ABSTRACT

A heat radiating apparatus is provided which includes at least two radiating portions positioned adjacent to one another, each of the radiating portions comprising a plurality of radiating fins, at least one heat pipe thermally connecting the radiating portions to each other, and a fan unit provided at a position corresponding to a side surface of the radiating portions and configured to generate an airflow between the radiating fins of the respective radiating portions. A heat radiating apparatus so constructed has decreased manufacturing cost and increased heat radiation efficiency.
Surface temperature of heart source: ~53.4°C

Case 1
Surface temperature of heart source: ~53.4°C

Case 2
Surface temperature of heart source: ~63.1°C

Case 3
Surface temperature of heart source: ~56.0°C

Temperature (°C) 44.9% 54.9% 64.9% 74.9%
HEAT RADiating APPARATUS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates to a heat radiating apparatus.

[0003] 2. Background of the Related Art

[0004] As the performance of electronic equipment improves, heat generated from inner parts tends to increase considerably. If the heat is not smoothly radiated, the adjacent parts, as well as the corresponding heating parts, are influenced by the heat, so that the electronic equipment does not exhibit the desired performance or is out of order due to damage to the parts.

[0005] Thus, in order to radiate the heat generated from the heat source of the electronic equipment, a heat related art heat radiating apparatus such as that shown in FIG. 1 is generally used. Referring to the FIG. 1, a casing 1 is shaped in a hexahedron both opposite faces of which are open. Radiating fins 3 each in the shape of a plate having a predetermined thickness and width are provided at regular intervals extending from one side surface to the other opposite side surface in the casing 1. Gaps between the radiating fins 3 form channels that allow air to flow from one of the open faces to the other open face of the casing 1.

[0006] Heat pipes 5 are installed to extend from the one side surface to the opposite side surface of the casing 1 to penetrate the casing 1 and the radiating fins 3. The heat pipes 5 serve to forcibly transfer the heat, which is generated by the heat source, to the radiating fins 3.

[0007] One end of each of the heat pipes 5 is connected to a heat source contact portion 7. The heat source contact portion 7, which is made of a material with a superior heat transfer rate, is installed so as to contact with a side of a heat source.

[0008] One of the open faces of the casing 1 is provided with a fan unit 9 for generating an airflow that passes between the radiating fins 3. The airflow takes the heat from the radiating fins 3, and radiates the heat outside of the heat radiating apparatus.

[0009] However, the heat radiating apparatus according to the above-described related art has at least the following problems. That is, the heat is transferred to the radiating fins 3, which are positioned a predetermined distance from the heat source contact portion 7, through the heat pipes 5. The heat is then radiated by allowing the airflow generated by the fan unit 9 to pass between the radiating fins 3. However, in the process where the heat pipes 5 cause the heat to be transferred from the heat source contact portion 7 to the radiating fins 3, the heat transfer rate deteriorates. This is due to the fact that the heat source contact portion 7 and the radiating fins 3, which are thermally connected to each other by the heat pipes 5, are relatively far from each other. In addition, since the heat source contact portion 7, the heat pipes 5, and the radiating fins 3 are not integrated but are separated from one another and they are only thermally in contact with one another, there is the disadvantage that a large space for installing the heat radiating apparatus is required.

SUMMARY OF THE INVENTION

[0010] An object of the invention is to solve at least the above problems and/or disadvantages and to provide at least the advantages described hereinafter.

[0011] In order to achieve at least the above objects, in whole or in part, and in accordance with the purposes of the invention, as embodied and broadly described herein, there is provided a heat radiating apparatus in accordance with an embodiment of the invention that includes at least two radiating portions positioned adjacent to one another, each of the radiating portions comprising a plurality of radiating fins, at least one heat pipe thermally connecting the radiating portions to each other, and a fan unit provided at a position corresponding to a side surface of the radiating portions and configured to generate an airflow between the radiating fins of the respective radiating portions.

[0012] To further achieve at least the above objects, in whole or in part, and in accordance with the purposes of the invention, as embodied and broadly described herein, there is provided a heat radiating apparatus in accordance with an embodiment of the invention that includes a first radiating portion comprising a heat source and radiating fins provided on the base plate to radiate heat, at least one heat pipe having one end thermally connected to the base plate and configured to transfer heat away from the first radiating portion, a second radiating portion thermally connected to the other end of the at least one heat pipe and configured to transfer heat away from the second radiating portion, the second radiating portion comprising radiating fins configured to radiate heat, and a fan unit installed between the first and second radiating portions and configured to cause the ambient air to pass through the first and second radiating portions and be discharged outside thereof.

[0013] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objects and advantages of the invention may be realized and attained as particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The invention will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:

[0015] FIG. 1 is a schematic perspective view of a related art heat radiating apparatus;

[0016] FIG. 2 is a schematic perspective view of a heat radiating apparatus according to an embodiment of the invention;

[0017] FIG. 3 is a schematic exploded perspective view of a portion of the heat radiating apparatus of FIG. 2;

[0018] FIG. 4 is a schematic sectional view of a portion of the heat radiating apparatus of FIG. 2;

[0019] FIG. 5 is a schematic view illustrating operation of an embodiment of the invention;

[0020] FIG. 6 is a schematic exploded perspective view of a heat radiating apparatus according to another embodiment of the invention;

[0021] FIG. 7 is a schematic perspective view of the heat radiating apparatus of FIG. 6;

[0022] FIG. 8 is a schematic sectional top view of a portion of a second radiating portion of the heat radiating apparatus of FIG. 6;
FIG. 9 is a schematic side view showing an operating state where airflow is generated by a fan unit in the heat radiating apparatus of FIG. 6; and

FIG. 10 is a graph illustrating effects of embodiments of the invention in comparison to related art.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Now, a heat radiating apparatus in accordance with embodiments will be described in detail with reference to the drawings, in which like reference numerals have been used to designate like elements.

FIG. 2 is a schematic perspective view of a heat radiating apparatus according to an embodiment of the invention. FIG. 3 is a schematic exploded perspective view of a portion of the heat radiating apparatus of FIG. 2. FIG. 4 is a schematic sectional view of a portion of the heat radiating apparatus of FIG. 2.

Referring to FIGS. 2-4, a first radiating portion 20 is provided. The first radiating portion 20 may be made of a material with a superior heat transfer rate, such as copper or aluminum. The first radiating portion 20 may comprise a base plate 22 with a predetermined thickness and area, and a plurality of radiating fins 24 may be formed on the base plate 22. The radiating fins 24 may be formed with gaps therebetween, and each radiating fin 24 may be in the form of a thin plate with a predetermined area and thickness. That is, the radiating fins 24 may protrude from the base plate 22 at predetermined intervals. However, the radiating fins 24 are not necessarily in the shape of a thin plate; other shapes may also be appropriate.

A plurality of pipe holes 26 may be bored through the base plate 22 of the first radiating portion 20 in one direction. The pipe holes 26 may be formed extending therethrough, from one side surface to the other side surface of the base plate 22. The pipe holes 26 are not necessarily bored through the base plate 22. Alternatively, they may be bored directly through the radiating fins 24.

One end of each of the heat pipes 30 may penetrate each of the pipe holes 26, respectively. The heat pipes 30 serve to transfer the heat from one end to the other end thereof, while working fluid in the heat pipes 30 is repeatedly subject to the phase change processes of evaporation and liquefaction. One end of each of the heat pipes 30 may be thermally connected to the base plate 22 of the first radiating portion 20, while the other end thereof may be thermally connected to a base plate 42 of a second radiating portion 40, which will be described below.

As set forth above, the pipe holes 26 may be bored through the radiating fins 24. In such a case, the heat pipes 26 would penetrate the pipe holes 26 provided in the radiating fins 24 and thus extend therethrough. Alternatively, the heat pipes could be positioned adjacent to the heat radiating fins 24.

Each heat pipe 30 may be bent to form a ‘U’ shape. The straight portions of each heat pipe 30 may be inserted into the pipe holes 26 and 46 of the first and second radiating portions 20 and 40, respectively, while the bent portion may protrude outwardly, as shown in FIG. 2. Thus, the heat pipes 30 are not simply inserted into the pipe holes 24 and 46, but the heat pipe 30 and the base plate 22 are connected to each other by, for example, welding in order to minimize contact thermal resistance.

The second radiating portion 40 may then be, for example, laminated on the first radiating portion 20. The first and second radiating portions 20 and 40 may be manufactured in the same configuration. That is, a plurality of plate-shaped radiating fins 44 may be formed on the base plate 42 with a predetermined area and thickness and at certain intervals. The pipe holes 46 may then be transversely bored through the base plate 42.

Alternatively, the first and second radiating portions 20 and 40 may be fastened to each other by, for example, welding. That is, upper ends of the radiating fins 24 of the first radiating portion 20 and a lower surface of the base plate 42 of the second radiating portion 40 may be fastened to each other, for example, by welding.

A fan unit 50 for generating airflow that passes between the radiating fins 24 and 44 of the first and second radiating portions 20 and 40 may be attached to the radiating portions 20 and 40. In the embodiment of FIG. 2, the fan unit 50 is attached to a side surface of the radiating portions 20 and 40. The fan unit 50 is provided with a fan driven by a motor which causes ambient air to pass between the radiating fins 24 and 44. The fan unit 50 may also be installed to be at a position opposite to that shown in FIG. 2. In such a case, the airflow generated by the fan unit 50 can pass between the radiating fins 24 and 44 of the radiating portions 20 and 40.

In addition, the fan unit 50 may be seated on a portion corresponding to distal ends of the radiating fins 44 of the second radiating portion 40 (that is, an upper face of the second radiating portion 40 with respect to FIG. 2). In such a case, the airflow generated by the fan unit 50 is directed from the distal ends of the radiating fins 44 toward the base plate 42 of the second radiating portion 40, strikes against the base plate 42, and then, is discharged to both ends of the second radiating portion 40.

Referring to FIGS. 6 to 8, another embodiment of the invention will be described. Referring to FIGS. 6-8, a first radiating portion 120 may be thermally, directly connected to a heat source, such as a central processing unit (CPU). The first radiating portion 120 may be made of a metal with a superior heat transfer rate, such as copper or aluminum. The first radiating portion 120 may be provided with a base plate 122 which is in contact with a heat source and takes the heat. The base plate 122 may be shaped in the form a substantially flat hexahedron.

A plurality of radiating fins 124 may be provided on a surface of the base plate 122, that is, a surface opposite to that in contact with the heat source. The plurality of the radiating fins 124, each of which may be in the form of a substantially quadrangular plate, may be provided at regular intervals. The heat transferred from the heat source through the base plate 122 may be transferred to airflow generated by a fan unit 150, which will be described below, from the radiating fins 124. The radiating fins 124 may be formed integrally with the base plate 122.

Heat pipes 130 may be installed so as to penetrate the base plate 122 of the first radiating portion 120. The heat pipes 130 serve to transfer the heat from one end to the other
end thereof, while working fluid in the heat pipes 130 may be repeatedly subject to the processes of evaporation and liquefaction. One end of the heat pipes 130 may be thermally connected to the base plate 122 of the first radiating portion 120, while the other end thereof may be thermally connected to a second radiating portion 140, which will be described below. Each heat pipe 130 may be bent in the form of a ‘U’. One end of each heat pipe 130 may penetrate the base plate 122 of the first radiating portion 120 via penetrating holes 126, while the other end thereof may penetrate the radiating fins 142 of the second radiating portion 140.

[0039] The second radiating portion 140 may be installed above an upper portion of the first radiating portion 120 while the fan unit 150, which will be described below, is interposed therebetween. The second radiating portion 140 is also a portion where the heat generated from the heat source is radiated. The second radiating portion 140 may be formed by connecting a plurality of the radiating fins 142. As shown in the schematic sectional view of FIG. 8, the second radiating portion 140 may be formed by, for example, laminating a plurality of the radiating fins 142 together, the cross section of each of which may be formed in a ‘[-]’ shape, with predetermined gaps formed therebetween. The structure of the second radiating portion 140 is not limited to that shown in FIG. 8; other configurations may also be appropriate. The second radiating portion 140 may be installed so that the respective radiating fins 142 are directed in the same direction as the radiating fins 124 formed on the first radiating portion 120. The radiating fins 142 may be made of a metal with a superior heat transfer rate, such as copper or aluminum.

[0040] The fan unit 150 may be provided between the first and second radiating portions 120 and 140. The fan unit 150 may generate the airflow for the heat transfer in the radiating fins 124 and 144. The fan unit 150 may generate the airflow so that the airflow passes between the radiating fins 124 and 144 and directly strikes against the base plate 122. The fan unit 150 may be provided with a fan, as well as a motor for driving the fan. Both opposite faces of the fan unit 150 may be fastened to the first and second radiating portions 120 and 140, so that the first and second radiating portions 120 and 140 are integrally coupled therewith.

[0041] Hereinafter, operation of a heat radiating apparatus according to embodiments of the invention so constructed will be described in detail.

[0042] First, referring, for example, to FIG. 5, operation with respect to one embodiment of the invention will be described. The first and second radiating portions 20 and 40 are formed by integrally forming the base plates 22 and 42 and the radiating fins 24 and 44, respectively, and are laminated in two layers and fastened to each other by, for example, welding. Then, the base plates 22 and 42 are thermally connected to each other by inserting the heat pipes 30 into the pipe holes 26 and 46 formed in the base plates 22 and 42. Then, the heat pipes 30 and the base plates 22 and 42 are fastened by, for example, welding, so that contact thermal resistance is minimized. Next, the heat radiating apparatus is completed by mounting the fan unit 50 on a side surface of the radiating portions 20 and 40.

[0043] The heat radiating apparatus so constructed is installed so that a bottom surface of the base plate 22 of the first radiating portion 20 is in contact with a heat source. For example, the base plate 22 of the first radiating portion 20 may be installed to be in contact with or adjacent to a CPU of a computer in order to radiate the heat generated by the CPU.

[0044] In a state where the heat radiating apparatus according to embodiments of the invention is installed as above, heat generated from the heat source, for example, the CPU, is transferred to the base plate 22 of the first radiating portion 20. Some of the heat transferred to the base plate 22 of the first radiating portion 20 is transferred to the heat pipes 30, and the other is transferred to the radiating fins 24.

[0045] The heat transferred from the base plate 22 of the first radiating portion 20 to the heat pipes 30 is transferred to the base plate 42 of the second radiating portion 40. Then, the heat is conducted from the base plate 42 of the second radiating portion 40 to the radiating fins 44. The airflow generated by the fan unit 50 takes the heat while passing between the radiating fins 24 and 44. That is, the airflow takes the heat and discharges the heat to outside the heat radiating apparatus while passing between the radiating fins 24 and 44 of the respective first and second radiating portions 20 and 40. If only the airflow that passes between the radiating fins 44 of the second radiating portion 40 is generated since the fan unit 50 is seated on the upper face of the second radiating portion 40, the heat transferred to the radiating fins 24 of the first radiating portion 20 is radiated by heat transfer with the ambient air flowing by natural convection. Further, the heat transferred to the radiating fins 44 of the second radiating portion 40 is transferred to the airflow generated by the fan unit 50 and is then discharged.

[0046] Next, referring to FIG. 9, operation of the embodiment of FIG. 7 will be described below. With this embodiment, the base plate 122 of the first radiating portion 120 is in direct contact with a heat source 160. Thus, the heat generated from the heat source 160 is transferred to the base plate 122.

[0047] Some of the heat transferred to the base plate 122 is transferred to the radiating fins 124 of the first radiating portion 120, and the other is transferred to the radiating fins 142 of the second radiating portion 140 through the heat pipes 130. The heat transferred to the respective radiating fins 124 and 142 is transferred to the airflow generated by the fan unit 150, and then is discharged to the outside.

[0048] That is, if the fan unit 150 operates, an airflow passing between the first and second radiating portions 120 and 140 is generated. First, the air passes through between the radiating fins 142 from an upper portion of the second radiating portion 140, and is then sucked into the fan unit 150. Here, the heat transfer occurs in the process where the air passes between the radiating fins 142 of the second radiating portion 140. That is, heat transfer from the radiating fins 142 to the air occurs.

[0049] Next, the air sucked into the fan unit 150 is delivered to the first radiating portion 120. That is, the air is delivered to the base plate 122 between the radiating fins 124 of the first radiating portion 120. In such a process, the heat is transferred from the radiating fins 124 to the air.

[0050] The air discharged from the fan unit 150 is discharged from the distal ends of the radiating fins 124 of the first radiating portion 120 toward the base plate 122. When the air strikes against the base plate 122 with a predetermined...
mined pressure, the air directly takes the heat generated from the heat source and discharges the heat. The air flowing into the first radiating portion 120 by the fan unit 150 is delivered from the distal ends of the radiating fins 124 to the base plate 122, strikes against the base plate 122, and is then discharged through both side ends of the radiating fins 124, as shown by arrow in FIG. 9.

[0051] FIG. 10 shows experimental results obtained using embodiments discussed above. Here, Cases 1, 2, and 3 show the results when heat radiation occurs using the embodiments of the invention, the related art shown in FIG. 1, and a fan and a radiating portion in direct contact with a heat source, respectively.

[0052] Temperature distribution at every portion of the respective heat radiating apparatus is represented in FIG. 10. An 80W heat source 160 is used and an environmental temperature is 35°C. As a result of the tests under these conditions, a surface of the heat source 160 when using Cases 1, 2, and 3 measures ~53.4°C, ~69.1°C, and ~58°C, respectively. As seen here, when a heat radiating apparatus according to embodiments of the invention is used, the temperature of the heat source 160 is lowest.

[0053] Although the radiating portions may be provided in two layers in the embodiments shown in the accompanying drawings, a plurality of radiating portions may be provided. Further, the base plates of the adjacent radiating portions may be thermally connected to each other using the heat pipes.

[0054] At least the following advantages are provided by embodiments of the invention.

[0055] A heat radiating apparatus according to embodiments of the invention forcibly radiates heat generated from a heat source, for example, of electronic equipment. The heat radiating apparatus according to embodiments of the invention provides a superior heat transfer rate in comparison to related art devices. Additionally, the heat radiating apparatus according to embodiments of the invention requires a minimized installation space. In addition, since the space for installing the heat radiating apparatus is minimized, it is possible to lighten, slim, simplify and compact the electronic equipment in which the heat radiating apparatus is used.

[0056] Further, since the structure for thermally connecting the heat pipes and the radiating portions is relatively simple, it is easy to manufacture the heat radiating apparatus, thus decreasing the manufacturing cost. Further, since in certain embodiments the radiating portions may be laminated in multiple layers and the base plates of the respective radiating portions may be thermally connected to each other through the heat pipes, the heat is radiated at the radiating fins provided on the respective radiating portions. Thus, there is the advantage that the radiation performance increases.

[0057] Furthermore, in certain embodiments the components of the heat radiating apparatus may be laminated or coupled to each other with isolation. Thus, since the space occupied by the heat radiating apparatus is minimized, it is possible to lighten, slim, simplify, and compact the electronic equipment in which the heat radiating apparatus is used.

[0058] The foregoing embodiments and advantages are merely exemplary and are not to be construed as limiting the invention. The present teaching can be readily applied to other types of apparatuses. The description of the invention is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents but also equivalent structures.

What is claimed is:
1. A heat radiating apparatus, comprising:
   - at least two radiating portions positioned adjacent to one another, each of the radiating portions comprising a plurality of radiating fins;
   - at least one heat pipe thermally connecting the radiating portions to each other; and
   - a fan unit provided at a position corresponding to a side surface of the radiating portions and configured to generate an airflow between the radiating fins of the respective radiating portions.
2. The heat radiating apparatus as claimed in claim 1, wherein each of the radiating portions further comprise a base plate on which the plurality of radiating fins are formed at predetermined intervals.
3. The heat radiating apparatus as claimed in claim 2, wherein the plurality of radiating fins are integrally formed on the base plate at the predetermined intervals.
4. The heat radiating apparatus as claimed in claim 2, wherein the at least one heat pipe thermally connects the base plates of the radiating portions to each other.
5. The heat radiating apparatus as claimed in claim 1, wherein the at least one heat pipe thermally connects the base plate of at least one of the radiating portions to the plurality of radiating fins of the other of the radiating portions.
6. The heat radiating apparatus as claimed in claim 1, wherein the at least two radiating portions are laminated to one another.
7. The heat radiating apparatus as claimed in claim 1, wherein the fan unit is positioned adjacent an outer side surface of the at least two radiating portions.
8. The heat radiating apparatus as claimed in claim 1, wherein the fan unit is interposed between inner side surfaces of the at least two radiating portions.
9. The heat radiating apparatus as claimed in claim 1, wherein the base plate is formed with a pipe hole in which the heat pipe is seated.
10. The heat radiating apparatus as claimed in claim 9, wherein the pipe hole is inserted into the pipe hole and welded thereto.
11. The heat radiating apparatus as claimed in claim 1, wherein the fan unit is positioned so as to cause the airflow to flow through channels provided between the plurality of radiating fins of the respective radiating portions.
12. The heat radiating apparatus as claimed in claim 1, wherein a base plate of at least one of the radiating portions is configured to contact with a heat source.
13. The heat radiating apparatus as claimed in claim 1, wherein a cross section of the radiating fins of at least one of the radiating portions is in the shape of a providing a gap
between the plurality of radiating fins when the respective plurality of radiating fins are attached to one another.

14. The heat radiating apparatus as claimed in claim 1, wherein the at least one heat pipe is in the shape of a U.

15. The heat radiating apparatus as claimed in claim 1, wherein the at least two radiating portions are formed of at least one of copper or aluminum.

16. A heat radiating apparatus, comprising:
   a first radiating portion comprising a base plate in contact with a heat source and a plurality of radiating fins provided on the base plate configured to radiate heat;
   at least one heat pipe having one end thermally connected to the base plate and configured to transfer heat away from the first radiating portion;
   a second radiating portion thermally connected to the other end of the at least one heat pipe and configured to transfer heat away from the second radiating portion, the second radiating portion comprising a plurality of radiating fins configured to radiate heat;
   a fan unit installed adjacent the first and second radiating portions and configured to cause ambient air to pass through the first and second radiating portions and be discharged outside thereof.

17. The heat radiating apparatus as claimed in claim 16, wherein the fan unit is positioned adjacent an outer side surface of the first and second radiating portions.

18. The heat radiating apparatus as claimed in claim 16, wherein the fan unit is interposed between the first and second radiating portions.

19. The heat radiating apparatus as claimed in claim 16, wherein the radiating fins of the first radiating portion are integrally formed on the base plate.

20. The heat radiating apparatus as claimed in claim 16, wherein airflow generated by the fan unit passes through gaps formed between the plurality of radiating fins provided on the respective first and second radiating portions.

21. The heat radiating apparatus as claimed in claim 20, wherein the air discharged from the fan unit passes through the plurality of radiating fins of the first radiating portion and comes into direct contact with the base plate of the first radiating portion.

22. The heat radiating apparatus as claimed in claim 16, wherein the at least one heat pipe is in the shape of a U.

23. The heat radiating apparatus as claimed in claim 16, wherein a cross section of the plurality of radiating fins of the second radiating portion is in the shape of a [ providing a gap between the respective plurality of radiating fins when the plurality of radiating fins are attached to one another.

24. The heat radiating apparatus as claimed in claim 16, wherein the first and second radiating portions are formed of at least one of copper or aluminum.

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