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(54) MICRO-LOOP HEAT PIPE

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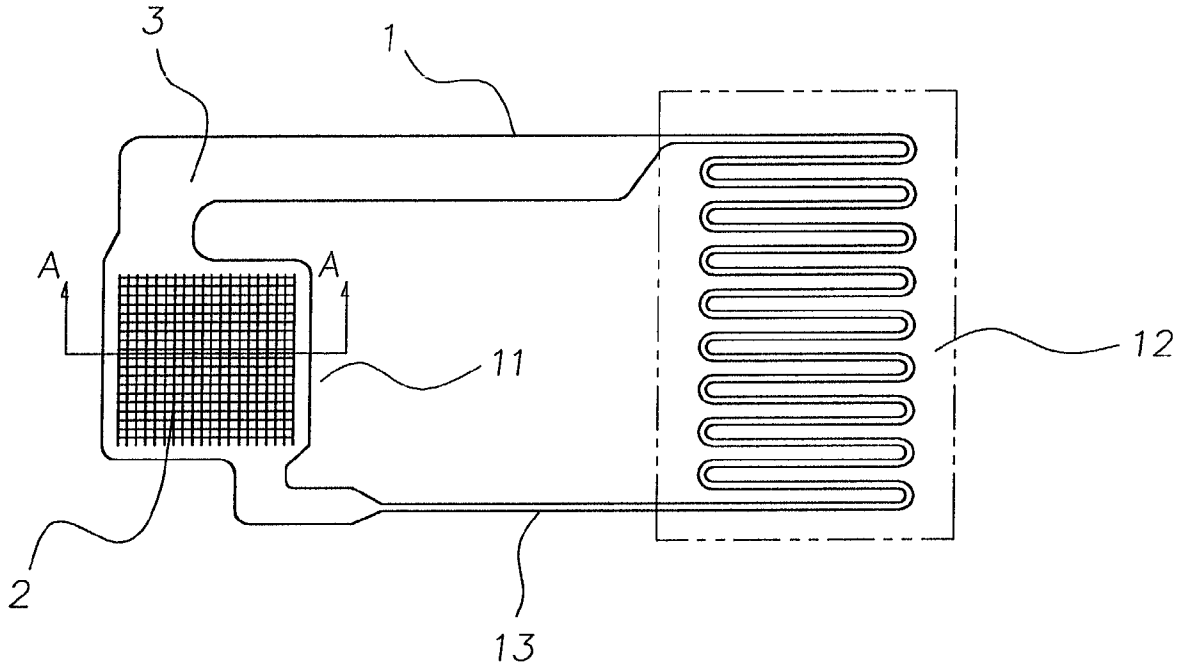
(57) **ABSTRACT**

A MICRO-LOOP HEAT PIPE, under the condition of no additional acting-force, removes the waste heat from the devices needed heat-dissipation to the well heat-dissipating circumstance by flexible contact. The MICRO-LOOP HEAT PIPE comprising: at least a flexible metal film, which forms a closed space in which fluid may circulate, and has a heat-absorbing zone and a heat-dissipating zone that both are connected by flow path; at least a wick structure by metal net, which is a flexible structure arranged in the heat-absorbing zone, and in which the transferred-into heat may be conducted uniformly; and a working fluid, may be filled into the flexible metal film, absorbs heat in the heat-absorbing zone, vaporizes into gas state, and generates a pressure source that may make the working fluid circulate inside the flexible metal film; the gasified working fluid may be cooled (or heat-dissipated) in the heat-dissipating zone and changed back to liquid state.



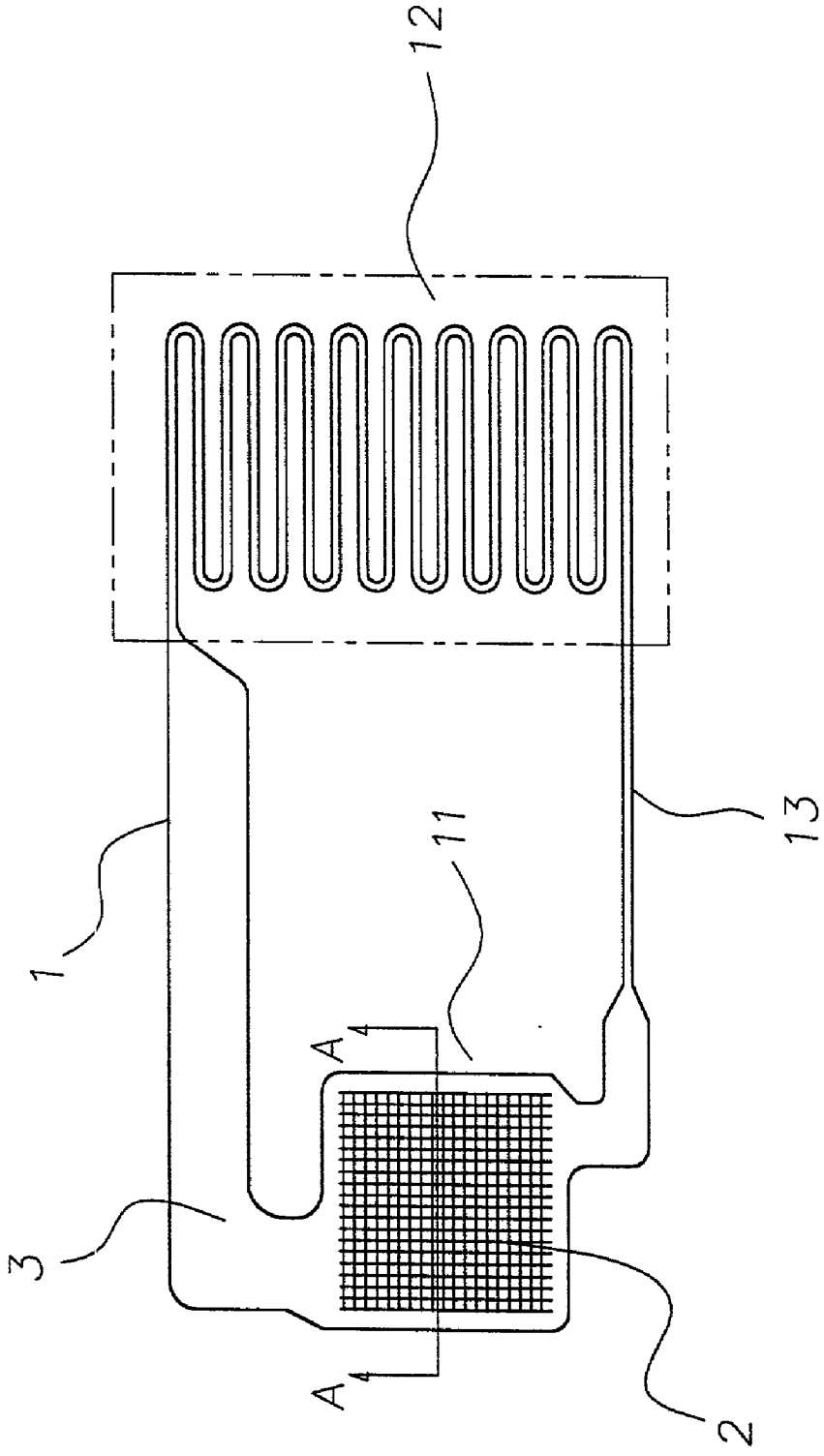


FIG. 1

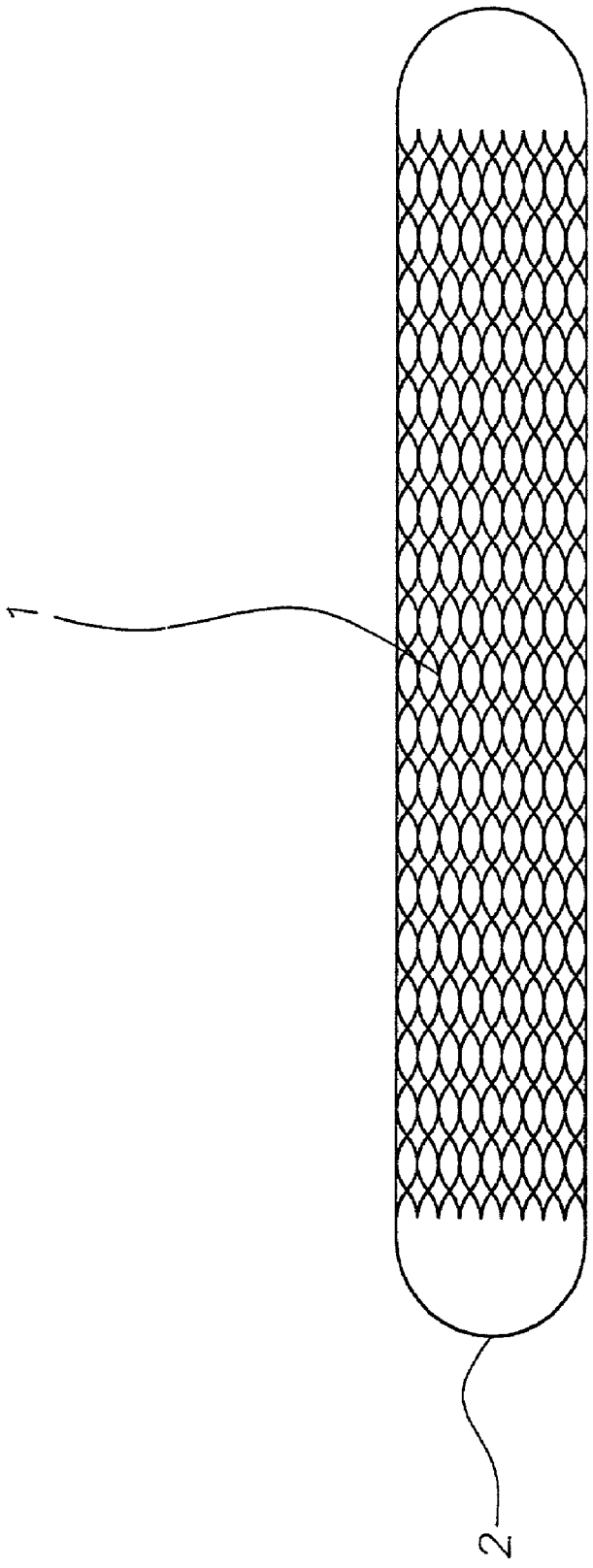


FIG. 2

MICRO-LOOP HEAT PIPE

FIELD OF THE INVENTION

[0001] The present invention relates to a MICRO-LOOP HEAT PIPE, under the condition of no additional acting-force, removes the waste heat from the devices needed heat-dissipation to the well heat-dissipating circumstance by flexible contact.

BACKGROUND OF THE INVENTION

[0002] In the developing trends of lightness, thinness, shortness, and smallness for hi-tech products, the solution for the problem of heat dissipation becomes more and more important.

[0003] In the prior arts, the desktop computer is arranged with a fan in the CPU by applying air to cool it. However, in a limited space, above problem needs another structure to solve the problem of insufficient room for arranging a fan. For example, the heat dissipation of CPU of laptop computer, due to the limitation of space, is different from the fan arranged in the CPU of the desktop computer. In the prior arts for CPU's heat-dissipation of laptop computer, an application of heat-dissipating tube is used. One end of the heat-dissipating tube is a heat-absorbing end that absorbs the waste heat of the CPU. Another end is a heat-dissipating end, of which height is higher than the absorbing end. A working fluid of low boiling point is contained in the heat-dissipating tube. The working fluid is heated and become gas state by the heat-dissipating end of the heat-dissipating tube receiving the dissipated heat from the CPU. The gasified working fluid then floats up to the other cooling end of the heat-dissipating tube. The cooling end is usually arranged in the back portion of the LCD where the ventilation is good, or it is arranged on the machine shell. The gasified working fluid is cooled therein and changed from gas state back to liquid state. The liquidized working fluid is then flowed back to the heat-absorbing end by the operation of gravity and completes a heat-fluid circulation. By this manner of heat-fluid circulation, the CPU's heat is continuously dissipated out to the atmosphere.

[0004] In above-described structure, although it is simple, but a working fluid of two phases (i.e. liquid state and gas state) co-existing simultaneously in a tube body becomes a liquid-gas mixture that makes the volume of filled liquid become an important factor. Since it is impossible to control the behavior between the phases of liquid and gas, so the most quantity of removable heat is around 20~25 W.

[0005] For another heat-dissipating device in the prior arts, it is a closed metal structure containing working fluid. A circulating path is formed inside the heat-dissipating device, and which includes a heat-absorbing zone and a heat-dissipating zone. Wherein, the heat-absorbing zone is arranged with a wick manufactured by the method of powder metallurgy. Furthermore, the function of the wick is to increase the heat-absorbing area of the heat-absorbing zone. The working fluid absorbs heat in the heat-absorbing zone, and then inflates into gas state. The working fluid of liquid state is pushed toward the heat-absorbing zone by the pressure. The working fluid of gas state is cooled in the heat-dissipating zone, and then condensed into liquid state. And, again the working fluid of liquid state is pushed by the pressure toward the heat-absorbing zone and a heat-fluid circulation is generated.

[0006] However, since the wick is made by the method of powder metallurgy, so it is impossible to control the behavior of the flow field inside the wick and to make a mass production. Furthermore, the wick made by the method of powder metallurgy has no flexibility. Therefore, the entire system is formed by the traditional method of pipe welding, so the manufacturing cost is very high.

SUMMARY OF THE INVENTION

[0007] The main object of the present invention is to provide a MICRO-LOOP HEAT PIPE, of which metal net structure may be designed and manufactured as a wick by the connection technology of micro electric mechanic system (MEMS). It is also possible to make mass production and control the flow field behavior inside the wick. The wick is flexible and its geometric size is variable. The entire system is also a flexible structure and it is formed by the connection technology of the micro electric mechanic system (MEMS). The elements or devices required by the flexible contact may increase the efficiency of heat transfer, increase the reliability of manufacture, and reduce the cost of manufacture.

[0008] In order to fulfill above-mentioned objects, a MICRO-LOOP HEAT PIPE has been invented. Under the condition of no additional acting-force, it may remove the waste heat from the devices needed heat-dissipation to the well heat-dissipating circumstance by flexible contact. The MICRO-LOOP HEAT PIPE comprising: at least a flexible metal film, at least a wick structure by metal net, and a working fluid.

[0009] The flexible metal film forms a closed space in which fluids may circulate, and has a heat-absorbing zone and a heat-dissipating zone that both are connected by flow path.

[0010] The metal net structure is a flexible structure arranged in the heat-absorbing zone, and in which the transferred-into heat may be conducted uniformly. And,

[0011] The working fluid, may be filled into the flexible metal film, absorbs heat in the heat-absorbing zone, vaporizes into gas state, and generates a pressure source that may make the working fluid circulate inside the flexible metal film. The gasified working fluid may be cooled (or heat-dissipated) in the heat-dissipating zone and changed back to liquid state.

[0012] In order to more clearly describe the operation principle of the MICRO-LOOP HEAT PIPE proposed in the present invention, detailed description in cooperation with corresponding drawings are presented as following.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] **FIG. 1** is an illustration of action principle of the MICRO-LOOP HEAT PIPE of the present invention.

[0014] **FIG. 2** is a cross-sectional view of A-A line in **FIG. 1**.

DETAILED DESCRIPTION OF THE INVENTION

[0015] The present invention is mainly to provide a MICRO-LOOP HEAT PIPE, of which metal net structure may be designed and manufactured as a wick by the connection technology of micro electric mechanic system (MEMS). It is also possible to make mass production and control the flow field behavior inside the wick. The wick is flexible and its geometric size is variable. The entire system is also a flexible structure and it is formed by the connection

technology of the micro electric mechanic system (MEMS). The elements or the devices required by the flexible contact may increase the efficiency of heat transfer, increase the reliability of manufacture, and reduce the cost of manufacture.

[0016] The action principle and structure of the invention are described as following. Please refer to **FIG. 1** and **FIG. 2**, which show a MICRO-LOOP HEAT PIPE of the invention, under the condition of no additional acting-force, removes the waste heat from the devices needed heat-dissipation to the well heat-dissipating circumstance by flexible contact. The MICRO-LOOP HEAT PIPE includes: at least a flexible metal film **1**, at least a wick structure by metal net **2**, and a working fluid **3**. The flexible metal film **1** forms a closed space in which fluids may circulate, and has a heat-absorbing zone **11** and a heat-dissipating zone **12** that both are connected by flow path **13**.

[0017] The metal net structure **2** is a flexible structure arranged in the heat-absorbing zone **11**, and in which the transferred-into heat may be conducted uniformly. Also, the metal net structure **2** may be firstly constructed as a flat plane net that is connected by metal threads of same or different thread radius in the way of diffusion bonding. Secondly, the flat plane net is connected upwardly by the manner of diffusion bonding to be formed as a three-dimensional net. And,

[0018] The working fluid **3**, may be filled into the flexible metal film **1** absorbs heat in the heat-absorbing zone **11**, vaporizes into gas state, and generates a pressure source that may make the working fluid **3** circulate inside the flexible metal film **1**. The gasified working fluid **3** may be cooled (or heat-dissipated) in the heat-dissipating zone **12** and changed back to liquid state. Wherein, when the working fluid **3** is filled into the flexible metal net **1**, it can depend on the requirement of practical application and the pressure cooperating with flow path **13** to replace different kind of working fluid **3** in expectation to reach an optimal effect of heat-dissipation.

[0019] Preferably, the heat-dissipating zone **12** of the flexible metal film **1** has a structure of "S" shape that is applied for elongating the flow path of the working fluid **3** within the heat-dissipating zone **12** for enhancing the efficiency of heat-dissipation.

[0020] The material for above-described metal net structure **2** (i.e., wick) is material of high heat conductance, such as silver, copper, and aluminum, etc. The metal net structure **2** is made of above-mentioned materials by the connection technique (i.e., diffusion bonding) of micro electric mechanic system (MEMS). The entire metal net structure **2** may be designed according to the requirements of different products. Several metal-net structures **2** of different meshes and thread radiuses may be connected together to form a specific flow field, in which has a characteristic of excellent partial heat-transfer to transfer the heat of the heat-absorbing part of system into the entire metal net structure **2**. This metal net structure **2** also has good property of containing water. After the heat is transferred from outside into the metal net structure **2** that is filled with fluid, since this design will result redundant heat (i.e., higher temperature) that is partially accumulated inside the meshes of the metal net structure **2**, so it will make the liquid inside the metal net structure **2** generate partial gasification. The gasified fluid will flow outwardly from the metal net structure **2**, while the fluid in the metal net structure **2** after being partially gasified will absorb the condensed liquid fluid in the heat-dissipating zone **12** from outside into the metal net structure **2** by the principle of capillary action and under the condition of no additional acting-force.

[0021] The flexible metal film **1** of above description is a metal film made of basic material that has high heat-conductance, such as silver, copper, and aluminum, etc. The diameters of the micro flow path inside the heat dissipation zone **12** are between hundreds micro-meters to several micro-meters in order to facilitate both the heat-dissipation and the capillary action.

[0022] In summarizing above description, the MICRO-LOOP HEAT PIPE of the invention has applied the micro electric mechanic system (MEMS) to design and manufacture out the key element—"wick"—that is capable of mass production. The invention applies the flexibility of the elements or devices needed heat-dissipation for making flexible contact. The structure is adapted for all different products and may be optimally designed and matched with practical needs.

What is claimed is:

1. A MICRO-LOOP HEAT PIPE, under the condition of no additional acting-force, removes the waste heat from the devices needed heat-dissipation to the well heat-dissipating circumstance by flexible contact, the MICRO-LOOP HEAT PIPE comprising:

at least a flexible metal film, which forms a closed space in which fluids may circulate, and has a heat-absorbing zone and a heat-dissipating zone that both are connected by flow path;

at least a wick structure by metal net, which is a flexible structure arranged in the heat-absorbing zone, and in which the transferred-into heat may be conducted uniformly; and,

a working fluid, may be filled into the flexible metal film, absorbs heat in the heat-absorbing zone, vaporizes into gas state, and generates a pressure source that may make the working fluid circulate inside the flexible metal film; the gasified working fluid may be cooled (or heat-dissipated) in the heat-dissipating zone and changed back to liquid state.

2. The MICRO-LOOP HEAT PIPE of the claim 1, wherein the heat-dissipating zone of the flexible metal film has a structure of "S" shape that is applied for elongating the flow path of the working fluid within the heat-dissipating zone for enhancing the efficiency of heat-dissipation.

3. The MICRO-LOOP HEAT PIPE of the claim 1, wherein the material of the flexible metal film is a material of high heat-conductance and at least one of silver, copper, and aluminum, etc.

4. The MICRO-LOOP HEAT PIPE of the claim 1, wherein the material of the metal net structure is a material of high heat-conductance and at least one of silver, copper, and aluminum, etc.

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