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(54) **HEAT DISSPATION DEVICE AND CONTROL METHOD**

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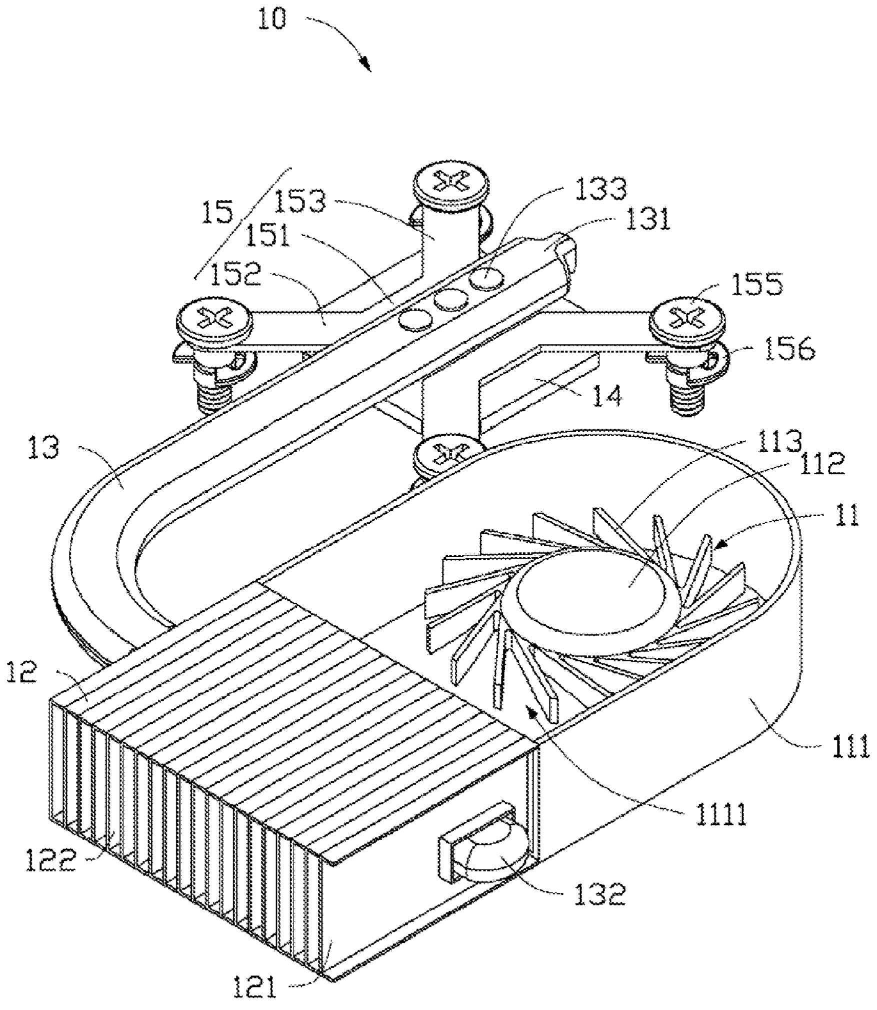
(57) **ABSTRACT**

A heat dissipation device for cooling a heat generating component, includes a fins module, a heat pipe, a fan, at least two temperature sensors, and a control system. The heat pipe includes an evaporation section absorbing heat from the heat generating component, and a condensation section thermally connected to the fins module. The fan is for driving airflow towards the fins module. The at least two temperature sensors are arranged on the evaporation section of the heat pipe, for continuously sensing temperatures of their respective positions on the heat pipe. The control system adjusts the speed of the fan and/or the operating power of the heat generating component according to the sensed temperatures of the at least two temperature sensors. A method for controlling the heat dissipation device is also provided.



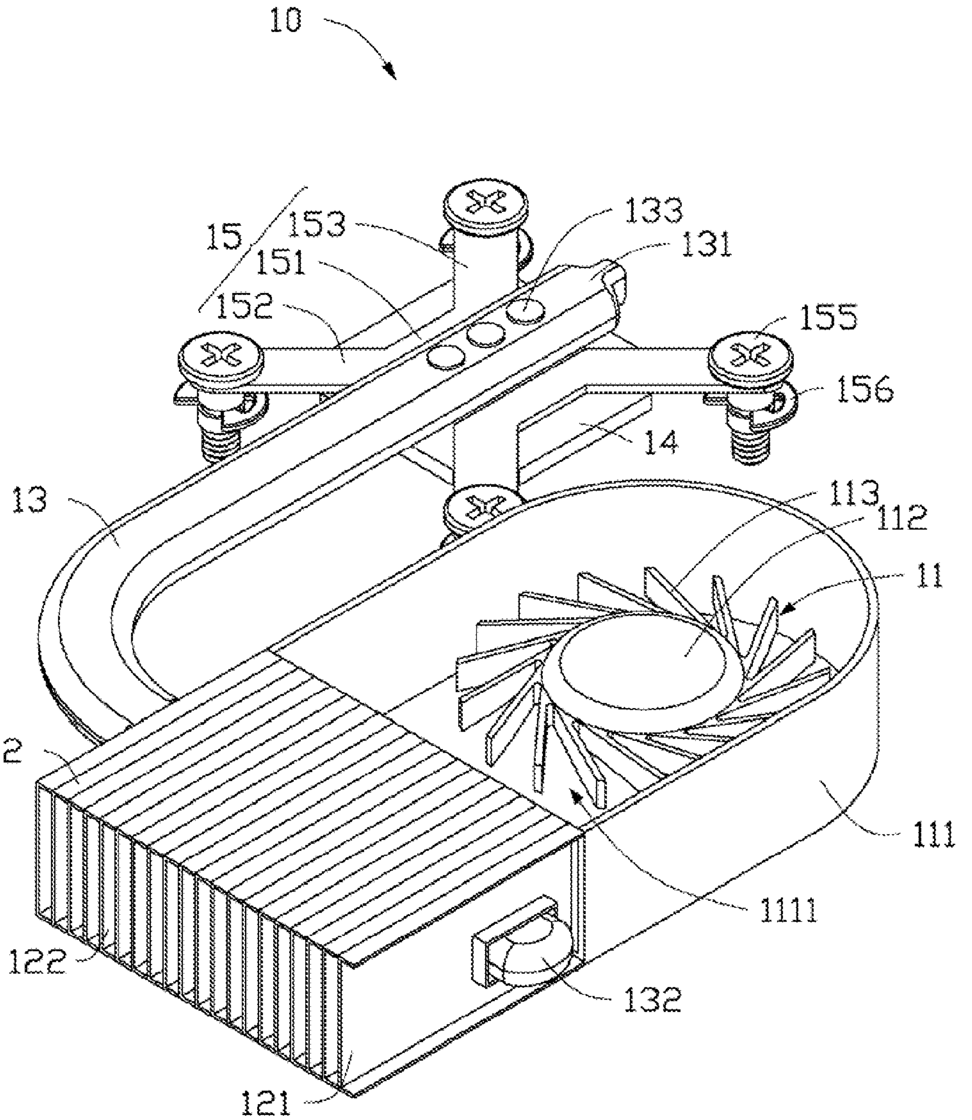

10
15
153
151
152
133
131
155
156
14
13
113
112
11
12
111
1111
122
132
121

FIG. 1

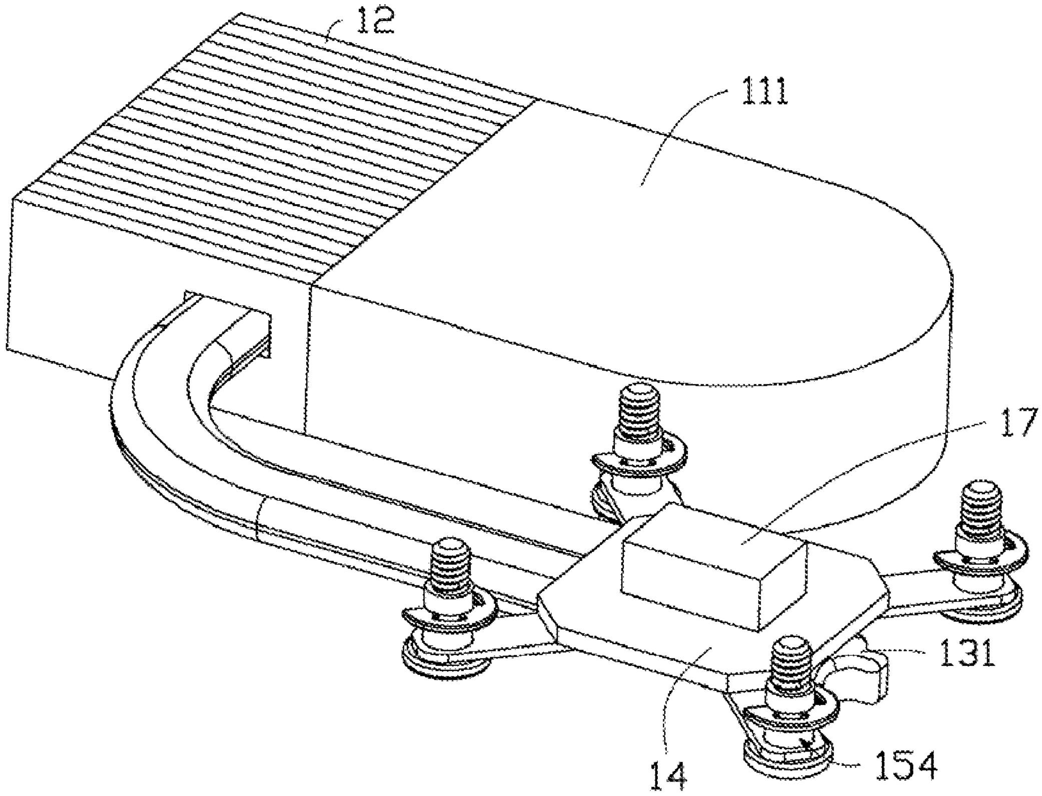


FIG. 2

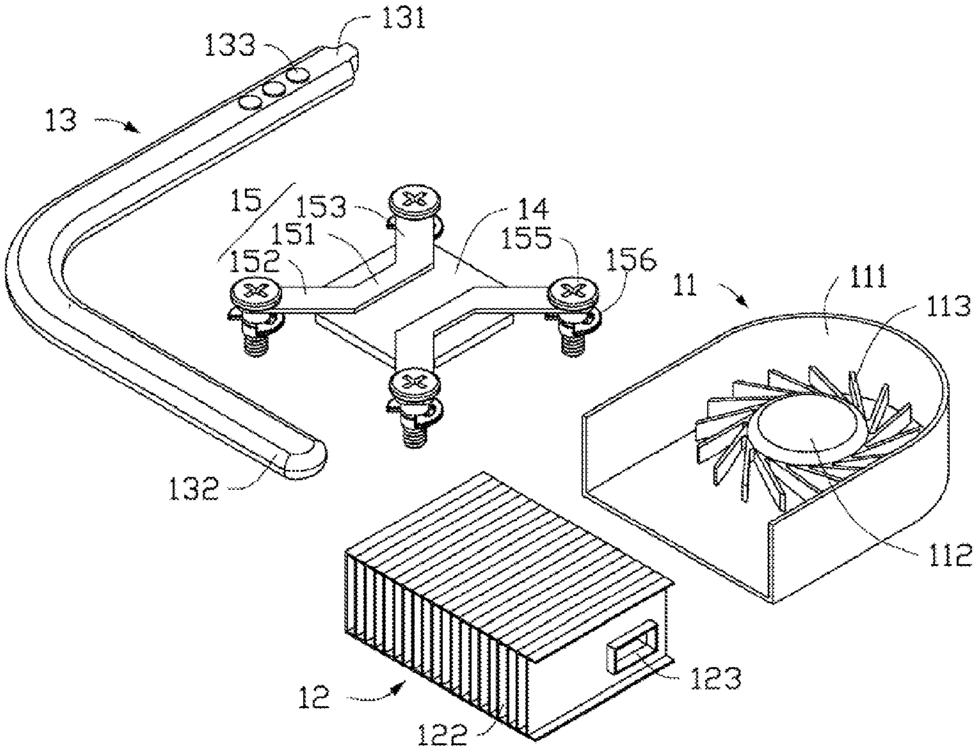


FIG. 3

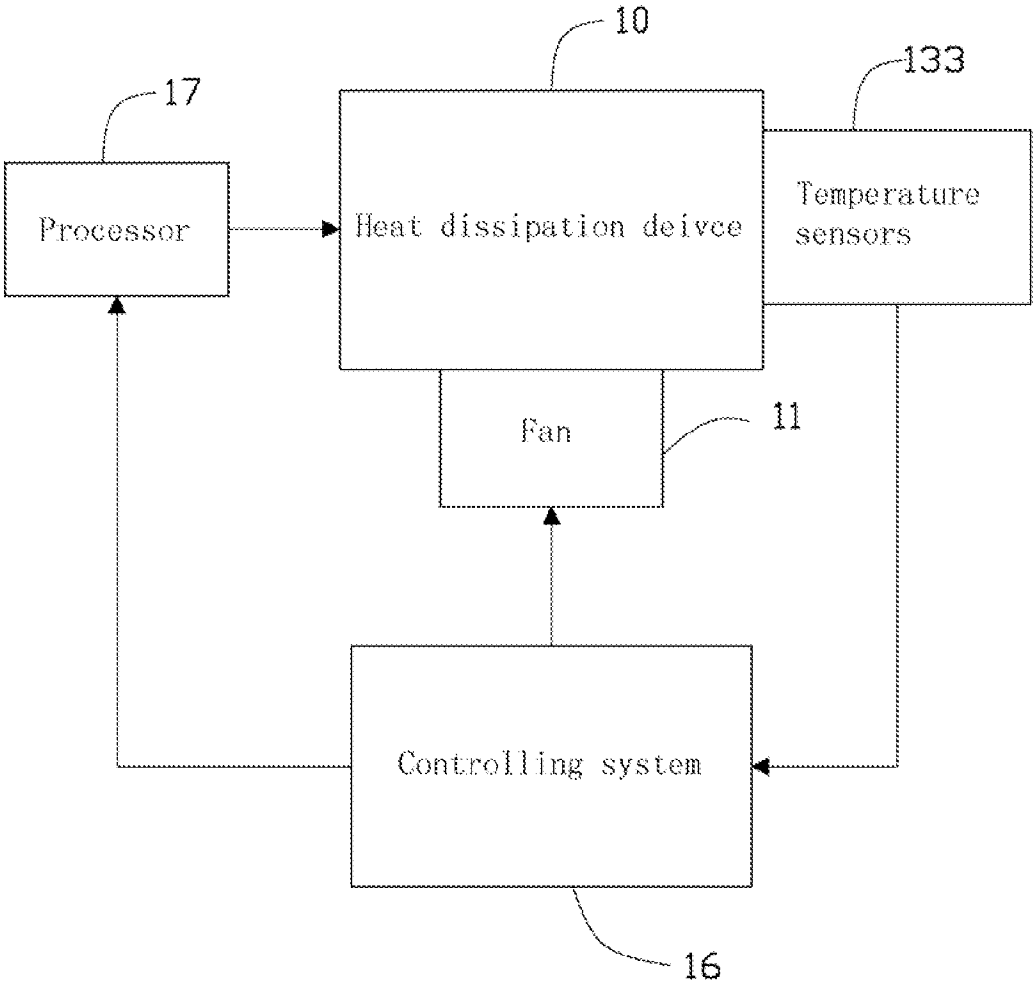

10
133
17
Processor
Heat dissipation deivce
Temperature sensors
Fan
11
Controlling system
16

FIG. 4

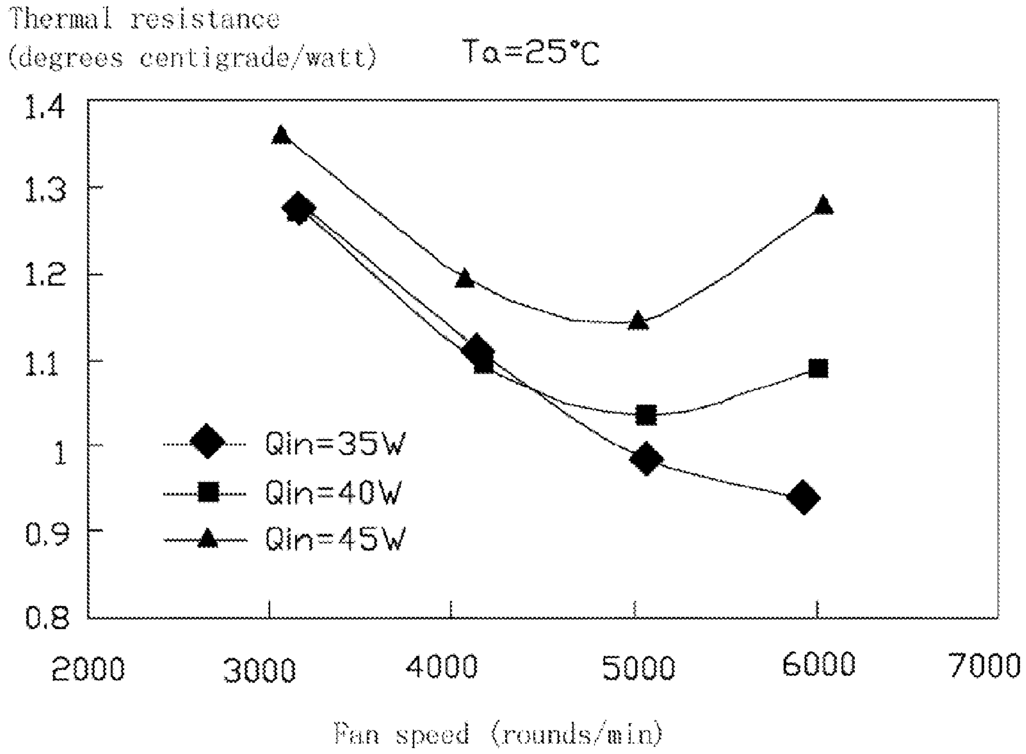

Thermal resistance
(degrees centigrade/watt)
Ta=25°C
1.4
1.3
1.2
1.1
1
0.9
0.8
2000
3000
4000
5000
6000
7000
Fan speed (rounds/min)
Qin=35W
Qin=40W
Qin=45W

FIG. 5

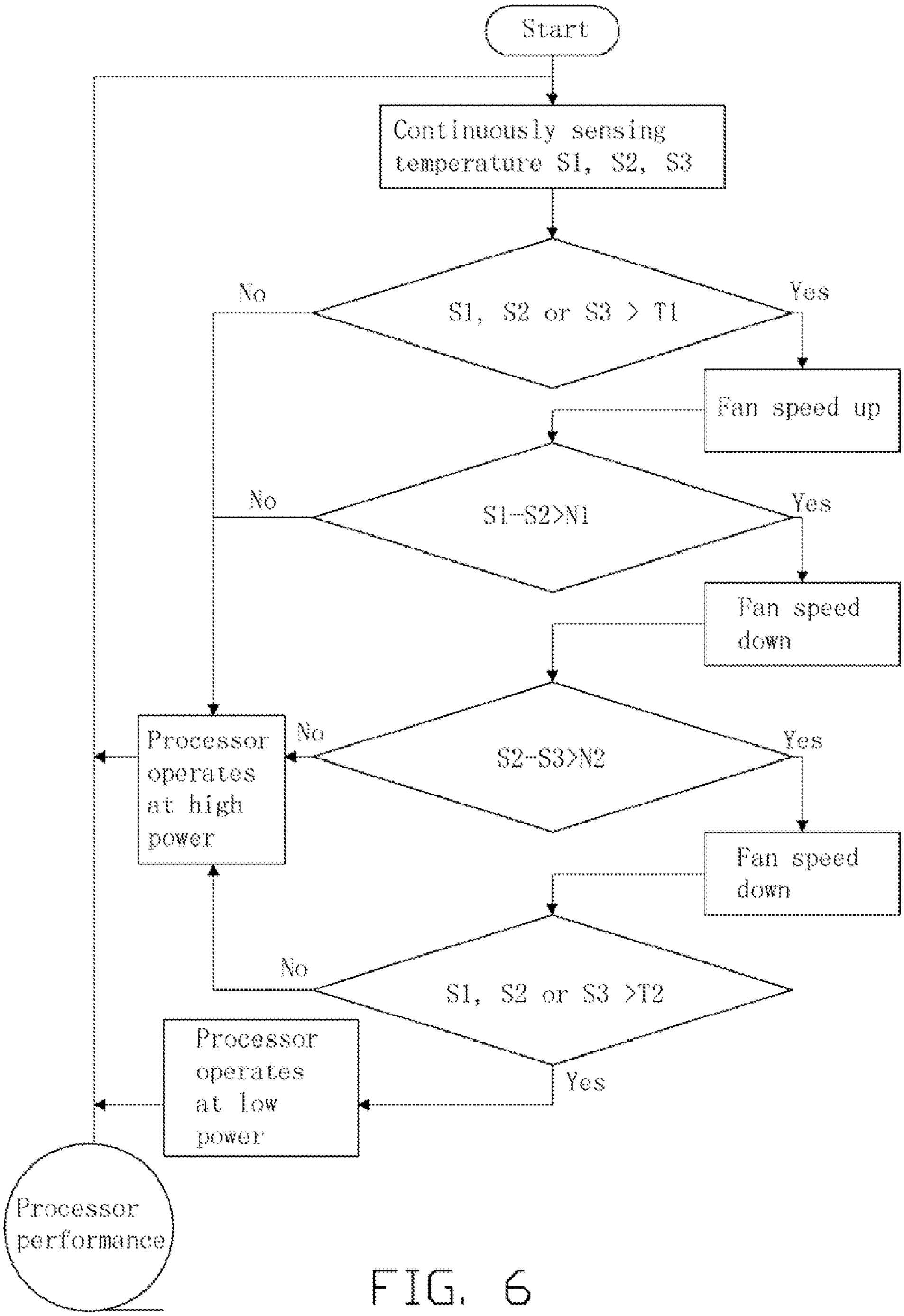

Start
Continuously sensing temperature S1, S2, S3
S1, S2 or S3 > T1
No
Yes
Fan speed up
S1-S2>N1
No
Yes
Fan speed down
S2-S3>N2
No
Yes
Processor operates at high power
Fan speed down
S1, S2 or S3 >T2
No
Yes
Processor operates at low power
Processor performance

FIG. 6

# HEAT DISSPATION DEVICE AND CONTROL METHOD

## BACKGROUND

**[0001]** 1. Technical Field

**[0002]** The present disclosure generally relates to heat dissipation devices, and control method for the heat dissipation devices.

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

**[0004]** During operation of electronic devices such as computer central processing units (CPUs), a large amount of heat is often produced. The heat must be quickly removed from the electronic devices to prevent them from becoming unstable or being damaged. Many heat dissipation devices are employed to dissipate heat produced by the electric device. A heat dissipation device generally comprises a base attached to the electric device, a plurality of fins thermally connected to the base by heat pipes, and a fan for driving airflow towards the fins. The base is intimately attached to the CPU for absorbing the heat generated by the CPU. Most of the heat accumulated on the base is transferred to the fins by the heat pipes and then the fins are cooled by airflow driven by the fan.

**[0005]** To achieve high efficiency heat transfer, a fan speed of the heat dissipation device is high, which is not energy saving.

**[0006]** Therefore, what is needed is to provide a heat dissipation device capable of effectively improving heat dissipating efficiency under different temperatures.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0007]** Many aspects of the disclosure can be better understood with reference to the following drawings. The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the disclosure.

**[0008]** FIG. **1** is a schematic view of a heat dissipation device in accordance with an embodiment of the present disclosure.

**[0009]** FIG. **2** is similar to FIG. **1**, but showing another aspect of the heat dissipation device.

**[0010]** FIG. **3** is an exploded view of the heat dissipation device of FIG. **1**.

**[0011]** FIG. **4** is a function block diagram of the circuit of the mobile phone of FIG. **1**.

**[0012]** FIG. **5** is a plot of the thermal resistance versus the fan speed of the heat dissipation device.

**[0013]** FIG. **6** is a flowchart illustrating a principle of fan speed and processor power adjustment of the heat dissipation device.

## DETAILED DESCRIPTION

**[0014]** Reference will now be made to the drawings to describe the present embodiment of a heat dissipation device, in detail.

**[0015]** Referring to FIGS. **1**-**4**, a heat dissipation device **10** according to an embodiment includes a fan **11**, a fins module **12**, a heat pipe **13**, a base **14**, two fixing plates **15**, and a control system **16**.

**[0016]** The fan **11** is for driving airflow towards the fins module **12**. The fan **11** includes a housing **111**, a hub **112** and a plurality of blades **113** radially and extending outward from the hub **112**. The housing **111** defines an air outlet **1111** at a lateral side. The hub **112** and the plurality of blades **113** are received in the housing **111**.

**[0017]** The fins module **12** is arranged adjacent to the air outlet **1111**. The fins module **12** includes a plurality of fins **121** arranged in parallel to each other. Air channels **122** are formed between each two neighboring fins **121**. The fins **121** each define a rectangular through hole **123** with a size matching the heat pipe **13**. The through holes **123** of the plurality of fins **121** are arranged in alignment, thereby the heat pipe **13** can penetrate through the plurality of fins **121** via the through holes **123**.

**[0018]** The heat pipe **13** has a curved shape with a flat profile. The heat pipe **13** is made of metal pipe with excellent heat conductivity and phase-change media sealed in the metal pipe. The heat pipe **13** includes an evaporation section **131** and a condensation section **132**.

**[0019]** The evaporation section **131** of the heat pipe **13** is thermally attached to a central portion of the base **14** and fixed to the base **14** by the fixing plate **15**. At least two temperature sensors **133** are arranged at different positions of the evaporation section **131**. At the position where each temperature sensor **133** sits, a temperature is sensed, and a sensed result is sent to the control system **16**, by the temperature sensor **133**. The number of temperature sensors **133** can be two, three, four, or more. In this embodiment, there are three temperature sensors **133** arranged on the evaporation section **131**.

**[0020]** The condensation section **132** of the heat pipe **13** is perpendicular to the evaporation section **131** and thermally connected to the fins module **12**. In addition, the condensation section **132** penetrates through the plurality of fins **121** via the through holes **123**.

**[0021]** The base **14** is a flat heat conductive plate with the four corners cut off. The base **14** has its bottom intimately attached to a processor **17** in use. The base **14** has its top attached to the evaporation section **131** of the heat pipe **13**.

**[0022]** The fixing plates **15** each include a central portion **151**, a first side portion **152** and a second side portion **153**. The central portion **151** is a strip-like portion fixed with the base **14**. The first and second side portions **152**, **153** respectively extend from an end of the central portion **151** along a direction inclined to the central portion **151**. The first and second side portions **152**, **153** each include a distal end, in which a through hole **154** is defined. Accordingly, the base **14** can be fixed to a circuit board (not illustrated) by bolts **155** penetrating through the through holes **154**. In this embodiment, a plurality of gaskets **156** engage with corresponding bolts **155** under the fixing plates **15**.

**[0023]** Referring to FIG. **4**, the control system **16** communicates with the processor **17** and the fan **11**, thereby adjusting a heat dissipating efficiency of the heat dissipation device **10**.

**[0024]** Referring to FIG. **5**, a plot of the thermal resistance versus the fan speed of the heat dissipation device **10** is illustrated. When the processor **17** has a relatively low power, for example 35 watts ($Q_{in}$=35 W), the thermal resistance of the heat dissipation device **10** decreases as the fan speed increases. When the processor **17** has a higher power, for example 40 and 45 watts ($Q_{in}$=40 W, $Q_{in}$=45 W), the thermal resistance of the heat dissipation device **10** first decreases and then increases, as the fan speed increases. Generally, the processor **17** has an operation power greater than 40 watts.

**[0025]** Referring to FIG. **6**, the control system **16** is capable of adjusting the speed of the fan **11** and the operation power of the processor **17**, according to temperatures respectively sensed by the three temperature sensors **133**. The principle of fan speed and processor power adjustment of the heat dissipation device **10** is described in detail as follows.

**[0026]** First, the three temperature sensors **133** continuously sense temperatures S**1**, S**2** and S**3** of the respective positions where they sit. The control system **16** respectively compares the temperatures S**1**, S**2** and S**3** with a first critical temperature T**1** which stands for a normal operating temperature of the processor **17**.

**[0027]** In condition that the temperatures S**1**, S**2** and S**3** are all lower than or equal to the first critical temperature T**1**, the control system **16** keeps the operation power of the processor **17** unchanged. If the temperatures S**1**, S**2** and S**3** are all lower than or equal to the first critical temperature T**1**, it shows that heat dissipating efficiency of the heat dissipation device **10** satisfactorily meets the cooling needs of the processor **17**. Accordingly, there is no need to adjust the operation power of the processor **17**.

**[0028]** In condition, that anyone of the temperatures S**1**, S**2**, and S**3** is higher than the first critical temperature T**1**, the control system **16** increases the speed of the fan **11**. If anyone of the temperatures S**1**, S**2**, and S**3** is higher than the first critical temperature T**1**, it shows that heat dissipating efficiency of the heat dissipation device **10** fails to meet the cooling needs of the processor **17**. Accordingly, the speed of the fan **11** increases to improve the heat dissipating efficiency of the heat dissipation device **10**. Successively, the control system **16** compares a difference between S**1** and S**2** with a first critical temperature difference N**1**, to check out whether there is a nonuniform temperature distribution caused by drying-out of the heat pipe **13**. The first critical temperature difference N**1** is defined with a value representing a threshold of normal temperature difference between two of the temperature sensors **133** on the heat pipe **13**.

**[0029]** In condition that the difference between S**1** and S**2** is lower than or equal to the first critical temperature difference N**1** ($S1-S2<N1$, or $S1-S2=N1$), the control system **16** keeps the operation power of the processor **17** unchanged. The condition $S1-S2<N1$ or $S1-S2=N1$ shows that there is no nonuniform temperature distribution on the heat pipe **13**, and the heat dissipating efficiency can be finely improved by only increasing the speed of the fan **11**. As such, there is no need to adjust the operation power of the processor **17**.

**[0030]** In condition that the difference between S**1** and S**2** is larger than the first critical temperature difference N**1** ($S1-S2>N1$), the control system **16** decreases the speed of the fan **11** and then compares the difference between S**2** and S**3** with a second critical temperature difference N**2**. The condition $S1-S2>N1$ shows that there is a nonuniform temperature distribution on the heat pipe **13**, and the heat dissipating efficiency cannot be finely improved by increasing the speed of the fan **11**. That is because the increased speed of the fan **11** leads to higher thermal resistance of the heat dissipation device **10**. As such, the speed of the fan **11** is decreased to reduce the thermal resistance of the heat dissipation device **10**, according to what is illustrated in FIG. **5**. Then a difference between S**2** and S**3** is compared with second critical temperature difference N**2** to further check whether there is a nonuniform temperature distribution on the heat pipe **13**. The second critical temperature difference N**2** is defined with a value representing another threshold of normal temperature difference between another two of the temperature sensors **133** on the heat pipe **13**.

**[0031]** In condition that the difference between S**2** and S**3** is lower than or equal to the second critical temperature difference N**2** ($S2-S3<N2$, or $S2-S3=N2$), the control system **16** keeps the operation power of the processor **17** unchanged. The condition $S2-S3<N2$ or $S2-S3=N2$ shows that the nonuniform temperature distribution on the heat pipe **13** is eliminated by decreasing the speed of the fan **11**, and it is the drying-out condition of the heat pipe **13** which leads to former low heat dissipating efficiency. As such, the heat dissipating efficiency can be improved by only decreasing the speed of the fan **11** to achieve lower thermal resistance of the heat dissipation device **10**.

**[0032]** In condition that the difference between S**2** and S**3** is larger than the second critical temperature difference N**2** ($S2-S3>N2$), the control system **16** decreases the speed of the fan **11** and respectively compares the temperatures S**1**, S**2** and S**3** with a second critical temperature T**2**. The condition $S2-S3>N2$ shows that the thermal resistance of the heat dissipation device **10** has not been reduced to a minimum value by decreasing the speed of the fan **11**, according to FIG. **5**. As such, the speed of the fan **11** further decreases to achieve a lower thermal resistance of the heat dissipation device **10**, and the temperatures S**1**, S**2** and S**3** with a second critical temperature T**2** to check out whether the processor **17** has been cooled to a satisfied temperature lower than or equal to the second critical temperature T**2**.

**[0033]** In condition that the temperatures S**1**, S**2**, and S**3** are all lower than or equal to the second critical temperature T**2**, the control system **16** keeps the operation power of the processor **17** unchanged. The condition that the temperatures S**1**, S**2**, and S**3** are all lower than or equal to the second critical temperature T**2** shows that, the processor **17** has been cooled to a satisfied temperature by further decreasing the speed of the fan **11**. As such, there is no need to lower the operation power of the processor **17**.

**[0034]** In condition, that anyone of the temperatures S**1**, S**2**, and S**3** is higher than T**2**, the control system **16** decreases the operation power of the processor **17**. The condition that the anyone of the temperatures S**1**, S**2**, and S**3** is higher than T**2** shows that, it is impossible to cool the processor **17** to the satisfied temperature range only by achieving lowest thermal resistance of the heat dissipation device **10**. As such, the processor **17** can only be cooled by reducing the operation power thereof.

**[0035]** It is to be understood that the above-described embodiments are intended to illustrate rather than limit the disclosure. Variations may be made to the embodiments without departing from the spirit of the disclosure as claimed. The above-described embodiments illustrate the scope of the disclosure but do not restrict the scope of the disclosure.

What is claimed is:

**1**. A heat dissipation device for cooling a heat generating component, comprising:

a fins module;

a heat pipe comprising an evaporation section for absorbing heat of the heat generating component, and a condensation section thermally connected to the fins module;

a fan for driving airflows to flow towards the fins module;

at least two temperature sensors arranged on the evaporation section of the heat pipe, the at least two temperature sensors being for continuously sensing temperatures of their respective positions on the heat pipe to get sensed temperatures; and a controlling system for adjusting a speed of the fan and/or an operating power of the heat generating component according to the sensed temperatures of the at least two temperature sensors.

**2**. The heat dissipation device of claim **1**, wherein the controlling system compares the sensed temperatures with a first predetermined temperature, and adjust the speed of the fan and/or an operating power of the heat generating component according to the comparison.

**3**. The heat dissipation device of claim **2**, wherein the controlling system increases the speed of the fan in condition that anyone the sensed temperatures is higher than the first predetermined temperature.

**4**. The heat dissipation device of claim **3**, wherein the controlling system compares a difference between the sensed temperatures from the at least two temperature sensors with a first predetermined temperature difference, and decreases the speed of the fan in condition that the difference between the sensed temperatures is larger than the first predetermined temperature difference.

**5**. The heat dissipation device of claim **4**, wherein the controlling system compares the sensed temperatures with a second predetermined temperature, and decreases the operating power of the heat generating component in condition that anyone of the sensed temperatures is higher than the second predetermined temperature.

**6**. A method for cooling a heat generating component, comprising:

providing a heat dissipation device with a heat pipe and a fan, and attaching an evaporation section of the heat pipe to the heat generating component;

getting sensed temperatures of different positions on the evaporation section of the heat pipe;

adjusting a speed of the fan and/or an operating power of the heat generating component according to the sensed temperatures.

**7**. The method of claim **6**, wherein the sensed temperatures are compared with a first predetermined temperature, and the speed of the fan and/or an operating power of the heat generating component is/are adjusted according to the comparison.

**8**. The method of claim **7**, wherein the speed of the fan is increased in condition that anyone the sensed temperatures are higher than the first predetermined temperature.

**9**. The method of claim **8**, wherein a difference between the sensed temperatures from the at least two temperature sensors is compared with a first predetermined temperature difference, and the speed of the fan is decreased in condition that the difference between the sensed temperatures is larger than the first predetermined temperature difference.

**10**. The method of claim **9**, wherein the sensed temperatures are compared with a second predetermined temperature, and the operating power of the heat generating component is decreased in condition that anyone of the sensed temperatures is higher than the second predetermined temperature.

* * * * *