

BUBBLE PUMP CIRCULATING HEAT PIPE RADIATOR

FIELD OF THE INVENTION

5 The present invention relates to a bubble pump circulating heat pipe radiator distinct from capillary core circulation, in particular, to a non-condensable gas collector, in which a cooling fluid is adopted to bring away the heat generated by heating elements through the radiator.

10 BACKGROUND ART

A bubble pump is a heat transfer device for generating a fluid flow in a system in virtue of the lift force of vapor bubbles generated by heat energy driving. In the field of thermal design of power electronics, the well-known heat pipe radiator mainly comprises a
15 radiating body, heat pipes and condensers. The document CN1902754A, entitled "A cooling system with a bubble pump", illustrates that a heat-receiving part receives heat; a cooling fluid absorbs heat by heating and evaporation; a bubble pump is configured to generate a fluid flow in the system; and a condenser is configured to condense evaporated cooling fluid and emit the heat of condensation.

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SUMMARY

The objective of the present invention is to fill in the gaps in the prior art and provide a cooling solution with a module having a power of more than 250W, for ensuring the
25 operation reliability of each heating element in a system, wherein the structural form of fin radiating body and the manufacturing process of circulating heat pipe are simple and economical, water may be directly used as a cooling fluid, and a bubble pump and a non-condensable gas collection are integrated. The main problem is the effective heat dissipation of semiconductor elements such as oppositely-mounted switching power
30 supplies, industrial converters with medium and high power, insulated gate bipolar transistors (IGBT) and rectifier bridge modules.

In order to solve the above technical problem, a bubble pump circulating heat pipe radiator according to an aspect of the present invention comprises a radiating body
35 composed of two spliced parts, a circulating heat pipe embedded into the radiating body is clamped by pre-processed semicircles of the radiating body. A cooling fluid absorbs heat and generates bubbles. In order to ensure the heat dissipation efficiency, a cold neck is

disposed above the circulating heat pipe so as to collect non-condensable gas. The process that the gas collected by the cold neck is exhausted by an external vacuum pump does not fall within the protection scope of the patent. A flat portion of the circulating heat pipe is exposed and flush with a heat-receiving end of the radiating body, and the surface thereof is processed to be smooth and flat by machining. The circulating heat pipe is vacuum-tight and vertically disposed; a liquid level of water therein is maintained at a U-shaped portion of the circulating heat pipe; and deionized water is taken as a heat transfer medium.

As a preferred structure of the present invention, there are at least two circulating heat pipes, and the heat pipes have different widths. The heat pipe with a large width is bent at an angle of 3 to 15° with respect to a direction of combined parting surfaces of the two spliced parts of the radiating body, and the heat pipe with a small width is deflected at a corresponding angle with respect to the direction of combined parting surfaces of the two spliced parts of the radiating body, such that a distance between the circulating heat pipes, which is suitable for dimensions of heating elements, is formed on the substrate of the radiating body, and hence the heat transfer efficiency can be improved. A power module is disposed on the flat portion of the circulating heat pipe; a plurality of power modules may be disposed on one group of radiators; and a plurality of rows of power modules may be disposed on a plurality of groups of radiators.

As for a profile radiator, at end surfaces of the spliced parts of the radiating body, the substrate for radiating has an increased thickness on the periphery of cross sections of the heat pipes according to the heat distribution condition, and correspondingly, fins have different heights and are formed by drawing process of aluminum material.

Further improvements are performed aiming to the prior art: the interiors of the circulating heat pipes are highly vacuumized, and the flat surface of the circulating heat pipe forms a bubble pump after heating. That is to say, after a water solution is heated, when the temperature is raised to a boiling point under the pressure, one portion of water is evaporated and raised in a form of vapor-liquid mixture, and an automatic fluid circulation in the heat pipe can be formed. The non-condensable gas generated in the circulating heat pipe is collected by a cold-neck reducer pipe disposed over the heat pipe, and an upper portion of the cold neck is in a shape of inverted cone so that the collected condensed water returns back to the circulating heat pipe. Moreover, a circular radiate fin radiator is sleeved on outside of the cold neck connected with the circulating heat pipe, and the cold neck is equivalent to a condenser. By means of the reducer pipe, a lower

pipe opening is welded and communicated with the circulating heat pipe, and an upper pipe opening is connected with a vacuum pump, a shut-off valve and a pressure gauge.

The present invention has advantages below: since a capillary core with a precise and complex structure in the conventional circulating heat pipe is not required here, the structure of the evaporation section is greatly simplified, and hence the heat transfer efficiency is high and the manufacturing cost of circulating heat pipe is reduced; the structural form of radiating fin, substrate and circulating heat pipe can be easily achieved technically; and the present invention has an extensive application prospect and strong practicality in an aspect of heat dissipation of power module in the fields of power electronic switching power supplies, converters and the like.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a bubble pump circulating heat pipe radiator according to an embodiment of the present invention.

FIG. 2 is a schematic side view of the bubble pump circulating heat pipe radiator as shown in FIG. 1.

FIG. 3 is a partial enlarged sectional view of a condenser part of the bubble pump circulating heat pipe radiator along line A-A in FIG. 2.

FIG. 4 is a bottom view of FIG. 2.

FIG. 5 is a sectional view of the radiating body composed of two spliced parts as shown in FIG. 4 in which circulating heat pipes are removed.

DETAILED DESCRIPTION OF THE INVENTION

Detailed description will be given below to the bubble pump circulating heat pipe radiator according to the present invention with reference to the embodiments as illustrated in the accompanying drawings.

As illustrated in FIG. 1, a radiating body 1 is composed of two spliced parts; a narrow rectangular circulating heat pipe 2 and a wide rectangular circulating heat pipe 6 is embedded into the radiating body; heating elements 7 indicated by dotted lines are

attached to the flat circulating heat pipes 2, 6 which are also semi-embedded, and the contact surface is a smooth plane; and hence the thermal resistance can be reduced and the heat can be conveniently transferred. There are a long cold neck 3 and a short cold neck 5, the lengths of which are designed for neatly placing the circular radiate fin radiators 4, and the cold neck belongs to non-condensable gas collector or condenser in an aspect of function.

As illustrated in FIG. 2, the circulating heat pipes 2, 6 are vertically disposed and made of circular copper pipes; partial water in the left flat heat pipe is heated to generate bubbles so as to form a bubble pump; the horizontal dotted lines represent the liquid level of the water solution in the heat pipe; after the left heat pipe is heated, a vapor-liquid mixture is formed; the specific gravity of the vapor-liquid mixture is less than that of a water body in the right heat pipe, and hence a static pressure can be produced; and consequently, a water circulation can be spontaneously formed; the arrow indicates the flow direction of the cooling fluid.

As known from the sectional view in FIG. 3, the cold neck is a copper joint, the dimension of which can be determined by the gas collection capacity, a lower port of which is welded to the circulating heat pipe, and an upper end portion of which has a reduced diameter. The circular radiate fin radiators 4, which can be outside-purchased as standard elements, are respectively sleeved on the long cold neck 3 and the short cold neck 5.

As illustrated in FIG. 4, the circulating heat pipe 6 on a centerline is bent at an angle in the width direction of the circulating heat pipe 6, and the circulating heat pipe 2 on the centerline is deflected at a corresponding angle in the width direction; and two exposed parallel heat pipes are formed on the substrate of radiating body 1. It should be noted here that the flattened heat pipes cannot be seen in the view direction.

FIG. 5 illustrates the full view of the radiating body 1 composed of two spliced parts, which is a deformed aluminum profile, and the heat pipes are removed. A hole on the centerline is formed by enclosing two semicircles to clamp the heat pipes; openings are formed on the substrate of the radiating body 1, with which working surfaces of the two circulating heat pipes 2 and 6 are flush; and semicircle holes and openings are formed together with the profile by drawing process.

The foregoing is only an embodiment of the present invention. The improvements and deformations made to the structural form of more than two circulating heat pipes should fall within the protection scope of the present invention.

CLAIMS

1. A bubble pump circulating heat pipe radiator, characterized in that the bubble pump circulating heat pipe radiator comprises: a radiating body composed of two spliced parts, and a circulating heat pipe embedded into the radiating body; a cold neck for collecting non-condensable gas is disposed over the circulating heat pipe, a flat portion of the circulating heat pipe is exposed and flush with a substrate of the radiating body at a heat-receiving end, the circulating heat pipe is vacuum-tight and vertically disposed, and a liquid level of water therein is maintained at a U-shaped portion of the circulating heat pipe; and there are at least two circulating heat pipes, the rectangular widths of the circulating heat pipes are different, the circulating heat pipe with a large width is bent at an angle of 3 to 15° with respect to a direction of combined parting surfaces of the two spliced parts of the radiating body, and the circulating heat pipe with a small width is deflected at a corresponding angle with respect to the direction of combined parting surfaces of the two spliced parts of the radiating body, such that a distance between the circulating heat pipes, which is suitable for dimensions of heating elements, is formed on the substrate of the radiating body.
2. The bubble pump circulating heat pipe radiator according to claim 1, characterized in that at end surfaces of the two spliced parts of the radiating body, the substrate for radiating has an increased thickness on the periphery of cross section of the heat pipe according to the heat distribution condition, and correspondingly, fins have different heights and form a deformed profile by drawing process of aluminum material.
3. The bubble pump circulating heat pipe radiator according to claim 1, a flat heat-receiving portion of the circulating heat pipe forming a bubble pump, characterized in that non-condensable gas produced by very few bubbles in the circulating heat pipe is collected by a cold-neck reducer pipe connected with the circulating heat pipe, and an upper portion of the cold neck is in a shape of inverted cone so that the collected condensed water returns back to the circulating heat pipe.
4. The bubble pump circulating heat pipe radiator according to claim 1, characterized in that a circular radiate fin radiator is sleeved on the outside of the cold neck connected with the circulating heat pipe.

5. The bubble pump circulating heat pipe radiator according to claim 1, characterized in that the water at the U-shaped portion of the circulating heat pipe is used as a cooling fluid, and pure water, methanol, ethanol or chlorofluorocarbon may also be used as the cooling fluid.