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(54) HEAT-DISSIPATING FIN, HEAT-DISSIPATING DEVICE, AND METHOD FOR ENHANCING HEAT DISSIPATION EFFECT OF A HEAT-DISSIPATING FIN

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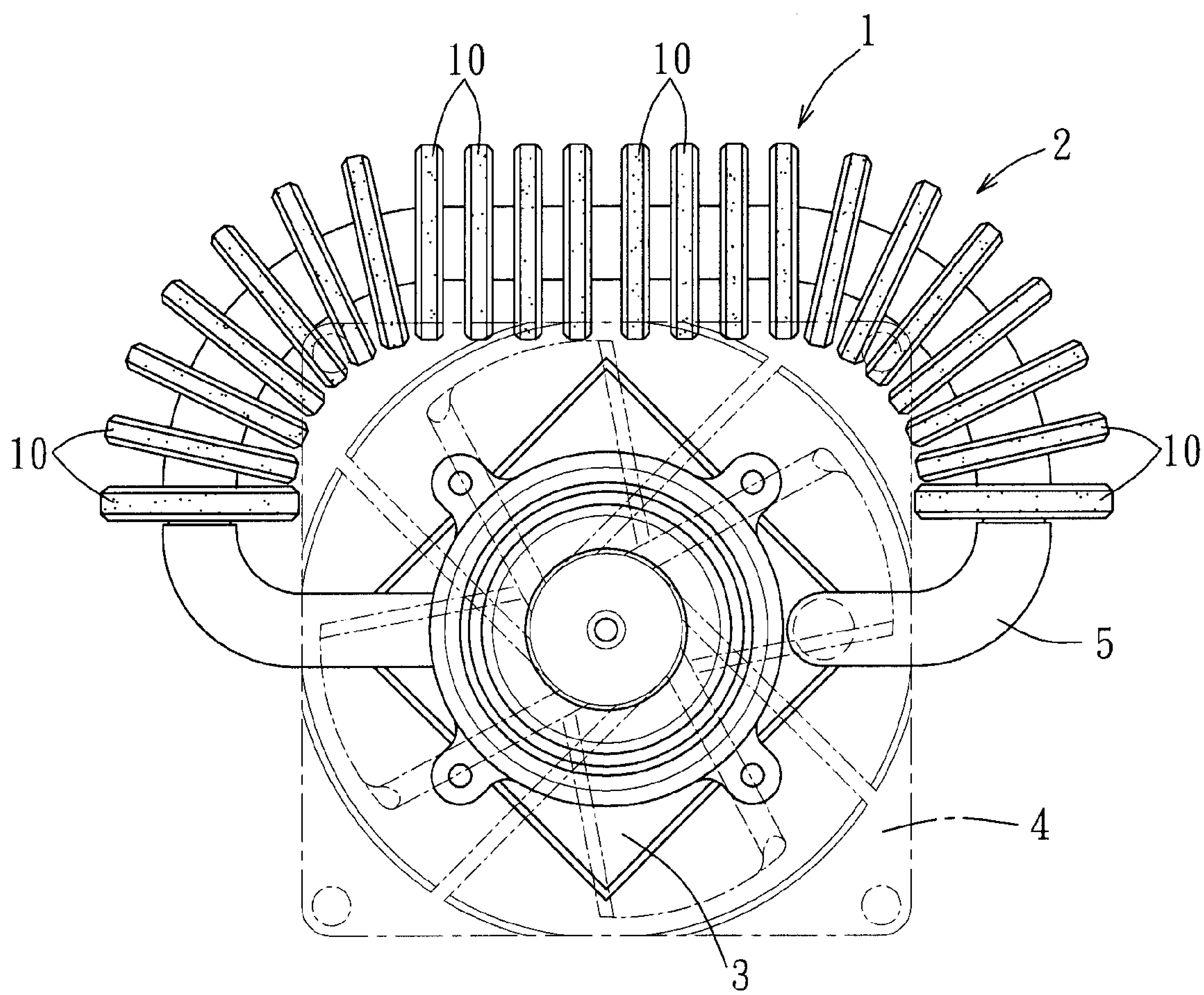
(57) ABSTRACT

In a method for enhancing heat dissipation effect of a heat-dissipating fin, a plurality of heat-conducting particles are affixed directly and contactingly to a part of a surface of the heat-dissipating fin to increase the surface area of the heat-dissipating fin so as to reduce thermal boundary layer effect. A heat-dissipating fin and a heat-dissipating device including a plurality of the heat-dissipating fins are also provided.



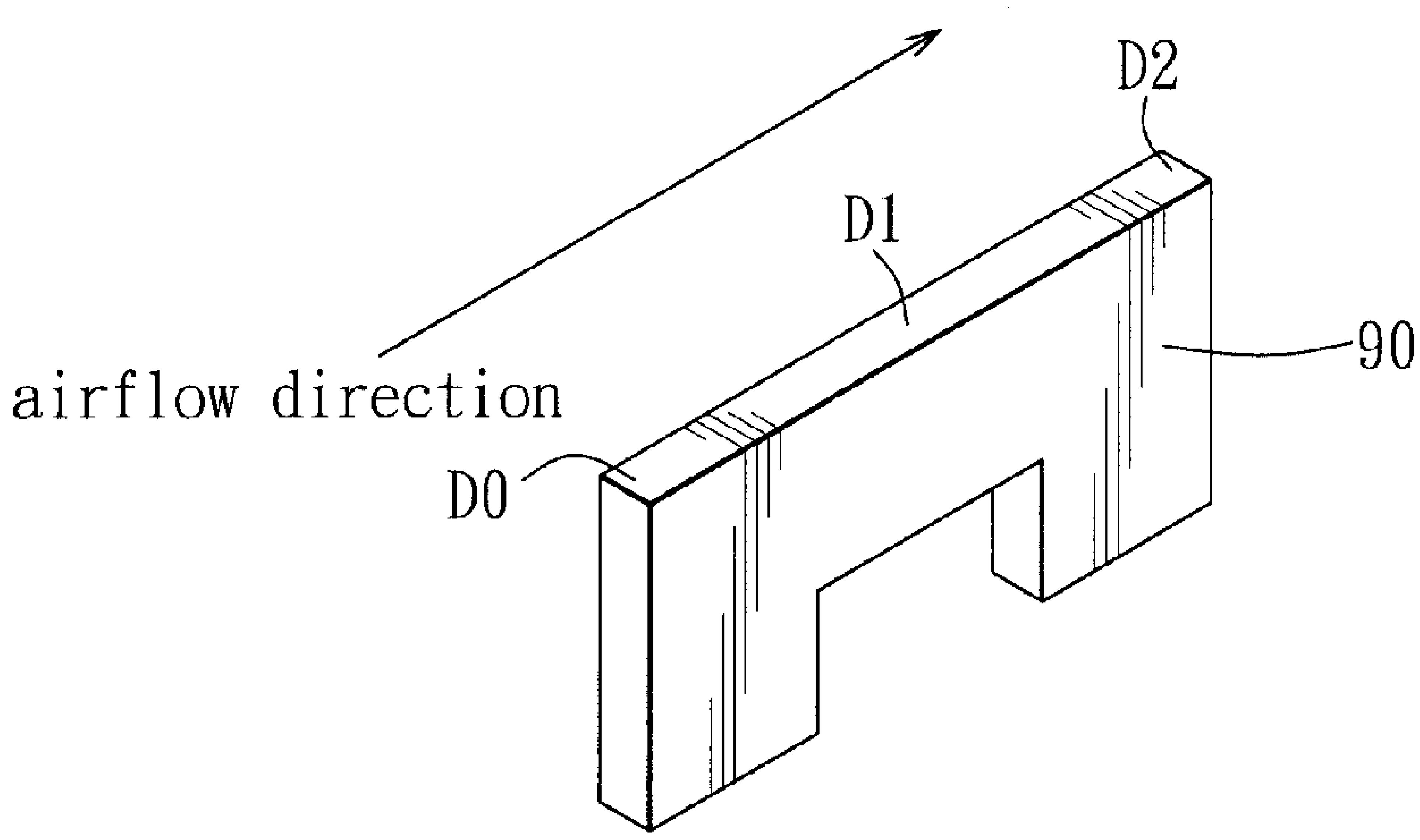


FIG. 1
PRIOR ART

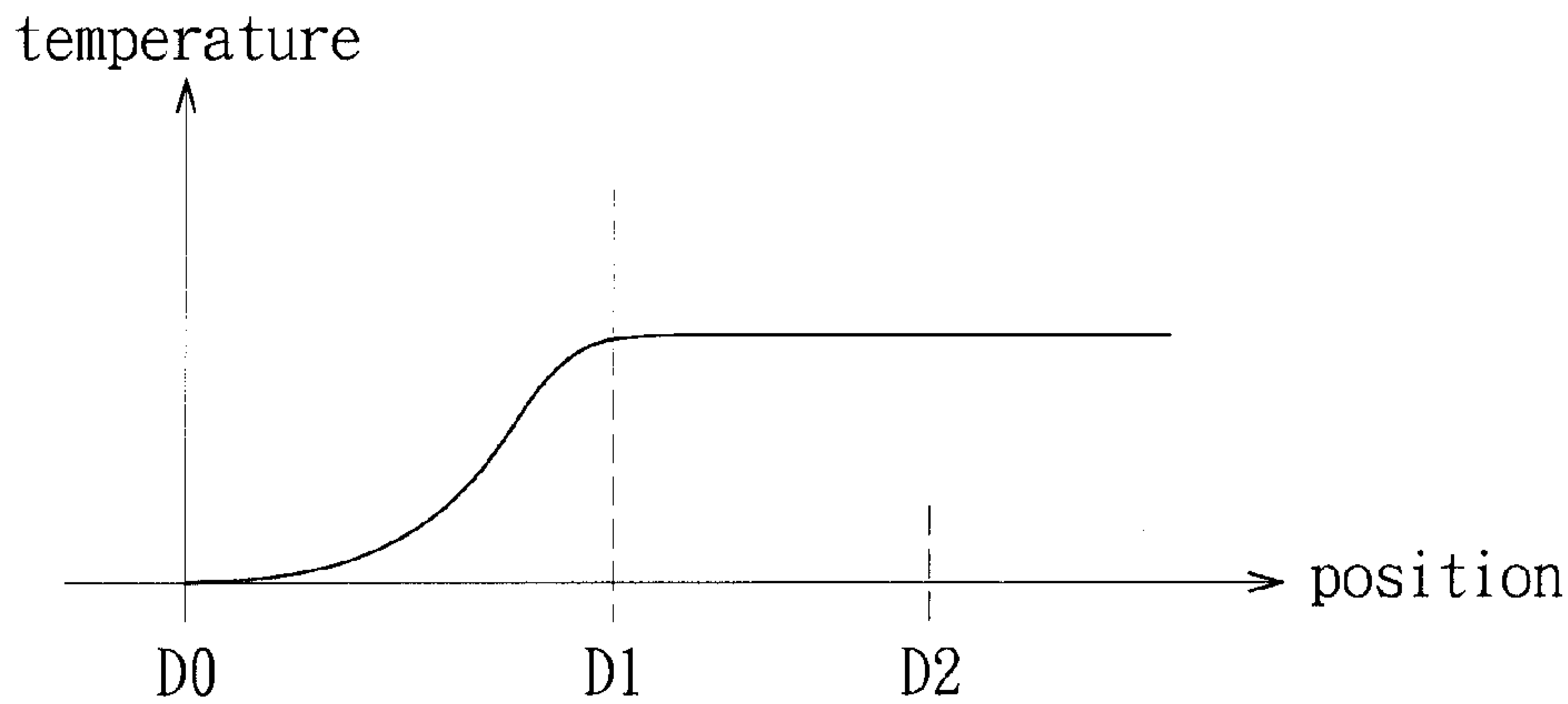


FIG. 2
PRIOR ART

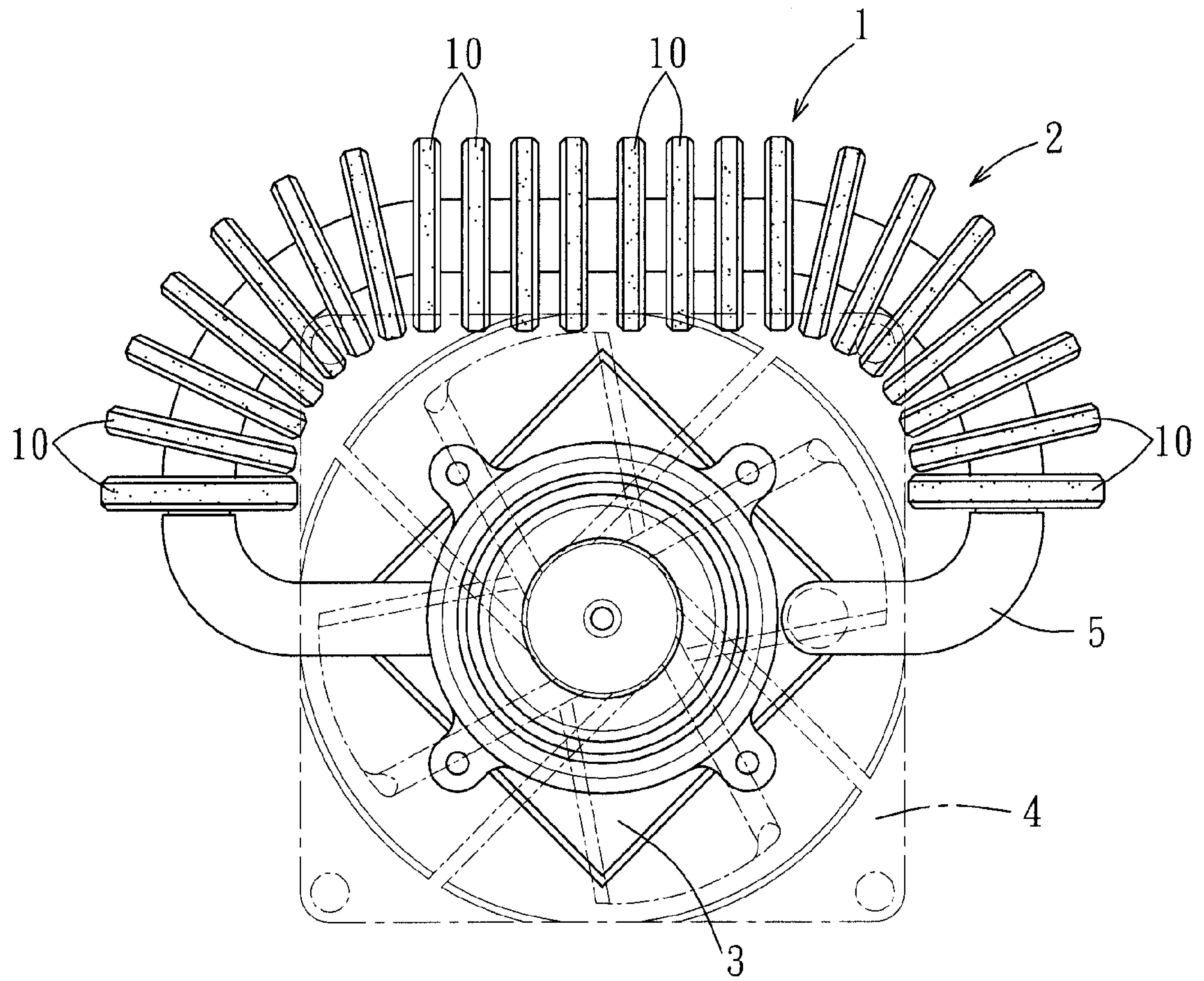


FIG. 3

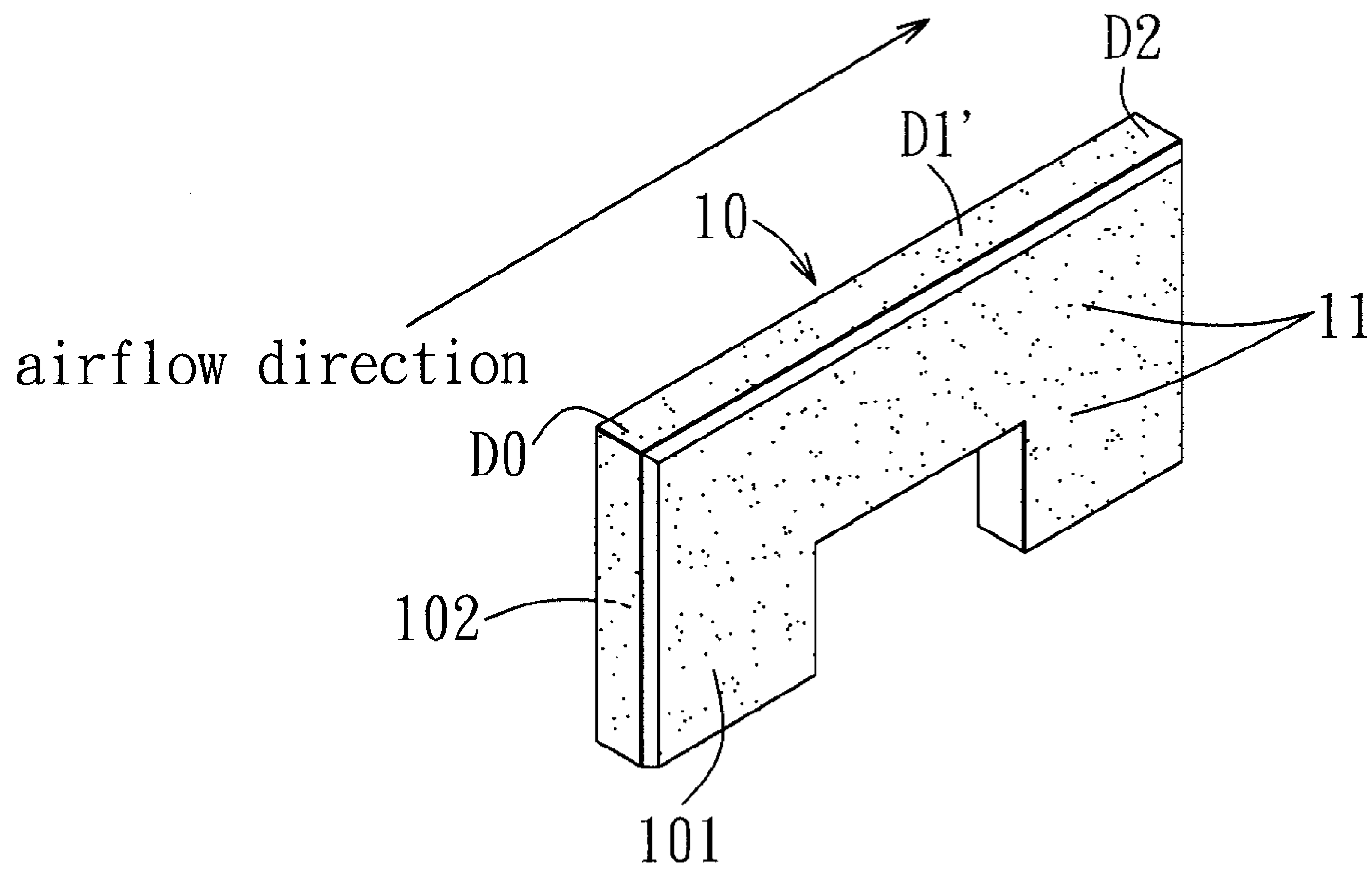

D2
D1'
10
airflow direction
11
D0
102
101

FIG. 4

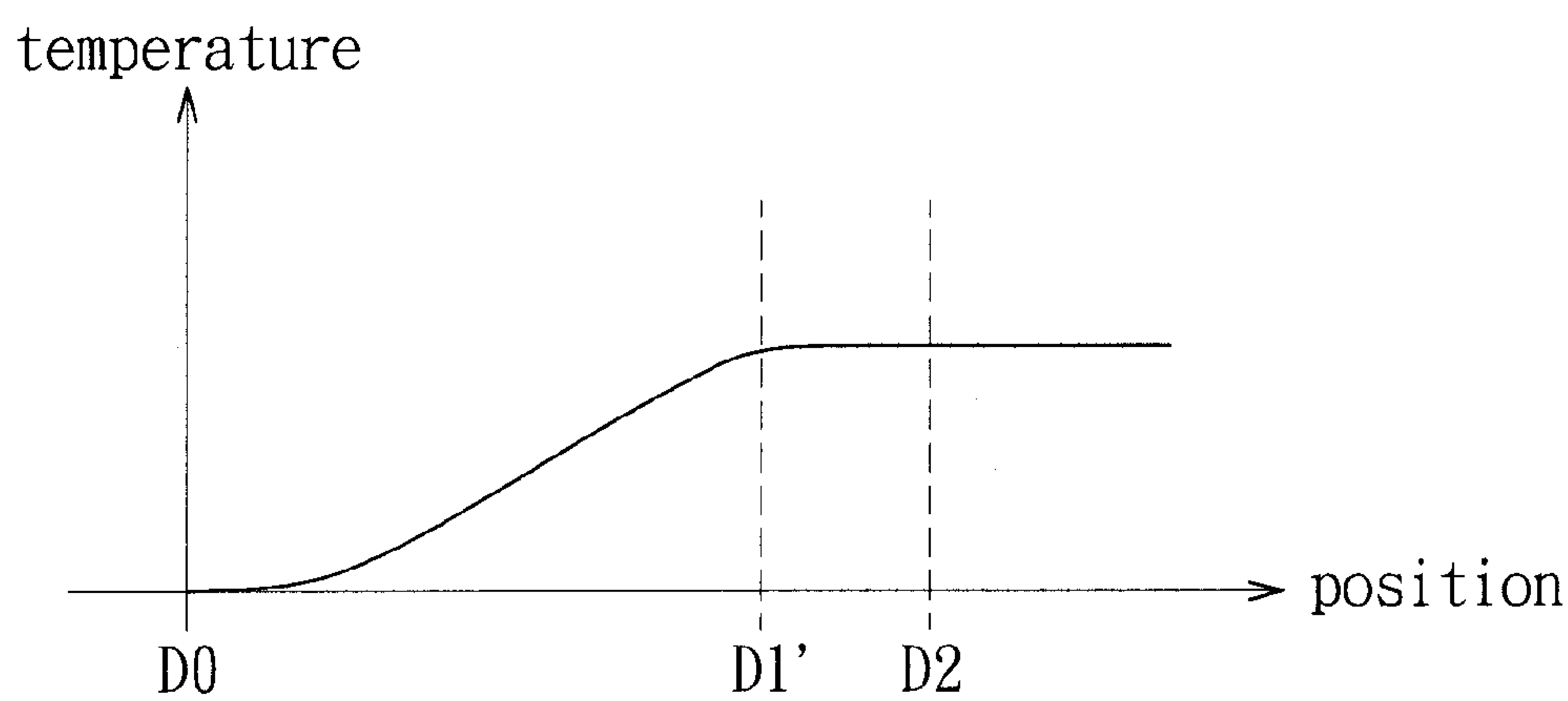

temperature
position
D0
D1'
D2

FIG. 5

HEAT-DISSIPATING FIN, HEAT-DISSIPATING DEVICE, AND METHOD FOR ENHANCING HEAT DISSIPATION EFFECT OF A HEAT-DISSIPATING FIN

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority of Taiwanese Application No. 098102029, filed on Jan. 20, 2009.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to a heat-dissipating fin, a heat-dissipating device, and a method for enhancing the heat dissipation effect of a heat-dissipating fin, more particularly to a heat-dissipating fin having a surface provided with a plurality of heat-conducting particles, a heat-dissipating device including the heat-dissipating fin, and a method for enhancing the heat dissipation effect of the heat-dissipating fin.

[0004] 2. Description of the Related Art

[0005] With the upgrading of the computing efficiency of computers, electronic components, such as central processing units (CPU), video graphics adapters (VGA), North bridge chips, etc., within a computer have to handle more and more data and to process the data at increasing speeds. Consequently, the heat generated by these electronic components during data processing correspondingly increases. Excessively high heat will seriously affect the computational stability and efficiency of the computer.

[0006] Therefore, a heat-dissipating device is generally mounted on an electronic component to help speed up dissipation of heat generated by the electronic component. However, in a notebook computer, a conventional heat-dissipating device having a plurality of heat-dissipating fins is no longer capable of achieving effective heat dissipation. The reason for this is that the space available for heat dissipation within the notebook computer is limited, so that the location for mounting the heat-dissipating device and the size of the heat-dissipating device are relatively restricted. As a result, a thermal boundary layer effect is likely to be produced during conduction of heat in the heat-dissipating device. Reference is made to FIG. **1**, which shows a conventional heat-dissipating fin **90**, and FIG. **2**, which illustrates the relationship between temperatures of the conventional heat-dissipating fin **90** measured at positions D**0**, D**1**, D**2** and the positions D**0**, D**1**, D**2** when a flow of air moves over the heat-dissipating fin **90** in a direction indicated by the arrow in FIG. **1**, wherein the y-axis represents the temperatures of the heat-dissipating fin **90**, and the x-axis represents the positions of the heat-dissipating fin **90** over which the air flows and the direction of the airflow. As shown in FIG. **1**, the air flows over the heat-dissipating fin **90** from position D**0** to position D**2**, and D**0**, D**1** and D**2** are different positions on the heat-dissipating fin **90**. Since the heat carried away by the air decreases with an increase in the distance over which the air moves, i.e., the lower the amount of heat that is dissipated, the higher will be the temperature of the heat-dissipating fin **90**, the temperature curve gradually ascends from D**0** to D**1**. However, after the air has flowed over position D**1** and continues to flow toward position D**2**, the temperature curve does not rise, which indicates that the amount of heat that can be carried away by the airflow has already reached a saturation point, so that the airflow is unable to carry away any more heat from the heat-dissipating fin **90**. This is the so-called thermal boundary layer effect. Thus, the temperature curve from D**1** to D**2** is approximately horizontal. The thermal boundary layer effect will be more evident in electronic components that generate a large amount of heat during operation. This accounts for why a notebook computer often suffers from poor heat dissipation.

SUMMARY OF THE INVENTION

[0007] Therefore, an object of the present invention is to provide a method for enhancing heat dissipation effect of a heat-dissipating fin.

[0008] Accordingly, the method for enhancing heat dissipation effect of a heat-dissipating fin of this invention comprises affixing directly and contactingly a plurality of heat-conducting particles to a part of a surface of the heat-dissipating fin.

[0009] Preferably, the heat-conducting particles are affixed to a part of the surface of the heat-dissipating fin using one of a sand-blasting technique and a sintering technique. When the method is for enhancing heat dissipation effect of more than one heat-dissipating fin, heat-conducting particles with a particle diameter not larger than one-tenth of a distance between each adjacent pair of the heat-dissipating fins are selected. In addition, the heat-dissipating fin is formed from a metal material, such as copper or aluminum, and the heat-conducting particles are formed from a metal material with a high coefficient of thermal conductivity, e.g., copper powder, aluminum powder, a mixture of copper and aluminum powders, etc.

[0010] Preferably, the distance between each adjacent pair of the heat-dissipating fins is 10^{-3} m, and the heat-conducting particles have a particle diameter of approximately 10^{-6} m. Preferably, the particle diameter of the heat-conducting particles ranges between 10^{-4} m and 10^{-6} m, and more preferably between 10^{-5} m and 10^{-6} m. From another viewpoint, it can be said that the particle diameter of the heat-conducting particles is in the order of 10^{-6} m, i.e., between 1×10^{-6} m and 10×10^{-6} m.

[0011] Furthermore, another object of the present invention is to provide a heat-dissipating fin for enhancing heat dissipation effect. The heat-dissipating fin of the present invention has a surface, at least a part of which is provided with a plurality of heat-conducting particles to increase the surface area of the heat-dissipating fin so as to reduce a thermal boundary layer effect. The heat-conducting particles are affixed to at least a part of the surface of the heat-dissipating fin using one of a sand-blasting technique and a sintering technique.

[0012] Preferably, the heat-dissipating fin is formed from a metal material, e.g., copper, aluminum, etc. The heat-conducting particles are formed from a metal material with a high coefficient of thermal conductivity, e.g., copper powder, aluminum powder, a mixture of copper and aluminum powders, etc.

[0013] Preferably, the heat-conducting particles have a particle diameter of approximately 10^{-6} m. Preferably, the particle diameter of the heat-conducting particles ranges between 10^{-4} m and 10^{-6} m, and more preferably between 10^{-5} m and 10^{-6} m. From another viewpoint, it can be said that the particle diameter of the heat-conducting particles is in the order of 10^{-6} m, i.e., between 1×10^{-6} m and 10×10^{-6} m.

[0014] In addition, a further object of the present invention is to provide a heat-dissipating device for enhancing heat dissipation effect.

[0015] The heat-dissipating device of the present invention comprises a plurality of heat-dissipating fins. At least one of the heat-dissipating fins has a surface, at least a part of which is provided with a plurality of heat-conducting particles to increase the surface area thereof so as to reduce a thermal boundary layer effect. The heat-conducting particles are affixed to at least a part of the surface of the at least one heat-dissipating fin using one of a sand-blasting technique and a sintering technique.

[0016] Preferably, the particle diameter of the heat-conducting particles is determined by a distance between the at least one of the heat-dissipating fins and an adjacent one of the heat-dissipating fins, and is not larger than one-tenth of the distance. In addition, the heat-dissipating fin is formed from a metal material, e.g., copper, aluminum, etc. The heat-conducting particles are formed from a metal material with a high coefficient of thermal conductivity, e.g., copper powder, aluminum powder, a mixture of copper and aluminum powders, etc.

[0017] Preferably, the distance between the at least one of the heat-dissipating fins and the adjacent one of the heat-dissipating fins is 10^{-3} m, and the heat-conducting particles have a particle diameter of approximately 10^{-6} m. Preferably, the particle diameter of the heat-conducting particles is between 10^{-4} m and 10^{-6} m, and more preferably between 10^{-5} m and 10^{-6} m. From another viewpoint, it can be said that the particle diameter of the heat-conducting particles is in the order of 10^{-6} m, i.e., between 1×10^{-6} m and 10×10^{-6} m.

[0018] The advantageous effect of the present invention resides in that, by forming a plurality of heat-conducting particles on the surface of the heat-dissipating fin to increase the surface area of the heat-dissipating fin, the heat dissipation effect of the heat-dissipating fin can be enhanced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Other features and advantages of the present invention will become apparent in the following detailed description of the preferred embodiment with reference to the accompanying drawings, of which:

[0020] FIG. **1** is a perspective view of a conventional heat-dissipating fin;

[0021] FIG. **2** is a plot illustrating the relationship between different positions at the conventional heat-dissipating fin of FIG. **1** and temperatures measured at the different positions;

[0022] FIG. **3** is a top view of the preferred embodiment of a heat-dissipating device according to the present invention, the heat-dissipating device being incorporated in a heat-dissipating module and mounted on an electronic component;

[0023] FIG. **4** is a perspective view of one of heat-dissipating fins of the heat-dissipating device according to the preferred embodiment; and

[0024] FIG. **5** is a plot similar to FIG. **2**, but illustrating the thermal boundary layer effect produced in the preferred embodiment according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0025] Referring to FIGS. **3** and **4**, the preferred embodiment of a heat-dissipating device **1** according to the present invention can be applied to a heat-dissipating module **2**, and can be mounted on an electronic component **3**, such as a central processing unit (CPU), a video graphics adapter (VGA), a North bridge chip, etc., to enhance dissipation of heat from the electronic component **3**.

[0026] In this embodiment, the heat-dissipating module **2** includes a fan **4**, a heat pipe **5**, and the heat-dissipating device **1**. The heat-dissipating device **1** includes a plurality of heat-dissipating fins **10**. In this embodiment, the heat-dissipating device **1** includes a plurality of inverted U-shaped heat-dissipating fins **10**, as shown in FIG. **4**. However, it is apparent from the following description that the heat-dissipating device **1** may be of any type, such as an assembly type, an integral type, etc., and may be of any shape, such as a rectangular shape, a polygonal shape, a circular shape, a radiating shape, etc. The heat pipe **5** of the heat-dissipating module **2** extends through openings of the heat-dissipating fins **10** and is tightly connected to the heat-dissipating fins **10**. Thus, heat generated by the electronic component **3** during operation can be conducted to the heat pipe **5** and to the heat-dissipating fins **10** connected to the heat pipe **5**, and the fan **4** is operated to create a flow of air so as to carry the heat away from the heat-dissipating fins **10** and hence away from the electronic component **3**.

[0027] Furthermore, in order to reduce the thermal boundary layer effect so as to permit more heat to be carried away from the heat-dissipating fins **10**, the time the air (cool air) flows over the heat-dissipating fins **10** has to be prolonged, i.e., prolonging the exchange of heat between the heat-dissipating fins **10** and the air (cool air) around them. Therefore, referring to FIG. **4**, in the heat-dissipating device **1** of this embodiment, a plurality of heat-conducting particles **11** are affixed to the surface of each of the heat-dissipating fins **10**. The heat-conducting particles **11** have surfaces that are partially in direct contact with the surfaces of the heat-dissipating fins **10** so as to increase the surface area of each of the heat-dissipating fins **10**, thereby prolonging the time needed for the air to flow over the heat-dissipating fins **10**. Reference is made to FIG. **5**, which illustrates the thermal boundary layer effect produced in the heat-dissipating fins **10** of the preferred embodiment. Compared to FIG. **2**, the point at which the amount of heat carried away by the airflow reaches a saturation point is advanced from position D**1** in FIG. **2** to position D**1'** in FIG. **5**. That is to say, the amount of heat that can be carried away by the airflow in this embodiment increases significantly in contrast to the conventional heat-dissipating fin **90** which has no heat-conducting particles **11** affixed thereto, and the thermal boundary layer effect in the heat-dissipating fins **10** is significantly reduced.

[0028] In practice, the heat-dissipating fins **10** of this embodiment are fabricated by first preparing fin bodies. In this embodiment, the fin bodies are metal plates of, e.g., copper or aluminum, and have a surface area of 400 mm^2. Subsequently, according to the distance between each adjacent pair of the fin bodies, heat-conducting particles **11** having a suitable particle size and any shape are selected. The reason for selecting suitably sized heat-conducting particles **11** is that, since the heat-dissipating device **1** generally includes a plurality of heat-dissipating fins **10** for heat dissipation, if the particle size of the heat-conducting particles **11** is too large, the heat-conducting particles **11** may be jammed between a clearance between each adjacent pair of the heat-dissipating fins **10**, which will adversely affect heat dissipation instead of enhancing it. Thus, the particle diameter of the heat-conducting particles **11** should not be larger than one-tenth of the distance between each adjacent pair of the heat-dissipating fins **10**. In this embodiment, the distance between each adjacent pair of the heat-dissipating fins **10** is 10^{-3} m. Therefore, the heat-conducting particles **11** may be copper powder particles or aluminum powder particles, and the particle diameter of the heat-conducting particles **11** may be approximately 10^{-6} m. Preferably, the particle diameter of the heat-conducting particles **11** ranges between 10^{-4} m and 10^{-6} m, and more preferably between 10^{-5} m and 10^{-6} m. From another viewpoint, it can be said that the particle diameter of the heat-conducting particles **11** is in the order of 10^{-6} m, i.e., between 1×10^{-6} m and 10×10^{6} m.

[0029] After the heat-conducting particles **11** are selected, the heat-conducting particles **11** are affixed directly and contactingly to the entire surface of each of the heat-dissipating fins **10** using a sand-blasting technique to thereby form the heat-dissipating fins **10** of this embodiment. The surface area of each of the heat-dissipating fins **10** thus formed can be increased by 100 mm^2. If the heat-dissipating device **1** has fifty-five heat-dissipating fins **10**, the overall surface area of the heat-dissipating fins **10** can be increased by 5500 mm^2, and the heat dissipation effect will be far superior to that of heat-dissipating fins without the heat-conducting particles **11**. It is noted that the heat-conducting particles **11** affixed to the heat-dissipating fins **10** are formed from a material with a high coefficient of thermal conductivity, such as a metal material or a mixture of various metal materials, like copper powder, aluminum powder, a mixture of copper powder and aluminum powder. The heat-conducting particles **11** may not necessarily be formed from the same material as the heat-dissipating fins **10**. For example, aluminum powder may be affixed to copper heat-dissipating fins **10**. Moreover, the method of affixing the heat-conducting particles **11** is not limited to sand-blasting technique, and may include sintering technique. That is, the heat-conducting particles **11** may be attached to the heat-dissipating fins **10** by sintering, spraying, gluing, etc.

[0030] Referring to FIG. **4**, each of the heat-dissipating fins **10** of this embodiment has a first surface **101** and a second surface **102**, and the heat-conducting particles **11** may be affixed to a part or parts of the first surface **101** or the second surface **102** of the heat-dissipating fins **10** or to one of the first and second surfaces **101**, **102**. In addition, in this embodiment, a plurality of the heat-dissipating fins **10** are first assembled to the heat-dissipating device **1**, and the heat-conducting particles **11** are sprayed onto the heat-dissipating device **1** in a single operation using a sand-blasting technique. On the other hand, the heat-conducting particles **11** may be sprayed onto each of the heat-dissipating fins **10** before assembling the heat-dissipating fins **10** to the heat-dissipating device **1**. Certainly, the type of the heat-dissipating device **1** is not limited to what is disclosed herein. If the heat-dissipating device **1** is not of an assembled type, the heat-conducting particles **11** can be sprayed directly and contactingly onto the heat-dissipating device **1** without being limited to this embodiment.

[0031] In sum, in the heat-dissipating device **1** of this invention, the surface area of the heat-dissipating fins **10** can be increased by affixing directly and contactingly the heat-conducting particles **11** to the heat-dissipating fins **10** using a sand-blasting technique or a sintering technique to prolong the time needed for airflow to move over the heat-dissipating fins **10** and increase the amount of heat that can be carried away by the airflow to thereby achieve a better heat dissipation effect.

[0032] While the present invention has been described in connection with what is considered the most practical and preferred embodiment, it is understood that this invention is not limited to the disclosed embodiment but is intended to cover various arrangements included within the spirit and scope of the broadest interpretation so as to encompass all such modifications and equivalent arrangements.

What is claimed is:

1. A method for enhancing heat dissipation effect of a heat-dissipating fin, comprising affixing directly and contactingly a plurality of heat-conducting particles to apart of a surface of the heat-dissipating fin.

2. The method for enhancing heat dissipation effect of a heat-dissipating fin of claim **1**, wherein the heat-dissipating fin and the heat-conducting particles are formed from a metal material.

3. The method for enhancing heat dissipation effect of a heat-dissipating fin of claim **2**, wherein the heat-conducting particles are one of copper powder particles and aluminum powder particles.

4. The method for enhancing heat dissipation effect of a heat-dissipating fin of claim **3**, wherein the heat-conducting particles are affixed to the surface of the heat-dissipating fin using one of a sand-blasting technique and a sintering technique.

5. The method for enhancing heat dissipation effect of a heat-dissipating fin of claim **4**, wherein, when said method is for enhancing heat dissipation of more than one heat-dissipating fin, heat-conducting particles with a particle diameter not larger than one-tenth of a distance between each adjacent pair of the heat-dissipating fins are selected for affixing to the surfaces of the heat-dissipating fins.

6. The method for enhancing heat dissipation effect of a heat-dissipating fin of claim **5**, wherein the heat-conducting particles have a particle diameter ranging between 10^{-4} m and 10^{-6} m.

7. The method for enhancing heat dissipation effect of a heat-dissipating fin of claim **6**, wherein the heat-conducting particles have a particle diameter ranging between 10^{-5} m and 10^{-6} m.

8. The method for enhancing heat dissipation effect of a heat-dissipating fin of claim **1**, wherein the heat-conducting particles are affixed to the entire surface of the heat-dissipating fin.

9. A heat-dissipating fin, comprising a fin body and a plurality of heat-conducting particles affixed to a part of a surface of said fin body.

10. The heat-dissipating fin of claim **9**, wherein said fin body and said heat-conducting particles are formed from metal, each of said heat-conducting particles having a surface partially in direct contact with said surface of said fin body.

11. The heat-dissipating fin of claim **10**, wherein said heat-conducting particles are one of copper powder particles and aluminum powder particles.

12. The heat-dissipating fin of claim **11**, wherein said heat-conducting particles have a particle diameter ranging between 10^{-4} m and 10^{-6} m.

13. The heat-dissipating fin of claim **12**, wherein said heat-conducting particles have a particle diameter ranging between 10^{-5} m and 10^{-6} m.

14. The heat-dissipating fin of claim **9**, wherein said heat-conducting particles are affixed to the entire surface of said fin body.

15. A heat-dissipating device, comprising a plurality of heat-dissipating fins, wherein at least one of said heat-dissipating fins has a surface, at least a part of which is provided with a plurality of heat-conducting particles.

16. The heat-dissipating device of claim **15**, wherein said heat-dissipating fins and said heat-conducting particles are formed from metal, each of said heat-conducting particles on said at least one heat-dissipating fin having a surface that is partially in direct contact with said surface of said at least one heat-dissipating fin.

17. The heat-dissipating device of claim **16**, wherein said heat-conducting particles are one of copper powder particles and aluminum powder particles.

18. The heat-dissipating device of claim **17**, wherein said heat-conducting particles have a particle diameter not larger than one-tenth of a distance between said at least one of said heat-dissipating fins and an adjacent one of said heat-dissipating fins.

19. The heat-dissipating device of claim **18**, wherein said heat-conducting particles have a particle diameter ranging between 10^{-4} m and 10^{-6} m.

20. The heat-dissipating device of claim **19**, wherein said heat-conducting particles have a particle diameter ranging between 10^{-5} m and 10^{-6} m.

21. The heat-dissipating device of claim **15**, wherein said heat-conducting particles are affixed to the entire surface of said at least one of said heat-dissipating fins.

* * * * *