e., vertical cross-sections of the portions through which cooling water flows) in the first area A.

[0049] Furthermore, a total area obtained by adding the areas of the sides that the cooling water faces perpendicularly in the third region C may be greater than a total area obtained by adding the areas of the sides that the cooling water faces perpendicularly in the second region B.

[0050] That is, the total area in which cooling water moves is increased from the part to which cooling water is introduced to the part from which cooling water is discharged.

[0051] As described above, since the surface area of the pins and the total area of the sides in which cooling water flows are increased from the part to which cooling water is introduced to the part from which cooling water is discharged, surface heat transmission efficiency can be increased to enhance heat dissipation characteristics.

[0052] In addition, in the present embodiment, as shown in FIGS. **1** and **2**, the space a between the first pins **101** arranged in the first region A may be greater than the space b between the second pins **103** arranged in the second region B, and the space b between the second pins **103** arranged in the second region B may be greater than the space c between the third pins **105** arranged in the third region C.

[0053] In this manner, since the space between the first pins **101** is large, the velocity of cooling water moving in the first region A is faster than that of cooling water moving in the second region B, and the velocity of cooling water moving in the second region B is faster than that of cooling water moving in the third region C, a loss of a flow pressure of cooling water moving to the third region C through the second region B can be minimized, thus reducing an amount of consumed pump power.

[0054] Namely, the heat sink **100** according to the present embodiment is implemented as follows. That is, since the first region A is directly connected to the cooling water introduction part **107**, in which cooling water having a low temperature flows, although the surface area of the first pins **101** is relatively small and the velocity of cooling water is faster, heat may be relatively properly transmitted with cooling water introduced from the first pins **101**, and although the temperature of the introduced cooling water is gradually increased toward the third region C through the second region B, since the surface area of the pins and the movement area of cooling water are increased, heat can be dissipated easily.

[0055] Computational results with respect to the distribution of velocity of the cooling water introduced into the heat sink **100** and experiment results with respect to a temperature distribution of the overall area of the heat sink **100** are shown in FIGS. **3** and **4**.

[0056] First, with reference to FIG. **3**, it is noted that the velocity of cooling water moving between the first pins **101** in the first region A is fast, the velocity of cooling water moving between the second pins **103** in the first region B is slightly slower than the velocity of cooling water moving in the first region A, and the velocity of cooling water moving between the third pins **105** in the third region C is slower than the velocity of cooling water moving in the second region B.

[0057] In comparison, with reference to FIG. **5** showing the distribution of velocity of cooling water introduced into the heat sink according to the prior art, it is noted that the velocity of cooling water is slow overall.

[0058] In addition, with reference to FIG. **4**, it is noted that temperature is uniformly distributed over the entirety of the first region A, the second region B, and the third region C of the heat sink **100** according to the present embodiment.

[0059] In comparison, with reference to FIG. **6** showing the temperature distribution of the heat sink according to the prior art, it is noted that temperature is increased toward the direction (the direction of the arrow) from which cooling water is discharged.

[0060] In addition, FIGS. **1** and **2** show the exposed internal structure of heat sink **100** to explain the internal structure thereof, but a skilled person in the art would recognize that a cover member (not shown) covering the first region A, the second region B, and the third region C may be further provided.

[0061] Furthermore, the heat sink **100** according to the present invention may be made of copper (Cu) or aluminum (Al), but the present invention is not particularly limited thereto and any material having good thermal conductivity may be used.

[0062] In addition, the heat sink **100** according to the present embodiment may be fabricated by injection molding using a mold having a corresponding shape, but the present invention is not particularly limited thereto.

[0063] According to the preferred embodiments of the present invention, since the heat sink has the structure in which the total area that the cooling water faces when moving after being introduced is gradually increased from the introduction part to the discharging part, whereby resistance generated against the flow of cooling water can be reduced, and accordingly, a loss of the cooling water flow pressure can be reduced.

[0064] In addition, since the loss of the cooling water flow pressure is reduced as mentioned above, the amount of consumed pump power can be reduced.

[0065] In addition, since the structure in which the surface area of the pins is gradually increased is used, a maximum temperature of the heating unit can be reduced and, at the same time, a temperature deviation of the overall heating area can be reduced.

[0066] Although the embodiment of the present invention has been disclosed for illustrative purposes, it will be appreciated that a heat sink according to the invention is not limited thereto, and those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention.

[0067] Accordingly, any and all modifications, variations or equivalent arrangements should be considered to be within the scope of the invention, and the detailed scope of the invention will be disclosed by the accompanying claims.

What is claimed is:

1. A heat sink comprising:

a first region connected to a cooling water introduction part and having a plurality of first pins arranged therein; and

a second region connected to a cooling water discharge part and having a plurality of second pins arranged therein.

2. The heat sink as set forth in claim **1**, further comprising:

one or more regions provided between the first and second regions and having pins arranged therein, the pins having a surface area greater than that of the first pins and smaller than that of the second pins.

3. The heat sink as set forth in claim **1**, wherein a space between the first pins arranged in the first region is greater than that between the second pins arranged in the second region.

4. The heat sink as set forth in claim **1**, wherein a total area of the sides that cooling water faces perpendicularly in the second region is greater than a total area of the sides that the cooling water faces perpendicularly in the first region.

5. The heat sink as set forth in claim **1**, further comprising:

a cover member covering the first and second regions.

6. The heat sink as set forth in claim **1**, wherein the heat sink is made of copper (Cu) or aluminum (Al).

7. A heat sink comprising:

a first region having a plurality of first pins arranged therein;

a second region having a plurality of second pins whose surface area is larger than that of the first pins, and formed to be adjacent to the first region; and

a third region having a plurality of third pins whose surface area is larger than that of the second pins, and formed to be adjacent to the second region.

8. The heat sink as set forth in claim **7**, wherein the first region is connected to a cooling water introduction part, the third region is connected to a cooling water discharge part, and a total area of the sides that cooling water faces perpendicularly in the second region is greater than a total area of the sides that the cooling water faces perpendicularly in the first region.

9. The heat sink as set forth in claim **7**, wherein the first region is connected to a cooling water introduction part, the third region is connected to a cooling water discharge part, and a total area of the sides that cooling water faces perpendicularly in the third region is greater than a total area of the sides that the cooling water faces perpendicularly in the second region.

10. The heat sink as set forth in claim **7**, wherein the first pins, the second pins, and the third pins are arranged at regular intervals in the first region, the second region, and the third region, respectively.

11. The heat sink as set forth in claim **10**, wherein a space between the first pins arranged in the first region is greater than that between the second pins arranged in the second region.

12. The heat sink as set forth in claim **10**, wherein the space between the second pins arranged in the second region is greater than that between the third pins arranged in the third region.

13. The heat sink as set forth in claim **7**, wherein the heat sink is made of copper (Cu) or aluminum (Al).

14. The heat sink as set forth in claim **7**, further comprising:

a cover member covering the first, the second, and the third regions.

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