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Hou et al.

(54) PLATE-TYPE HEAT PIPE

(75) Inventors: **Chuen-Shu Hou**, Tu-Cheng (TW); **Jiang-Jun Hu**, Shenzhen City (CN); **Chao Xu**, Shenzhen City (CN)

(73) Assignees: **FU ZHUN PRECISION INDUSTRY (SHEN ZHEN) CO., LTD.**, Shenzhen City (CN); **FOXCONN TECHNOLOGY CO., LTD.**, Tu-Cheng (TW)

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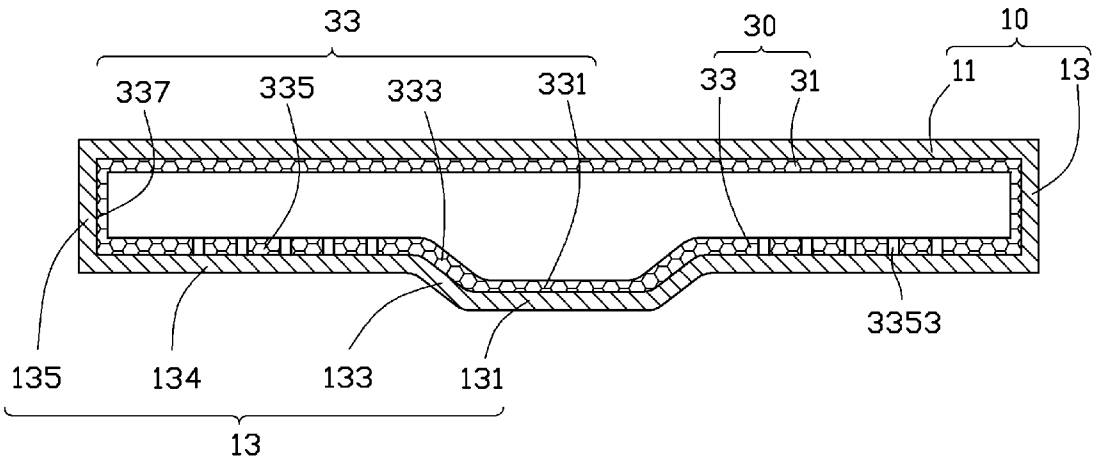
(57) **ABSTRACT**

An exemplary plate-type heat pipe includes a hermetic container, working fluid contained in the container, a first wick portion and two second wick portions formed on inner surfaces of the container. The container includes an evaporating plate and a condensing plate facing each other. The evaporating plate includes a heat absorbing portion, two transition portions extending outwardly and upwardly from opposite ends of the heat absorbing portion, respectively, and two extending portions extending outwardly from outer ends of the transition portions, respectively. The first wick portion is formed on an inner surface of the heat absorbing portion. The second wick portions are formed on inner surfaces of the transition portions, respectively. The third wick portions are formed on inner surfaces of the extending portions, respectively. The third wick portions define capillary pores and a plurality of holes therein.



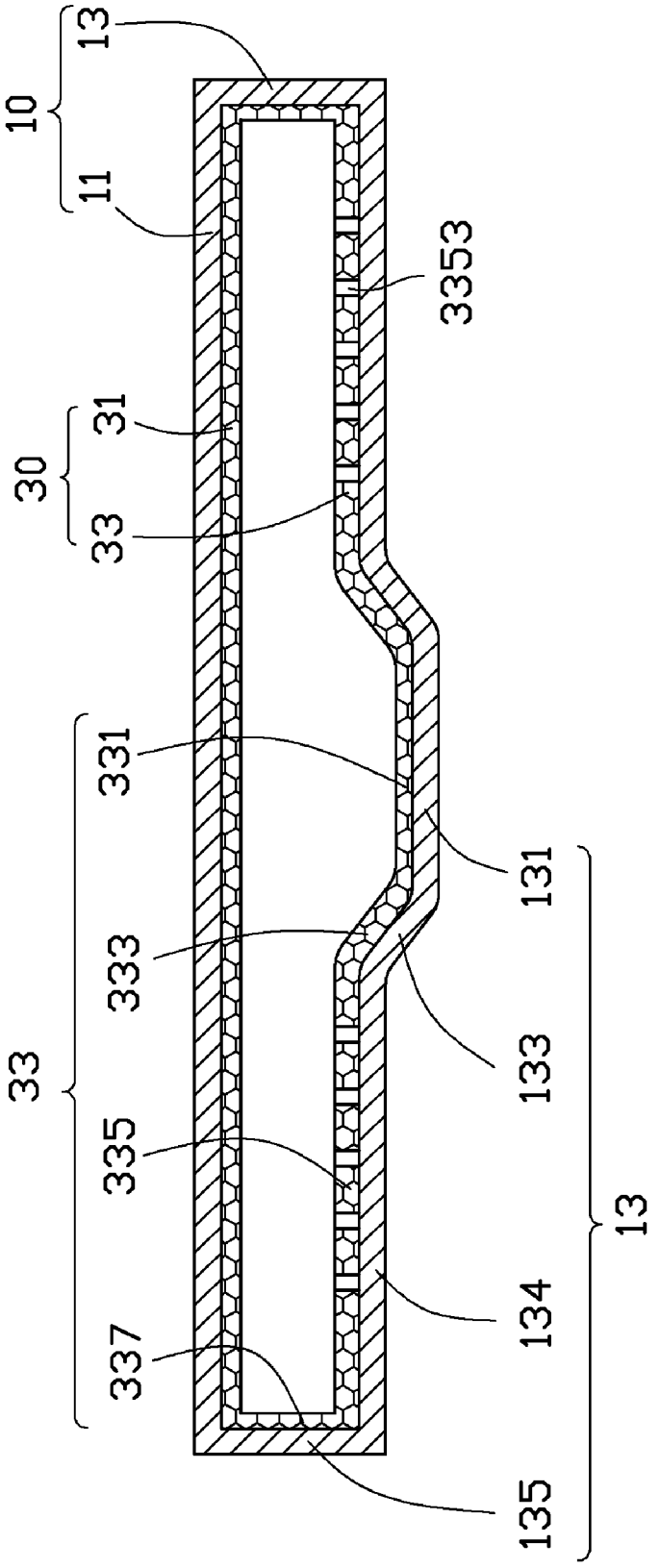


FIG. 1

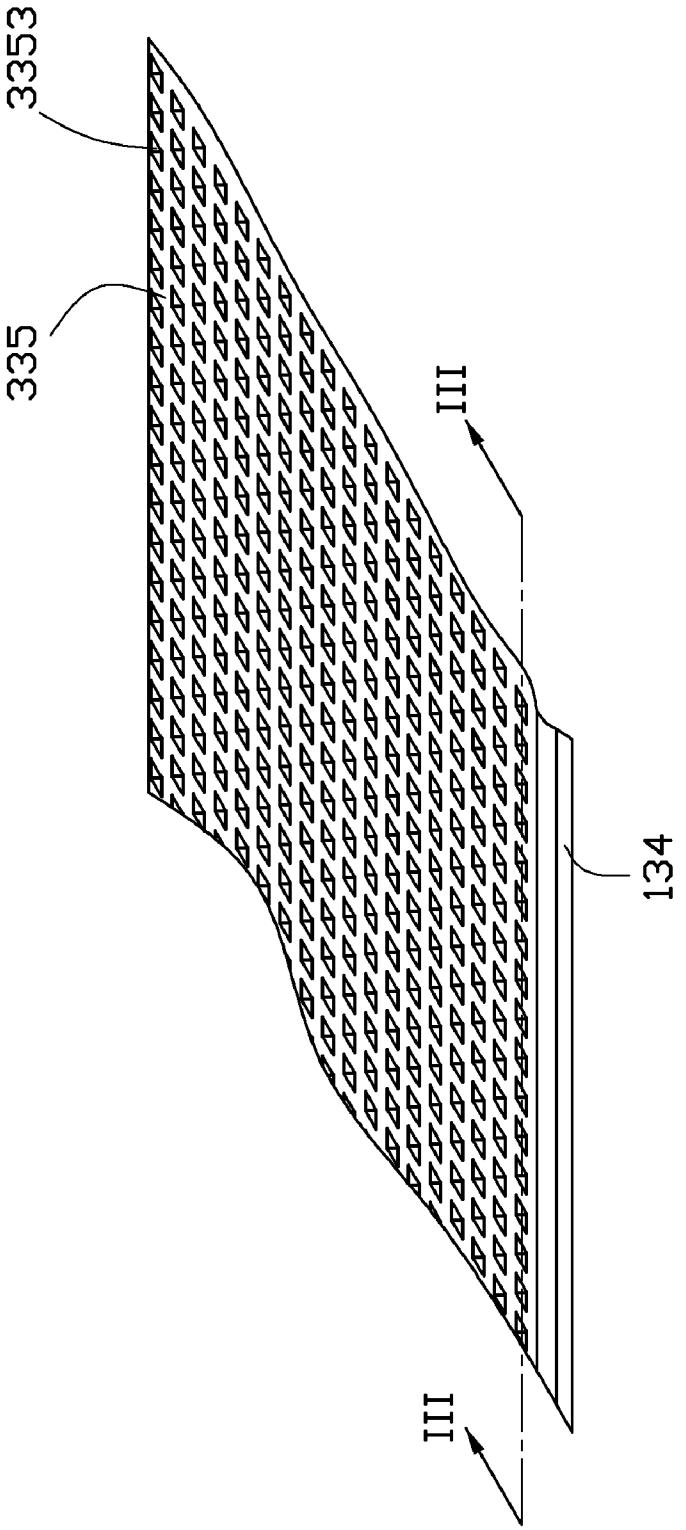


FIG. 2

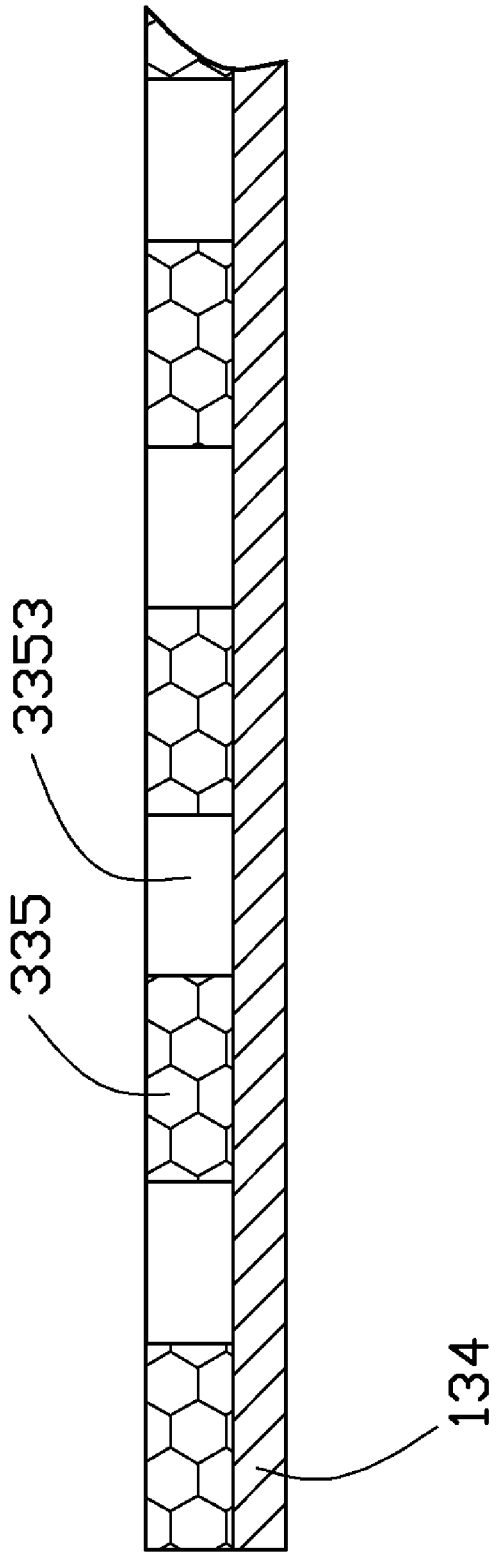


FIG. 3

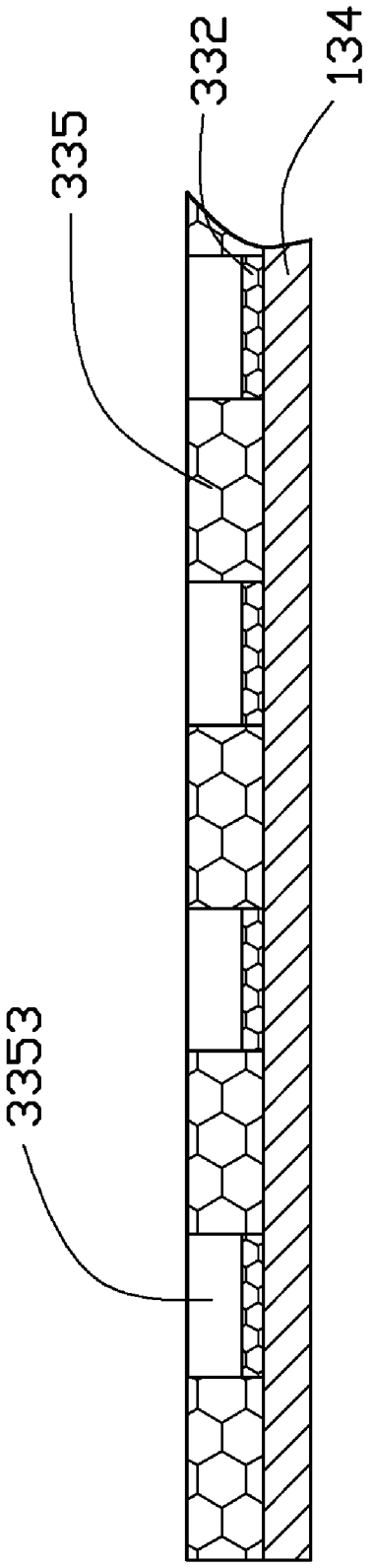


FIG. 4

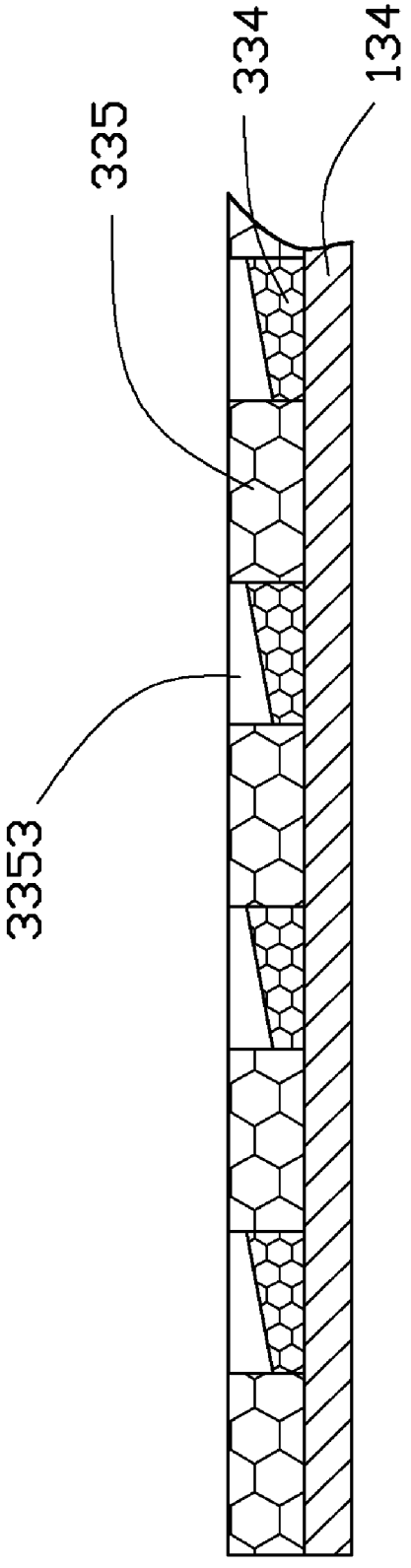


FIG. 5

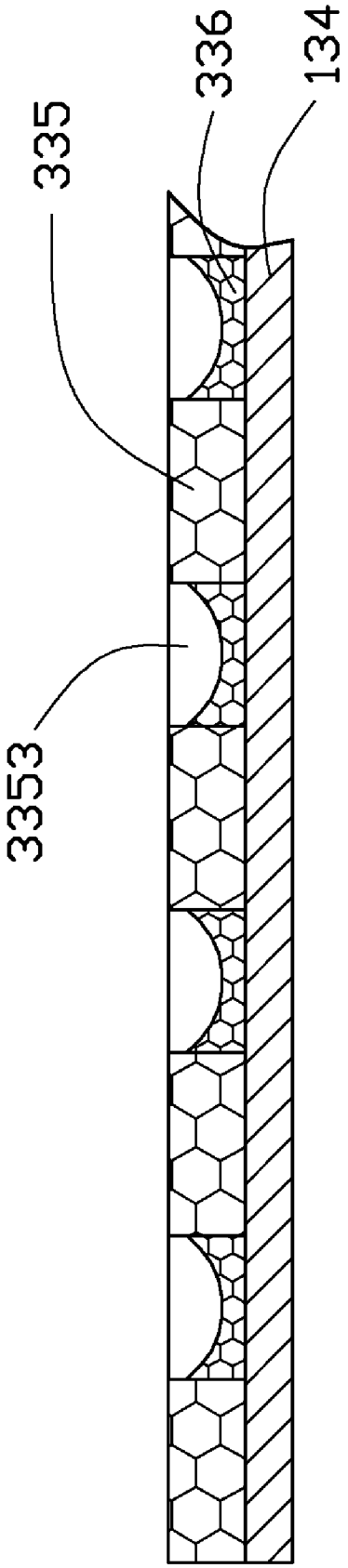


FIG. 6

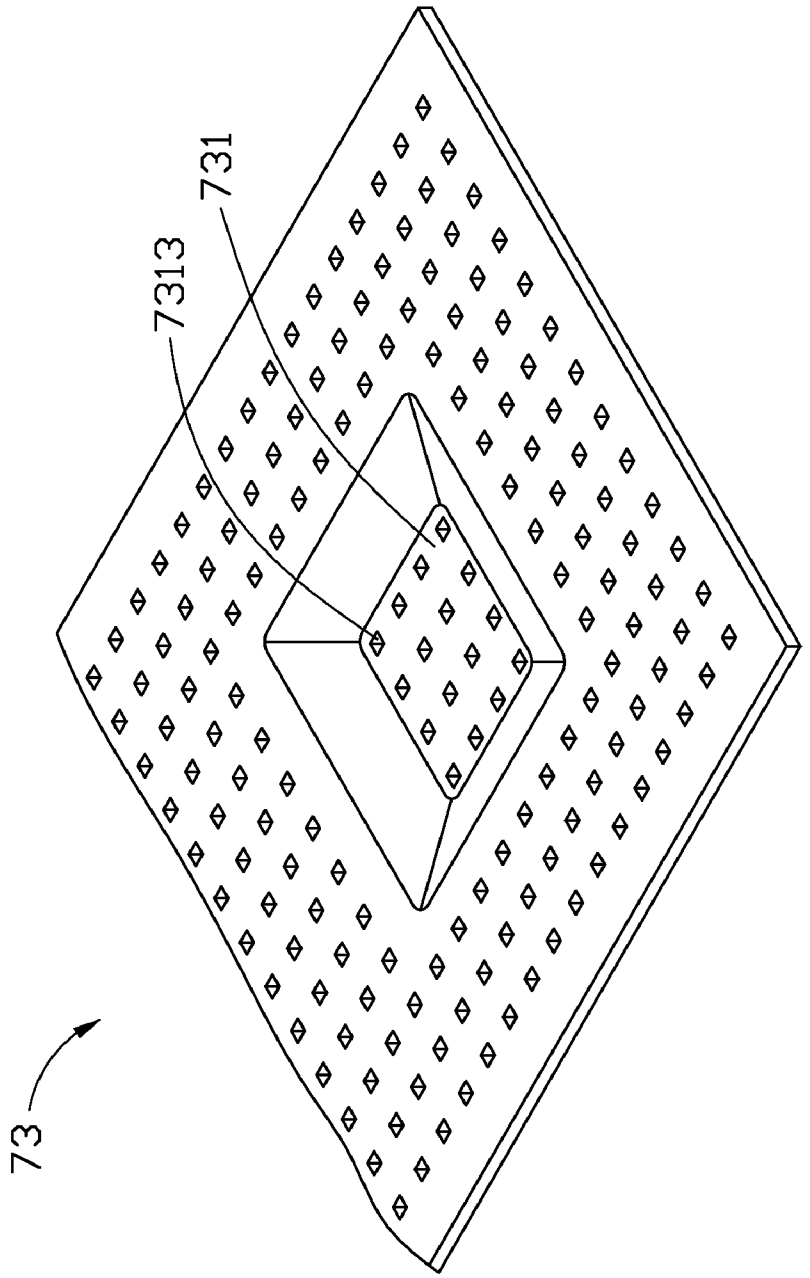


FIG. 7

PLATE-TYPE HEAT PIPE

BACKGROUND

[0001] 1. Technical Field

[0002] The present disclosure relates to heat pipes and, more particularly, to a plate-type heat pipe having good heat dissipation efficiency and stable and reliable performance.

[0003] 2. Description of Related Art

[0004] Generally, plate-type heat pipes efficiently dissipate heat from heat-generating components such as a central processing unit (CPU) of a computer. A conventional plate-type heat pipe comprises a top plate and a bottom cover hermetically contacting the top plate to form a container. A wick structure is adhered to an inner surface of the bottom cover. Working fluid is contained in the container. All parts of the wick structure have the same thickness. When the bottom cover of the plate-type heat pipe absorbs heat of the heat-generating component, the working fluid is vaporized to absorb the heat of the bottom cover.

[0005] If the wick structure is too thick, a part of the vaporized working fluid is retarded by the wick structure when the vaporized working fluid is escaping from the wick structure toward the top plate. Therefore, a plurality of bubbles is formed in and on the wick structure. The bubbles tend to block pores of the wick structure, and retard the flow of condensed working fluid into the wick structure. When this happens, the amount of condensed working fluid contained in the wick structure decreases. What working fluid there is in the wick structure may absorb the heat of the bottom cover too slowly, whereby heat is accumulated on the bottom cover, and the plate-type heat pipe overheats. Conversely, if the wick structure is too thin, the working fluid contained in the wick structure is liable to be dried off altogether. When this happens, the plate-type heat pipe will be destroyed.

[0006] What is needed, therefore, is a plate-type heat pipe having good heat dissipation efficiency and stable, reliable performance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] In the drawings, all the views are schematic.

[0008] FIG. **1** is a cross-sectional view of a plate-type heat pipe in accordance with a first embodiment of the present disclosure, the plate-type heat pipe including an evaporating plate having two extending portions, and two wick portions arranged on the extending portions.

[0009] FIG. **2** is an isometric view of part of one of the wick portions arranged on the corresponding extending portion of FIG. **1**.

[0010] FIG. **3** is an enlarged, cross-sectional view of part of the wick portion and extending portion of FIG. **2**, taken along line III-III thereof.

[0011] FIG. **4** is similar to FIG. **3**, but showing part of an extending portion arrangement of an evaporating plate of a plate-type heat pipe in accordance with a second embodiment of the present disclosure, with a wick portion and a number of auxiliary wick portions received in the wick portion.

[0012] FIG. **5** is similar to FIG. **3**, but showing part of an extending portion arrangement of an evaporating plate of a plate-type heat pipe in accordance with a third embodiment of the present disclosure, with a wick portion and a number of auxiliary wick portions received in the wick portion.

[0013] FIG. **6** is similar to FIG. **3**, but showing part of an extending portion arrangement of an evaporating plate of a plate-type heat pipe in accordance with a fourth embodiment of the present disclosure, with a wick portion and a number of auxiliary wick portions received in the wick portion.

[0014] FIG. **7** is an isometric view of a wick member of an evaporating plate of a plate-type heat pipe in accordance with a fifth embodiment of the present disclosure.

DETAILED DESCRIPTION

[0015] Referring to FIGS. **1-2**, a plate-type heat pipe in accordance with a first embodiment of the present disclosure is shown. The plate-type heat pipe includes a hermetic container **10**, a continuous wick structure **30** mounted on an inner surface of the container **10**, and working fluid (not shown) contained in the container **10**.

[0016] The container **10** is made of copper, aluminum, or an alloy thereof. The container **10** includes an elongated condensing plate **11** and a bowl-shaped evaporating plate **13** integrally formed as a single, one-piece, monolithic body without any seams. The evaporating plate **13** absorbs heat of heat-generating components (not shown) such as electronic devices. Then the condensing plate **11** dissipates the heat, transferred from the evaporating plate **13**, to the ambient environment. In alternative embodiments, the elongated condensing plate **11** and the bowl-shaped evaporating plate **13** can be distinct pieces, with the bowl-shaped evaporating plate **13** hermetically contacting the condensing plate **11**.

[0017] The evaporating plate **13** includes an elongated heat absorbing portion **131**, two transition portions **133**, two extending portions **134**, and two sidewalls **135**. The two transition portions **133** extend upwardly and outwardly from opposite lateral edges of the heat absorbing portion **131**, respectively, and are symmetrically opposite each other. The two extending portions **134** extend outwardly along opposite horizontal directions from outer edges of the transition portions **133**, respectively. The sidewalls **135** extend upwardly from outer edges of the extending portions **134**, respectively. The sidewalls **135** are perpendicular to the extending portions **134**. The extending portions **134** are parallel to the heat absorbing portion **131**, and are closer to the condensing plate **11** than the heat absorbing portion **131**. In the illustrated embodiment, top ends of the sidewalls **135** are integrally formed with two ends of the condensing plate **11**. That is, the evaporating plate **13** and the condensing plate **11** are a single body of the same material without any seams. In other embodiments, the evaporating plate **13** and the condensing plate **11** can be separate bodies hermetically connected together.

[0018] The wick structure **30** is made of sintered metallic powder, and includes an elongated first wick member **31** and a second wick member **33**. The first wick member **31** is adhered to an inner surface of the condensing plate **11**. The second wick member **33** is adhered to an inner surface of the evaporating plate **13**. The second wick member **33** is adapted for providing a capillary force to draw condensed working fluid from the first wick member **31** back toward a middle portion of the second wick member **33**. Opposite ends of the second wick structure **33** interconnect opposite ends of the first wick member **31**, respectively, thereby forming the continuous wick structure **30**.

[0019] Referring also to FIG. **3**, the second wick member includes an elongated first wick portion **331**, two second wick portions **333**, two third wick portions **335**, and two fourth wick portions **337**. The first wick portion **331**, the second

wick portions **333**, and the third wick portions **335** are spaced from the first wick member **31**.

[0020] The first wick portion **331** is adhered to an inner surface of the heat absorbing portion **131** of the evaporating plate **13**. The second wick portions **333** extend upwardly and outwardly from opposite ends of the first wick portion **331**, respectively, and are symmetrically opposite each other. The second wick portions **333** are adhered to inner surfaces of the transition portions **133** of the evaporating plate **13**. The first wick portion **331** is thinner than each of the second wick portions **333** and each of the third wick portions **335**. Thus, in general, the working fluid contained in the first wick portion **331** is vaporized faster than working fluid at a comparable location in a conventional plate-type heat pipe. Accordingly, the heat of the heat absorbing portion **131** is transferred quickly. The third wick portions **335** are horizontal, and extend outwardly from the second wick portions **333**, respectively. The third wick portions **335** are adhered to inner surfaces of the extending portions **134** of the evaporating plate **13**. The fourth wick portions **337** are adhered to inner surfaces of the sidewalls **135** of the evaporating plate **13**, and perpendicularly connect outer ends of the third wick portions **335**, respectively.

[0021] Each of the third wick portions **335** defines a plurality of rectangular or square through holes **3353** therein. In the illustrated embodiment, the through holes **3313** are arranged in a regular m×n array. The working fluid contained in the first wick portion **331** absorbs the heat of the heat absorbing portion **131** quickly, and then is vaporized. The vaporized working fluid moves to the first wick member **31** to dissipate the heat, and condenses at the first wick member **31**. The fourth wick portions **337**, third wick portions **335**, and second wick portions **333** cooperatively guide the condensing working fluid contained in or accumulated on the first wick member **31** back to the first wick portion **331**. Because the through holes **3353** are defined in the third wick portions **335**, a portion of the condensing working fluid is contained in the through holes **3353**. Thus, the amount of working fluid contained in the second wick member **33** is increased relative to working fluid at a comparable location in a conventional plate-type heat pipe. The working fluid contained in the through holes **3353** can ensure that a quantity of the condensing working fluid in the first wick portion **331** is sufficient even though evaporation of the working fluid in the first wick portion **331** is faster. Therefore, the plate-type heat pipe avoids becoming dried off. Thus, the plate-type heat pipe has stable, reliable performance. In alternative embodiments, the through holes **3353** can be triangular, circular, oval-shaped, elliptical, etc.

[0022] Referring to FIG. **4**, this shows an extending portion arrangement of a plate-type heat pipe in accordance with a second embodiment of the present disclosure. A third wick portion **335** and a plurality of auxiliary wick portions **332** are adhered to an inner surface of an extending portion **134**. The plate-type heat pipe in accordance with the second embodiment, is substantially the same as that shown in FIG. **1**, except the auxiliary wick portions **332**. Therefore a detailed description of most parts of the structure of the plate-type heat pipe in accordance with the second embodiment is omitted. In the illustrated embodiment, the auxiliary wick portions **332** fill bottom ends of through holes **3353**, respectively. Bottom end surfaces of the auxiliary wick portions **332** and a bottom surface of the third wick portion **335** are coplanar with one another, and are adhered to the inner surface of the extending portion **134**. The auxiliary wick portions **332** have the same thickness, and are much thinner than the third wick portion **335**. For example, each auxiliary wick portion **332** is less than half the thickness of the third wick portion **335**.

[0023] Because the auxiliary wick portions **332** are much thinner than the third wick portion **335**, a majority of each of the through holes **3353** is available to accommodate working fluid. The condensing working fluid is contained in pores of the second wick member **33** and the upper portions of the through holes **3353** not occupied by the auxiliary wick portions **332**. Therefore, a quantity of the condensing working fluid in the second wick member **33** is increased relative to working fluid at a comparable location in a conventional plate-type heat pipe. In addition, a capillary force of the second wick member **33** is improved because of the auxiliary wick portions **332** filling the bottoms of the through holes **3353** of the third wick portion **335**. Therefore, the condensed working fluid flows back to the first wick portion **331** more quickly. Thus, stable and reliable performance of the plate-type heat pipe can be ensured.

[0024] Referring to FIG. **5**, this shows an extending portion arrangement of a plate-type heat pipe in accordance with a third embodiment of the present disclosure. A third wick portion **335** and a plurality of auxiliary wick portions **334** are adhered to an inner surface of an extending portion **134**. A difference between the plate-type heat pipe of the third embodiment and the plate-type heat pipe shown in FIG. **4** is only in the shape of the auxiliary wick portions **334**. In the third embodiment, a cross-section of each of the auxiliary wick portions **334** is a trapezoid. Each auxiliary wick portion **334** has a smaller end, and a larger end opposite to the smaller end. The smaller ends of the auxiliary wick portions **334** are all oriented toward the same direction. A top side of each auxiliary wick portion **334** is aslant, and a bottom side of each auxiliary wick portion **334** is horizontal and adhered to the inner surface of the extending portion **134**. The larger ends of the auxiliary wick portions **334** are all thinner than the third wick portion **335**.

[0025] Referring to FIG. **6**, this shows an extending portion arrangement of a plate-type heat pipe in accordance with a fourth embodiment of the present disclosure. A third wick portion **335** and a plurality of auxiliary wick portions **336** are adhered to an inner surface of an extending portion **134**. A difference between the plate-type heat pipe of the fourth embodiment and the plate-type heat pipe shown in FIG. **4** is only in the shape of the auxiliary wick portions **336**. In the fourth embodiment, a cross-section of each of the auxiliary wick portions **336** has a top side being concave, and a bottom side being horizontal. The bottom sides are adhered to the inner surface of the extending portion **134**. A thickness of each auxiliary wick portion **336** gradually increases from a central portion thereof to each of opposite ends thereof. The opposite ends of the auxiliary wick portions **336** are all thinner than the third wick portion **335**.

[0026] Referring to FIG. **7**, this shows a second wick member **73** of a plate-type heat pipe of a fifth embodiment of the present disclosure. The second wick member **73** is similar to the second wick member **33** of the first embodiment, except that a plurality of rectangular or square through holes **7313** is defined in a first wick portion **731**. Therefore the vaporized working fluid in the first wick portion **731** escapes from the first wick portion **731** via the through holes **7313** quickly. Accordingly, unlike in conventional plate-type heat pipes, few or even no bubbles accumulate in the first wick portion

731 when the plate-type heat pipe is in operation. Thus, the heat dissipation efficiency of the plate-type heat pipe is improved.

[0027] It is to be understood, however, that even though numerous characteristics and advantages of various embodiments have been set forth in the foregoing description, together with details of the structures and functions of the embodiments, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the disclosure to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A plate-type heat pipe comprising:
a condensing plate;
an evaporating plate cooperating with the condensing plate to define a hermetic container, the evaporating plate comprising a heat absorbing portion and two extending portions located at opposite sides of the heat absorbing portion;
working fluid contained in the container; and
a first wick portion formed on an inner surface of the heat absorbing portion, and two second wick portions formed on inner surfaces of the extending portions, respectively, the second wick portions defining a plurality of holes therein.

2. The plate-type heat pipe of claim 1, wherein the holes are through holes, each of which extends through a thickness of the corresponding second wick portion.

3. The plate-type heat pipe of claim 2, wherein a number of auxiliary wick portions are received in the through holes, respectively, and contact the inner surfaces of the extending portions.

4. The plate-type heat pipe of claim 3, wherein each of the auxiliary wick portions is thinner than the second wick portion, and comprises a first side contacting the inner surface of the corresponding extending portion of the evaporating plate and an opposite second side.

5. The plate-type heat pipe of claim 4, wherein a cross-section of each of the auxiliary wick portions is a rectangle, the second side being parallel to the first side.

6. The plate-type heat pipe of claim 4, wherein a cross-section of each of the auxiliary wick portions is a trapezoid, the second side being aslant relative to the first side.

7. The plate-type heat pipe of claim 6, wherein the auxiliary wick portions are all oriented toward the same direction.

8. The plate-type heat pipe of claim 4, wherein the second side of each of the auxiliary wick portions is concave, and a thickness of each of the auxiliary wick portions gradually increases from a central portion thereof to each of opposite ends thereof.

9. The plate-type heat pipe of claim 1, wherein the evaporating plate further comprises two transition portions extending upwardly and outwardly from opposite edges of the heat absorbing portion and connecting with the two extending portions, respectively, and two third wick portions are formed on inner surfaces of the transition portions, respectively.

10. The plate-type heat pipe of claim 1, wherein the evaporating plate further comprises two sidewalls extending upwardly from outer ends of the two extending portions, respectively, and connecting with the condensing plate, and two fourth wick portions are formed on inner surfaces of the sidewalls, respectively.

11. The plate-type heat pipe of claim 10, wherein a wick member is adhered on an inner surface of the condensing plate and connects with the fourth wick portions.

12. The plate-type heat pipe of claim 1, wherein a plurality of holes is defined in the first wick portion.

13. A plate-type heat pipe comprising:
a hermetic container comprising an evaporating plate and a condensing plate facing each other, the evaporating plate comprising a heat absorbing portion adapted for contacting a heat-generating component, two transition portions extending aslant from opposite lateral sides of the heat absorbing portion, respectively, and two extending portions extending outwardly from outer sides of the transition portions, respectively, the extending portions being closer to the condensing plate than the heat absorbing portion;
working fluid contained in the container; and
a wick member formed on an inner surface of the evaporating plate, comprising a first wick portion formed on an inner surface of the heat absorbing portion, two second wick portions formed on inner surfaces of the transition portions, respectively, and two third wick portions formed on inner surfaces of the extending portions, respectively, the third wick portions defining a plurality of holes.

14. The plate-type heat pipe of claim 13, wherein the holes extends through the third wick portions in the thickness direction of the third wick portions.

15. The plate-type heat pipe of claim 14, wherein a plurality of auxiliary wick are arranged in the holes of the third wick portions and contacts the inner surfaces of the extending portions.

16. The plate-type heat pipe of claim 15, wherein each of the auxiliary wicks is thinner than the third wick portion.

17. The plate-type heat pipe of claim 15, wherein the evaporating plate further comprises two sidewall extending upwardly from outer ends of the extending portions, respectively and connect opposite ends of the condensing plate, respectively, two fourth wick portion are formed on inner surfaces of the sidewalls.

18. The plate-type heat pipe of claim 17, wherein another wick member is adhered on an inner surface of the condensing plate and connects with the fourth wick portions to form a continuous wick on an inner surface of the container.

19. The plate-type heat pipe of claim 13, wherein the first wick portion is thinner than second wick portion and the third wick portion.

20. The plate-type heat pipe of claim 19, wherein a plurality of holes is defined in the first wick portion.

* * * * *