US 20120279687A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2012/0279687 A1

(43) Pub. Date: Nov. 8, 2012

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(54) **FLAT-TYPE HEAT PIPE AND WICK STRUCTURE THEREOF**

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(21) Appl. No.: **13/101,180**

(22) Filed: **May 5, 2011**

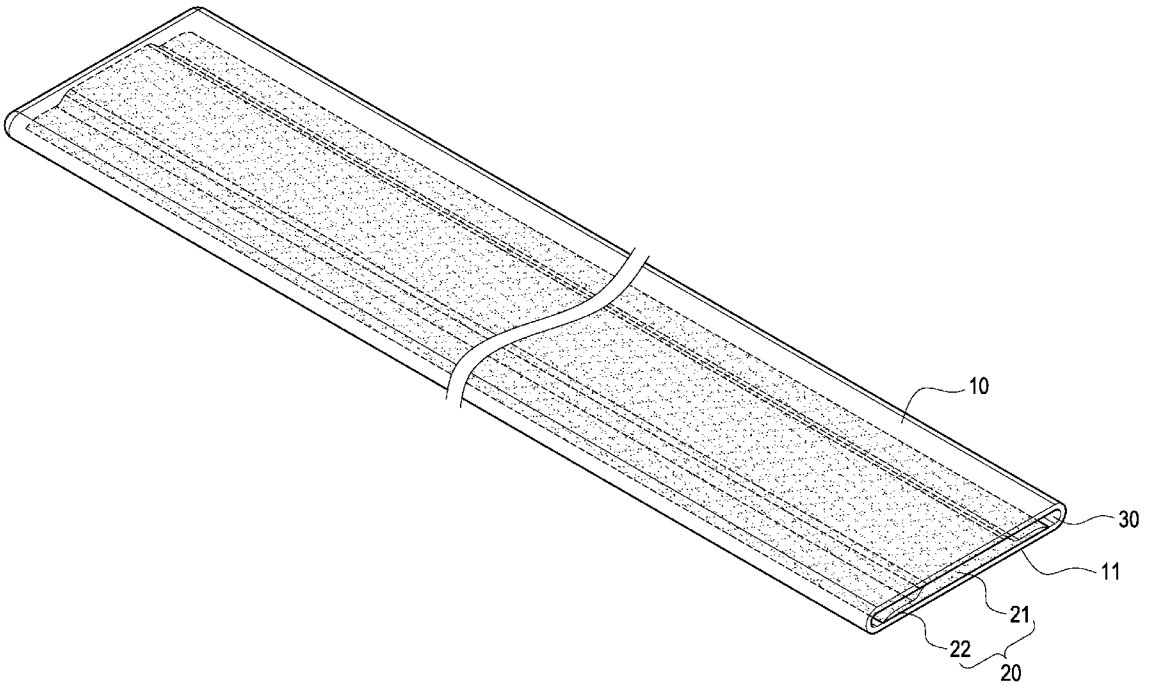
**Publication Classification**

(51) **Int. Cl.**
*F28D 15/04* (2006.01)

(52) **U.S. Cl.** ..... **165/104.26**

(57) **ABSTRACT**

The present invention provides a flat-type heat pipe and a wick structure thereof. The flat-type heat pipe has a flat tube. The wick structure is arranged inside the flat tube along an axial line of the flat tube. The wick structure comprises a first wick portion and two second wick portions connected on both sides of the first wick portion. The thickness of the first wick portion is larger than that of the second wick portion. The first wick portion abuts against an upper inner wall of the flat tube. An air channel is formed between each of the second wick portions and the upper inner wall of the flat tube. The wick structure supports the inner wall of the flat-type heat pipe without providing additional supporting structure, so that the heat pipe can be made more compact.



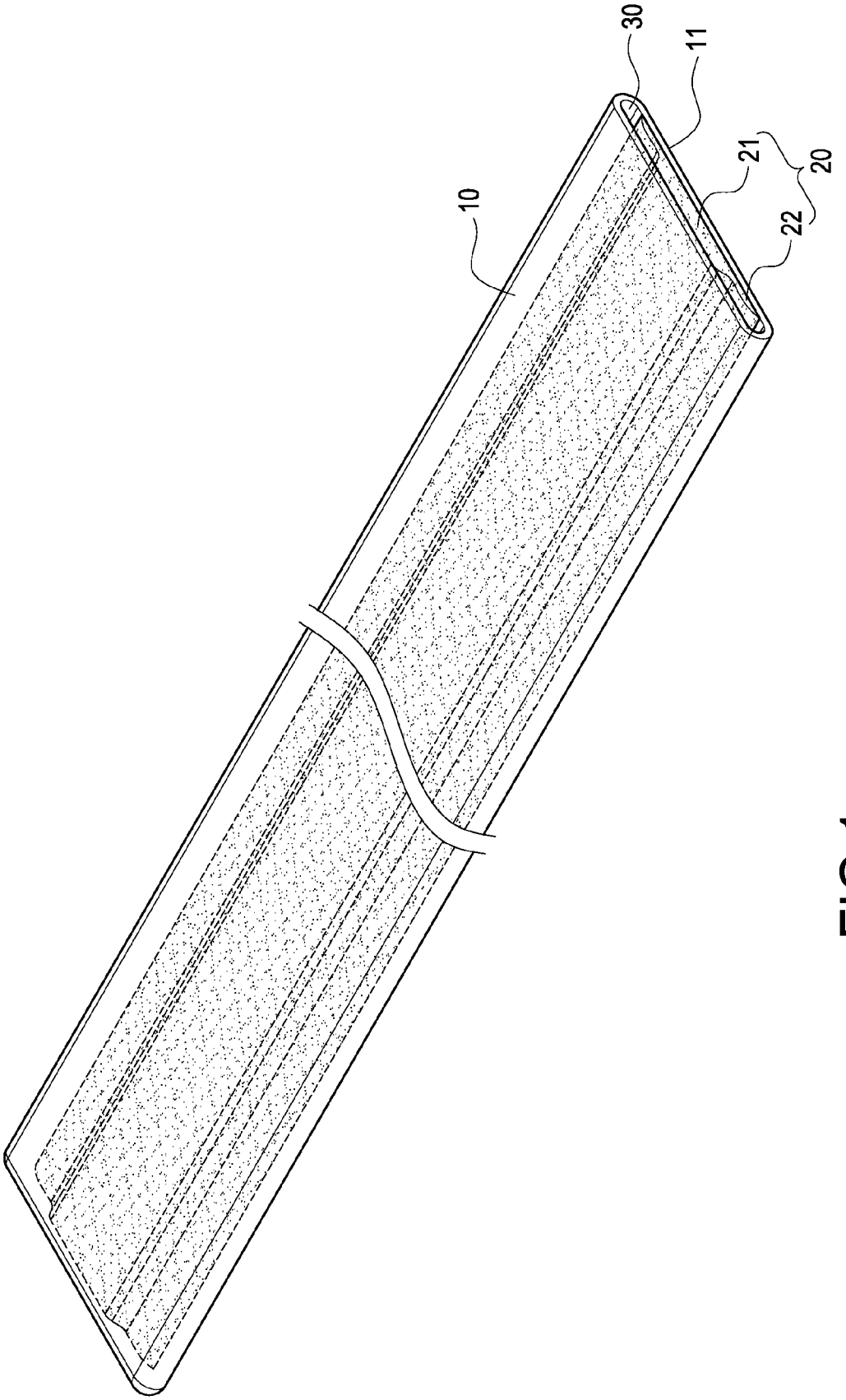



FIG.1

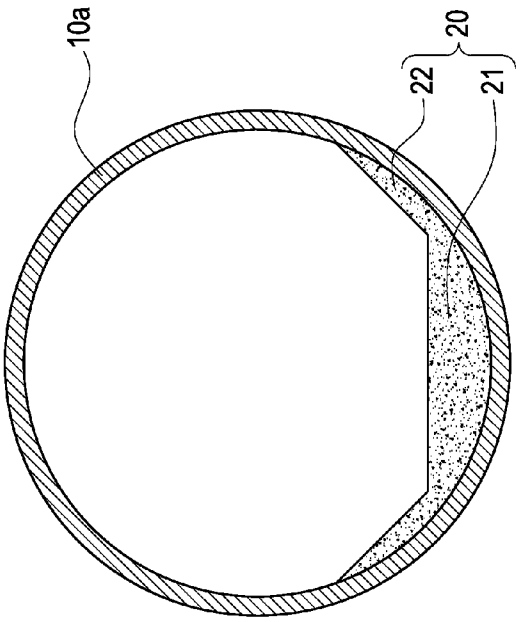



FIG.2

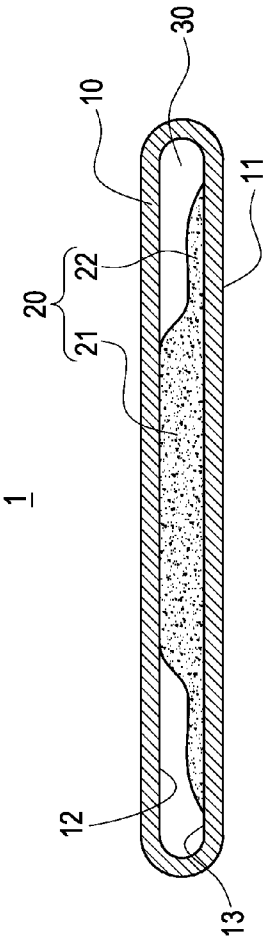



FIG.3

# FLAT-TYPE HEAT PIPE AND WICK STRUCTURE THEREOF

## BACKGROUND OF THE INVENTION

**[0001]** 1. Field of the Invention

**[0002]** The present invention relates to a heat pipe, in particular to a flat-type heat pipe and a wick structure thereof.

**[0003]** 2. Description of Prior Art

**[0004]** With the advancement of science and technology, electronic products and electronic elements are made more and more compact. Thus, heat pipes associated with these compact electronic products and electronic elements have to be made compact accordingly. According to the existing level in this art, a heat pipe whose thickness is smaller than 2 mm is referred to as a "super-thin heat pipe", and a heat pipe whose thickness is larger than 2 mm is referred to as a "thin heat pipe".

**[0005]** However, according to the existing level in this art, the manufacture of thin heat pipes and super-thin heat pipes encounters problems as follows. Since the thin heat pipe or the super-thin heat pipe has a flat tube, the thickness of the flat tube is required to be small enough to manufacture a standard thin heat pipe or super-thin heat pipe. Thus, if a supporting structure is provided in the flat tube, the thickness of the supporting structure may inevitably increase the thickness of the thin heat pipe or the super-thin heat pipe, so that the thin heat pipe or the super-thin heat pipe cannot be made compact sufficiently. On the other hand, if the interior of the flat tube is not provided with a supporting structure, the strength of the flat tube is insufficient and may be recessed due to the external atmospheric pressure.

**[0006]** Therefore, it is an important issue for the present Inventor to solve the above-mentioned problems.

## SUMMARY OF THE INVENTION

**[0007]** The present invention is to provide a flat-type heat pipe, in which a wick structure is provided to support inner walls of the flat-type heat pipe. By this wick structure, it is unnecessary to provide an additional supporting structure, so that the flat-type heat pipe can be made more compact.

**[0008]** The present invention is to provide a flat-type heat pipe, in which a wick structure is provided. The wick structure can be manufactured easily and provide a path for allowing vapor-phase and liquid-phase working fluid to flow therein smoothly, thereby generating a good effect on heat conduction and liquid reflow.

**[0009]** The present invention provides a flat-type heat pipe, configured to perform heat exchange with a heat source and including:

**[0010]** a flat tube having a lower surface brought into thermal contact with the heat source;

**[0011]** a working fluid filled in the flat tube; and

**[0012]** a wick structure arranged inside the flat tube along an axial line of the flat tube, the wick structure comprising a first wick portion and two second wick portions connected on both sides of the first wick portion, the thickness of the first wick portion being larger than that of the second wick portion, the first wick portion abutting against an upper inner wall of the flat tube, an air channel being formed between each of the second wick portions and the upper inner wall of the flat tube.

**[0013]** The present invention is to provide a wick structure of a flat-type heat pipe, which is configured to support the inner walls of the flat-type heat pipe. By this structure, it is unnecessary to provide an additional supporting structure, so that the flat-type heat pipe can be made more compact.

**[0014]** The present invention is to provide a wick structure of a flat-type heat pipe, which can be manufactured easily and provide a path for allowing vapor-phase and liquid-phase working fluid to flow therein smoothly, thereby generating a good effect on heat conduction and liquid reflow.

**[0015]** The present invention provides a wick structure of a flat-type heat pipe, the flat-type heat pipe having a flat tube, the wick structure being arranged inside the flat tube along an axial line of the flat tube, characterized in that:

**[0016]** The wick structure comprises a first wick portion and two second wick portions connected on both sides of the first wick portion, the thickness of the first wick portion is larger than that of the second wick portion, the first wick portion abuts against an upper inner wall of the flat tube, an air channel is formed between each of the second wick portions and the upper inner wall of the flat tube.

**[0017]** In comparison with prior art, the present invention has advantageous features as follows.

**[0018]** The wick structure of the present invention comprises a first wick portion and two second wick portions connected on both sides of the first wick portion. The thickness of the first wick portion is larger than that of the second wick portion. The first wick portion abuts against an upper inner wall of the flat tube. Thus, the first wick portion is configured to support the upper inner wall of the flat tube. As a result, it is unnecessary to provide another additional supporting structure in the flat tube, so that the flat-type heat pipe can be made more compact. Since the inner walls of the flat tube are supported by the first wick portion, the flat tube will not be recessed due to the external atmospheric pressure.

**[0019]** Further, since the wick structure of the present invention comprises a first wick portion and two second wick portions connected on both sides of the first wick portion, the wick structure of the present invention is configured to expand laterally from the axial line of the flat tube with a larger area. As a result, more working fluid exists in the expanded wick structure to absorb the heat of the heat source for evaporation. On the other hand, more liquid-phase working fluid flows back by means of the expanded wick structure, thereby generating a larger heat-conducting efficiency.

**[0020]** Further, according to the present invention, an air channel is formed between each of the second wick portions and the upper inner wall of the flat tube. The vapor-phase working fluid can quickly flow toward the other end of the heat pipe away from the heat source via the air channels and the smooth inner walls of the flat tube, thereby generating a rapid heat-conducting effect.

## BRIEF DESCRIPTION OF DRAWING

**[0021]** FIG. **1** is a perspective view of the present invention;

**[0022]** FIG. **2** is a side cross-sectional view of the present invention before being pressed flat; and

**[0023]** FIG. **3** is a side cross-sectional view of the present invention after being pressed flat.

## DETAILED DESCRIPTION OF THE INVENTION

**[0024]** The detailed description and technical contents of the present invention will become apparent with the following detailed description accompanied with related drawings. It is noteworthy to point out that the drawings is provided for the

illustration purpose only, but not intended for limiting the scope of the present invention.

**[0025]** Please refer to FIGS. **1** to **3**. The present invention provides a wick structure of a flat-type heat pipe. The flat-type heat pipe **1** has a flat tube **10**. The wick structure **20** is arranged inside the flat tube **10** along an axial line of the flat tube **10**. The wick structure **20** is made by sintered metal powder.

**[0026]** The manufacturing procedure of the present invention will be described as follows.

**[0027]** First, a circular tube **10***a* is provided, which has smooth inner walls. Then, a core rod (not shown) is inserted into the circular tube **10***a*. The outer diameter of the core rod is smaller than the inner diameter of the circular tube **10***a*. The profile of the upper portion of the core rod corresponds to the profile of the inner wall of the circular tube **10***a*. The profile of the lower portion of the core rod forms three edges, so that a gap can be formed between the core rod and the inner wall of the circular tube **10***a*. Metal powder is filled into the gap between the inner wall of the circular tube **10***a* and the core rod, thereby forming a construction shown in FIG. **2**. The profile of the lower portion of the core rod makes the metal powder to be shaped as a first wick portion **21** and two second wick portions **22** connected on both sides of the first wick portion **21**. It can be seen from FIG. **2** that, the thickness and width of the first wick portion **21** are larger than those of the second wick portion **22**. The width of the first wick portion **21** covers a region on both sides of the axial portion of the flat tube **10** and is almost one half of the width of the flat tube **10**. In other words, the first wick portion **21** supports the region on both sides of the axial portion of the flat tube **10**.

**[0028]** Next, the circular tube **10***a* filled with the core rod and the metal powder is sintered to form a porous wick structure **20**. Then, the core rod is drawn out of the circular tube **10***a*. When the wick structure **20** is still plastic, a pressing die (not shown) is used to press the circular tube **10***a*, so that the circular tube **10***a* shown in FIG. **2** is pressed to become a flat tube **10** shown in FIG. **3**.

**[0029]** It should be further noted that the present inventor has taken practical demands into consideration. More specifically, a lower surface **11** of the flat tube **10** is brought into thermal contact with a heat source (not shown). Thus, as shown in FIG. **2**, the metal powder is filled in the lower portion (rather than the upper portion) of the circular tube **10***a*, and then the metal powder is set by the core rod. After the circular tube **10***a* shown in FIG. **2** is pressed to form the flat tube **10** shown in FIG. **3**, the upper inner wall of the circular tube **10***a* is compressed, so that the upper inner wall **12** of the flat tube **10** abuts against the first wick portion **12** and is supported thereby. At this time, the second wick portion **21** is subjected to a deformation and adhered to the lower inner wall **13** of the flat tube **10**, thereby expanding laterally. Due to the specific profile of the core rod, the thickness and width of the second wick portion **22** are smaller than those of the first wick portion **21**. Even though the upper inner wall **12** of the flat tube **10** has abut against the first wick portion **21**, a distance still exists between the upper inner wall **12** of the flat tube **10** and the second wick portion **22**, thereby forming an air channel **30**.

**[0030]** The operating principle and advantages of the present invention will be described as follows.

**[0031]** Please refer to FIGS. **1** and **3**. At one end of the flat tube **10**, the lower surface **11** of the flat tube **10** is brought into thermal contact with a heat source (not shown). The end of the flat tube **10** contacting the heat source is referred to as a heat-absorbing end, and the other end of the flat tube **10** away from the heat source is referred to as a heat-releasing end. Since the lower surface **11** of the flat tube **10** is brought into thermal contact with the heat source and the wick structure **20** is arranged on the lower inner wall **13** of the flat tube **10**, the working fluid (not shown) in the wick structure **20** can sufficiently absorb the heat of the heat source for evaporation.

**[0032]** The vapor-phase working fluid has a small density, so that it will float in the air channel **30** formed between the second wick portion **22** and the upper inner wall **12** of the flat tube **10**. Since the inner walls of the flat tube **10** are smooth, the vapor-phase working fluid can rapidly flow from the heat-absorbing end toward the heat-releasing end. The vapor-phase working fluid reaching the heat-releasing end condenses to become liquid-phase working fluid. The liquid-phase working fluid naturally descends due to gravity force to flow into the wick structure **20**. Since the wick structure **20** is arranged on the lower inner wall **13** of the flat tube **10**, the liquid-phase working fluid can rapidly flow back to the heat-absorbing end along the expanded wick structure **20**, thereby generating an excellent effect on heat conduction and liquid reflow. In this way, the dry-out phenomenon of the heat-absorbing end can be avoided. That is to say, since the wick structure **20** of the present invention comprises a first wick portion **21** and two second wick portions **22** connected on both sides of the first wick portion **21**, the wick structure **20** of the present invention is configured to expand laterally from the axial line of the flat tube **10** with a larger area. As a result, more working fluid exists in the expanded wick structure **20** to absorb the heat of the heat source for evaporation. On the other hand, more liquid-phase working fluid flows back by means of the expanded wick structure **20**, thereby generating a larger heat-conducting efficiency.

**[0033]** The wick structure **20** of the present invention comprises a first wick portion **21** and two second wick portions **22** connected on both sides of the first wick portion **21**. The thickness and width of the first wick portion **21** are larger than those of the second wick portion **22**. The first wick portion **21** abuts against the upper inner wall **12** of the flat tube **10**. Thus, the first wick portion **21** is configured to support the upper inner wall **12** of the flat tube **10**. As a result, it is unnecessary to provide another additional supporting structure in the flat tube **10**, so that the flat-type heat pipe **1** can be made more compact. Since the inner walls of the flat tube **10** are supported by the first wick portion **21**, the flat tube **10** will not be recessed due to the external atmospheric pressure.

**[0034]** It should be further noted that, preferably, the width of the wick structure **20** corresponds to the width of the heat source. For example, if the width of the heat source is 10 mm, the width of the wick structure **20** may be 10 mm, so that the width of the wick structure **20** can be completely used for heat conduction. Thus, if the width of the flat tube **10** is 25 mm, the wick structure **20** is substantially located in the region near the axial line of the flat tube **10**.

**[0035]** Although the present invention has been described with reference to the foregoing preferred embodiment, it will be understood that the invention is not limited to the details thereof. Various equivalent variations and modifications can still occur to those skilled in this art in view of the teachings of the present invention. Thus, all such variations and equivalent modifications are also embraced within the scope of the invention as defined in the appended claims.

What is claimed is:

**1**. A flat-type heat pipe, configured to perform heat exchange with a heat source and including:

a flat tube having a lower surface brought into thermal contact with the heat source;

a working fluid filled in the flat tube; and

a wick structure arranged inside the flat tube along an axial line of the flat tube, the wick structure comprising a first wick portion and two second wick portions connected on both sides of the first wick portion, the thickness of the first wick portion being larger than that of the second wick portion, the first wick portion abutting against an upper inner wall of the flat tube, an air channel being formed between each of the second wick portions and the upper inner wall of the flat tube.

**2**. The flat-type heat pipe according to claim **1**, wherein the wick structure is made of sintered metal powder, the first wick portion and the two second wick portions are connected to a lower inner wall of the flat tube.

**3**. The flat-type heat pipe according to claim **2**, wherein the width of the first wick portion covers a region on both sides of a central axial line of the flat tube to support the region on both sides of the central axial line of the flat tube, the width of the first wick portion is larger than the width of the second wick portion.

**4**. The flat-type heat pipe according to claim **3**, wherein the width of the wick structure is equal to that of the heat source.

**5**. A wick structure of a flat-type heat pipe, the flat-type heat pipe having a flat tube, the wick structure being arranged inside the flat tube along an axial line of the flat tube, characterized in that:

the wick structure comprises a first wick portion and two second wick portions connected on both sides of the first wick portion, the thickness of the first wick portion is larger than that of the second wick portion, the first wick portion abut against an upper inner wall of the flat tube, an air channel is formed between each of the second wick portions and the upper inner wall of the flat tube.

**6**. The wick structure of a flat-type heat pipe according to claim **5**, wherein a lower surface of the flat tube is brought into thermal contact with a heat source, the wick structure is made of sintered metal powder, the first wick portion and the two second wick portions are connected to a lower inner wall of the flat tube.

**7**. The wick structure of a flat-type heat pipe according to claim **6**, wherein the width of the first wick portion covers a region on both sides of a central axial line of the flat tube to support the region on both sides of the central axial line of the flat tube, the width of the first wick portion is larger than the width of the second wick portion.

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