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(54) **PLATE-TYPE HEAT PIPE**

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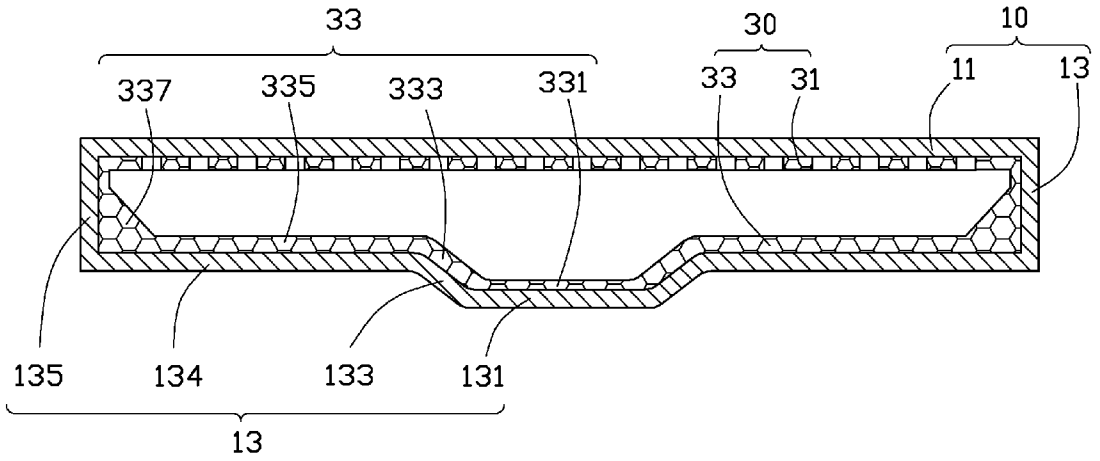
(57) **ABSTRACT**

A plate-type heat pipe includes a condensing plate, an evaporating plate and a first wick member. The evaporating plate cooperates with the condensing plate to define a hermetic container. Working fluid is contained in the container. The first wick member is formed on an inner surface of the condensing plate. The first wick member defines a plurality of through holes therein.



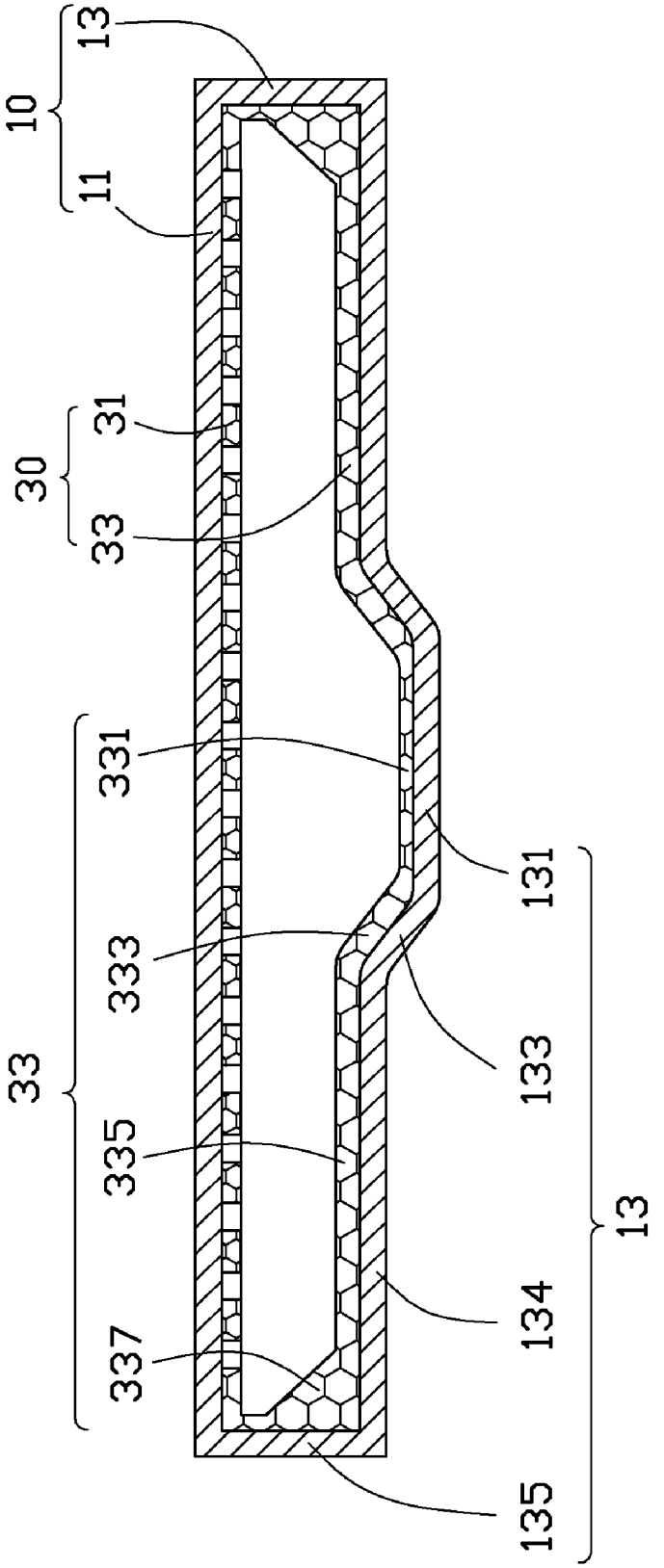


FIG. 1

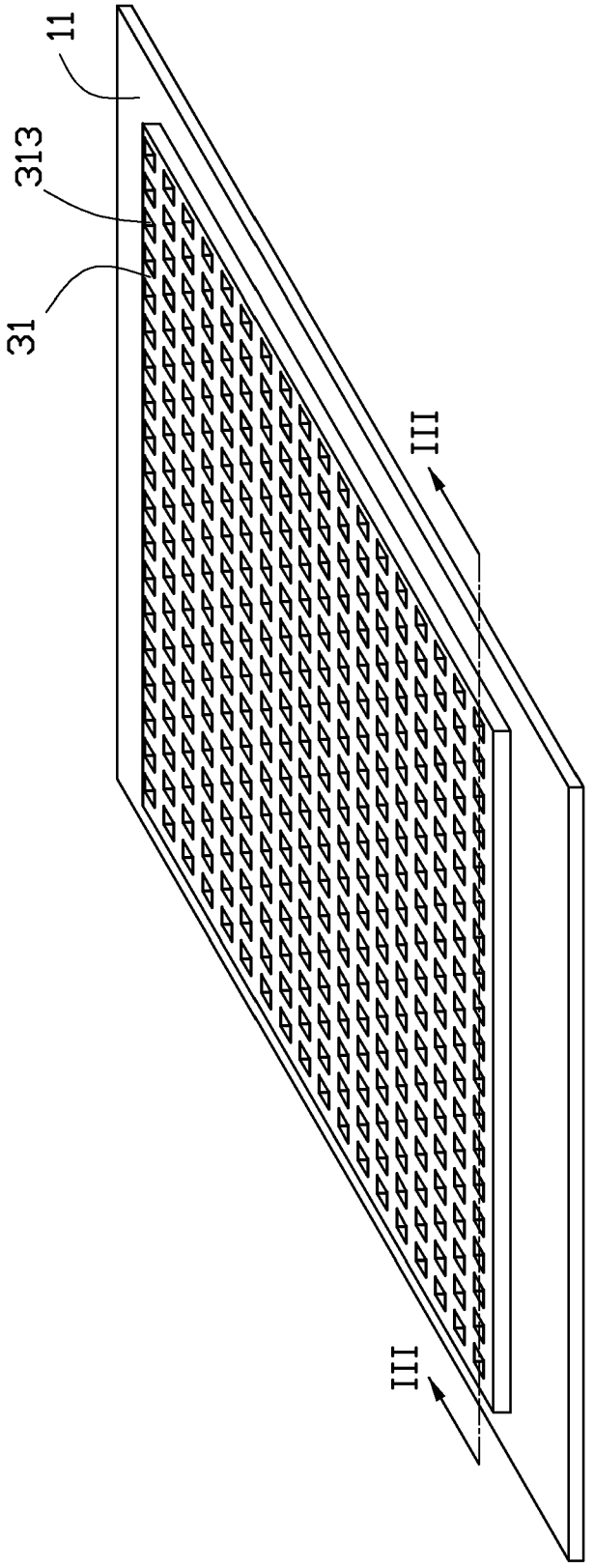


FIG. 2

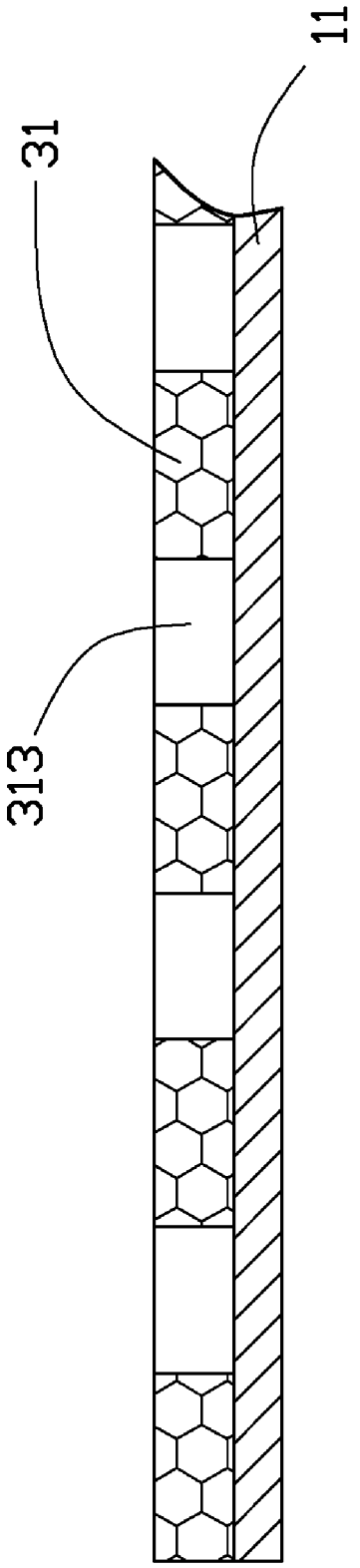


FIG. 3

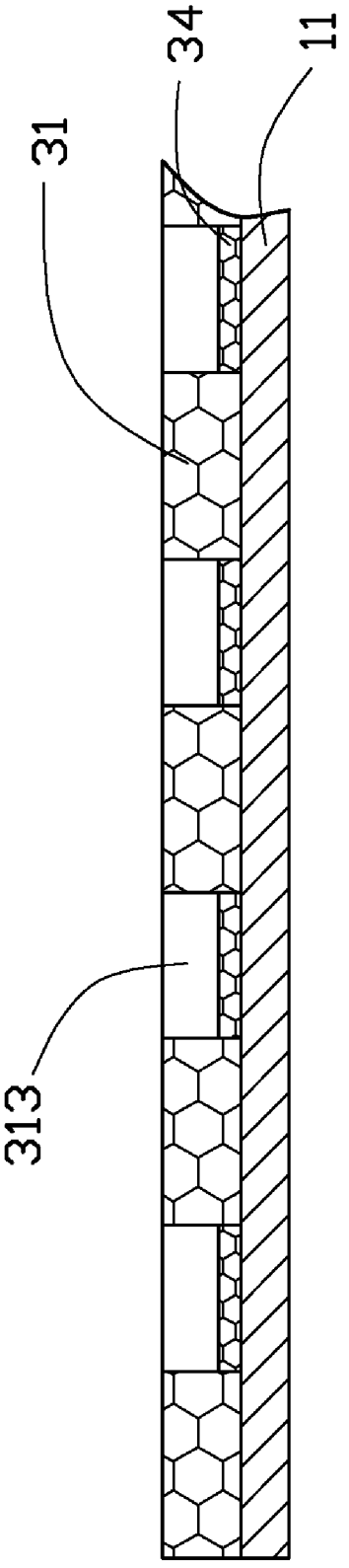


FIG. 4

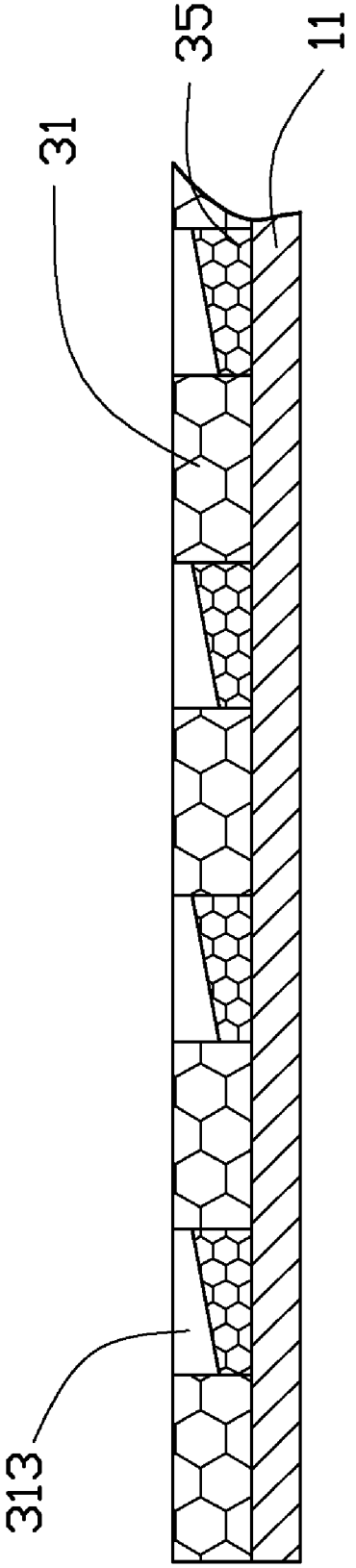


FIG. 5

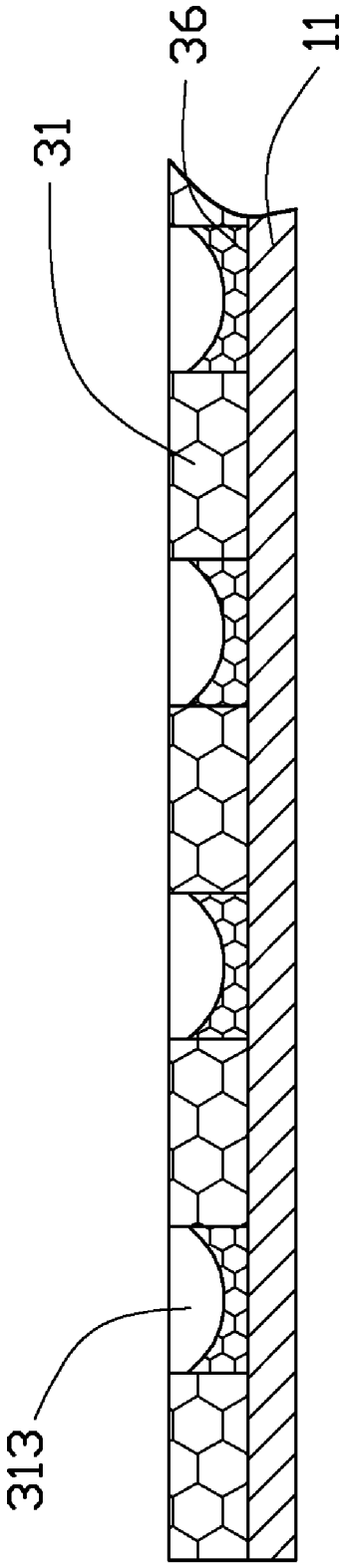


FIG. 6

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 continuous wick structure is adhered to inner surfaces of the top plate and 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 and transfers heat to the ambient environment at the wick structure mounted on the top plate.

[0005] The wick structure intervenes between the vaporized working fluid and the inner surface of the top plate at which the vaporized working fluid can release its latent heat of vaporization and change into condensate. Therefore, the wick structure tends to retard the phase change occurring at the top plate. The heat may transfer to the ambient environment too slowly, and is thus liable to accumulate on the container formed by the top plate and the bottom cover. In due course, the plate-type heat pipe may be overheat, and the heat dissipation efficiency of the plate-type heat pipe is reduced.

[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] 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 a condensing plate, a first wick member, and a second wick member.

[0008] FIG. **2** is an isometric, inverted view of the condensing plate of FIG. **1**, showing the first wick member mounted on the condensing plate.

[0009] FIG. **3** is an enlarged, cross-sectional view of part of the condensing plate with the first wick member, corresponding to line of FIG. **2**.

[0010] FIG. **4** is similar to FIG. **3**, but showing part of a condensing plate arrangement of a plate-type heat pipe in accordance with a second embodiment of the present disclosure, with a first wick member and a number of third wick members mounted on the condensing plate.

[0011] FIG. **5** is similar to FIG. **3**, but showing part of a condensing plate arrangement of a plate-type heat pipe in accordance with a third embodiment of the present disclosure, with a first wick member and a number of third wick members mounted on the condensing plate.

[0012] FIG. **6** is similar to FIG. **3**, but showing part of a condensing plate arrangement of a plate-type heat pipe in accordance with a fourth embodiment of the present disclosure, with a first wick member and a number of third wick members mounted on the condensing plate.

DETAILED DESCRIPTION

[0013] 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 comprises 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**.

[0014] The container **10** is made of copper, aluminum, or an alloy thereof, and comprises an elongated condensing plate **11** and a bowl-shaped evaporating plate **13** hermetically contacting the condensing plate **11**. The evaporating plate **13** absorbs heat generated by one or more components (not shown) such as electronic devices. The condensing plate **11** dissipates heat transferred from the evaporating plate **13** to the ambient environment.

[0015] The evaporating plate **13** comprises an elongated heat absorbing portion **131**, two transition portions **133**, two extending portions **134**, and two sidewalls **135**. The transition portions **133** extend outwardly and upwardly from opposite ends of the heat absorbing portion **131**, respectively, and are symmetrically opposite each other. The extending portions **134** extend outwardly along opposite horizontal directions from outer ends of the transition portions **133**, respectively. The sidewalls **135** extend upwardly from outer ends of the extending portions **134**, respectively. 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.

[0016] The wick structure **30** is made of metallic powder by a sintering process. The wick structure **30** comprises a 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**. Opposite ends of the second wick member **33** connect opposite ends of the first wick member **31**, respectively, thereby forming the continuous wick structure **30**.

[0017] The second wick member **33** comprises 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** is adhered to a top surface of the heat absorbing portion **131** of the evaporating plate **13**. The first wick portion **331** is thinner than each of the second wick portions **333**. Thus, in general, the working fluid contained in the first wick portion **331** is vaporized faster than the working fluid contained in the second wick portion **333**. Accordingly, the heat of the heat absorbing portion **131** is transferred by the first wick portion **331** quickly. 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 top surfaces of the transition portions **133** of the evaporating plate **13**. 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 top surfaces of the extending portions **134** of the evaporating plate **13**. Each fourth wick portion **337** is adhered to an inner surface of the corresponding sidewall **135** of the evaporating plate **13**, and fills a corner formed by the sidewall **135** and the corresponding extending portion **134**. A cross-

section of each fourth wick portion **337** is substantially triangular. That is, a transverse thickness (horizontal, from left to right, as viewed in FIG. **1**) of the fourth wick portion **337** progressively decreases from a bottom end of the fourth wick portion **337** central to a top end of the fourth wick portion **337**.

[0018] Referring also to FIG. **3**, the first wick member **31** is elongated and defines a plurality of through holes **313** therein. In the illustrated embodiment, the through holes **313** are square or rectangular through holes **313**, and are arranged in a regular m×n array. The first wick member **31** guides the condensed working fluid back to the opposite ends of the second wick member **33** of the evaporating plate **13**. A bottom surface of the first wick member **31** is spaced from a top surface of the first wick portion **331**, from top surfaces of the second wick portions **333**, and from top surfaces of the third wick portions **335**. Because the through holes **313** are defined in the first wick member **31**, heat of at least some of the vaporized working fluid is absorbed by the condensing plate **11** directly. Therefore, unlike in other conventional plate-type heat pipes, there is little or even no retardation associated with a wick structure intervening between the vaporized working fluid and the condensing plate **11**. Thus, the heat dissipation efficiency of the present plate-type heat pipe is improved. In alternative embodiments, the through holes **313** can be triangular, circular, oval-shaped, elliptical, etc.

[0019] Referring to FIG. **4**, this shows showing part of a condensing plate arrangement of a plate-type heat pipe in accordance with a second embodiment of the present disclosure. A first wick member **31** and a number of third wick members **34** are adhered to an inner surface of a condensing plate **11**. In the illustrated embodiment, the third wick members **34** fill top ends of the through holes **313**, respectively. Top end surfaces of the third wick members **34** and a top surface of the first wick member **31** are coplanar with one another. Each of the third wick members **34** has a same thickness. A ratio of the thickness of each third wick member **34** to a thickness of the first wick member **31** is in the range from about 1/10 to about 4/5. Because the third wick members **34** are thinner than the first wick member **31**, paths of heat transfer of the vaporized working fluid to the condensing plate **11** are generally shorter than those of conventional plate-type heat pipes. Thus, the heat dissipation efficiency of the present plate-type heat pipe is improved. In addition, condensed working fluid contained in the third wick members **34** flows to the first wick member **31** to help drive the working fluid contained in the first wick member **31** to quickly flow back to the opposite ends of the second wick member **33** mounted on the evaporating plate **13**. Thus, stable and reliable performance of the plate-type heat pipe can be ensured.

[0020] Referring to FIG. **5**, this shows showing part of a condensing plate arrangement of a plate-type heat pipe in accordance with a third embodiment of the present disclosure. A first wick member **31** and a number of third wick members **35** are adhered to an inner surface of a condensing plate **11**. A cross-section of each of the third wick members **35** is a trapezoid. Each third wick member **35** has a smaller end, and a larger end opposite to the smaller end. The smaller ends of the third wick members **35** are all oriented toward the same direction. The larger ends of the third wick members **35** are all thinner than the first wick member **31**.

[0021] Referring to FIG. **6**, this shows showing part of a condensing plate arrangement of a plate-type heat pipe in accordance with a fourth embodiment of the present disclosure. A first wick member **31** and a plurality of third wick members **36** are adhered to an inner surface of a condensing plate **11**. A cross-section of each of the third wick members **36** is concave. The cross-section may for example be arcuate or arc-shaped. That is, a thickness of each third wick member **36** gradually increases from a central portion thereof to each of opposite ends thereof. The opposite ends of the third wick members **36** are all thinner than the first wick member **31**.

[0022] 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, working fluid contained in the container; and
a first wick member formed on an inner surface of the condensing plate, the first wick member defining a plurality of through holes therein.

2. The plate-type heat pipe of claim **1**, wherein the first wick member is made of sintered metallic powder.

3. The plate-type heat pipe of claim **1**, wherein a plurality of second wick members fill top ends of the through holes, respectively, and contact the inner surface of the condensing plate.

4. The plate-type heat pipe of claim **3**, wherein each of the second wick members is thinner than the first wick member.

5. The plate-type heat pipe of claim **4**, wherein a cross-section of each of the second wick members is a rectangle.

6. The plate-type heat pipe of claim **4**, wherein a cross-section of each of the second wick members is a trapezoid.

7. The plate-type heat pipe of claim **6**, wherein each of the second wick members has a smaller end, and the smaller ends of the second wick members are all oriented toward the same direction.

8. The plate-type heat pipe of claim **4**, wherein a cross-section of each of the second wick members is concave.

9. The plate-type heat pipe of claim **8**, wherein a thickness of each of the second wick members gradually increases from a central portion thereof to each of opposite ends thereof.

10. The plate-type heat pipe of claim **1**, wherein the evaporating plate comprises a central heat absorbing portion and two sidewalls extending upwardly at opposite sides of the heat absorbing portion and abutting against the condensing plate, a second wick member comprises a first wick portion adhered on an inner surface of the heat absorbing portion and two second wick portions adhered on inner surfaces of the sidewalls.

11. The plate-type heat pipe of claim **10**, wherein the evaporating plate further comprises two transition portions extend outwardly and upwardly from opposite ends of the heat absorbing portion, and the second wick member further comprises two third wick portions adhered on inner surfaces of the transition portions.

12. The plate-type heat pipe of claim **11**, wherein the evaporating plate further comprises two extending portions extending outwardly from opposite ends of the transition portions, respectively, and connecting with the two sidewalls,

respectively, and the second wick member further comprises two fourth wick portions adhered on inner surfaces of the extending portions.

13. The plate-type heat pipe of claim **12**, wherein each of the fourth wick portions fills a corner formed by the corresponding sidewall and the corresponding extending portion.

14. The plate-type heat pipe of claim **10**, wherein a cross-section of each of the second wick portions is generally triangular.

15. The plate-type heat pipe of claim **10**, wherein the evaporating plate and the condensing plate are a single body of the same material without any seams.

16. The plate-type heat pipe of claim **13**, wherein a plurality of third wick members fill top ends of the through holes, respectively, and contact the inner surface of the condensing plate.

17. The plate-type heat pipe of claim **16**, wherein each of the third wick members is thinner than the first wick member.

18. The plate-type heat pipe of claim **17**, wherein a cross-section of each of the third wick members is a rectangle.

19. The plate-type heat pipe of claim **17**, wherein a cross-section of each of the third wick members is a trapezoid.

20. The plate-type heat pipe of claim **19**, wherein each of the third wick members has a smaller end, and the smaller ends of the second wick members are all oriented toward the same direction.

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